FIRST ANNUAL REPORT

OF THE

KANSAS EXPERIMENT STATION,

STATE AGRICULTURAL COLLEGE.

FOR THE YEAR 1888.

TOPEKA, KANSAS:
THE GEO. W. CRANE PUBLISHING COMPANY.
1889.

The Station may be addressed at Manhattan, Kansas.

KANSAS STATE AGRICULTURAL COLLEGE,
MANHATTAN, KAS., Jan. 31, 1889.

To His Excellency, Governor L. U. HUMPHREY:

DEAR SIR — I herewith transmit, as required by Act of Congress approved March 7th, 1887, the first annual report of the Experiment Station of the Kansas State Agricultural College, for the year 1888, including the financial statement to June 30, 1888.

Respectfully yours,

GEO. T. FAIRCHILD,
Secretary Board of Regents.

TABLE OF CONTENTS.

REPORT OF THE COUNCIL.

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMEN — In presenting for your consideration the first annual report of the Kansas Experiment Station in detail from the several departments, it is proper to recount facts already known to you, but of public interest, concerning the organization and progress of the work.

The Kansas Experiment Station owes its existence to the enactment by Congress of a measure entitled "An Act to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July 2, 1862," which received the assent of the President March 2, 1887. The conditions of this measure, commonly known as "The Hatch Act," were promptly accepted by the Legislature, in a resolution dated March 3, 1887, by which the responsibility of carrying out the provisions of the law was vested in the Board of Regents of the Kansas State Agricultural College.

On account of the failure of the congressional enactment to make the necessary appropriation, no action was taken by the Board in the matter until after the passage by Congress of a special appropriation bill, approved by the President February 1, 1888, by which the Station received $15,000, to be applied to the liquidation of the expenses of the then current year.

On February 8, the Board of Regents organized the Station, in a series of resolutions, in which it is provided among other things — (1) that the general executive management of the Station shall be under the control of a council consisting of the President of the College and the Professors of Agriculture, Horticulture and Entomology, Chemistry, Botany, and Veterinary Science; (2) that the President of the College shall be *ex officio* chairman of the Council, and the Professor of Agriculture *ex officio* Director and general superintendent in executing the plans of the Council; and (3), after detailing minutely the duties of each officer, it is stated that each member of the Council shall have full control of work assigned to his department — choosing his own assistants, subject to ratification by the Council.

The Council thus organized met for the first time on February 10th. Subsequently, during the College year, meetings, with very few exceptions, have been held weekly, and during the time of the College vacation at less frequent intervals. At these meetings questions pertaining to the scope, value and practicability of all the proposed experimental undertakings of each department together with the form and character of all publications and all proposed purchases of every nature, have received full discussion and final action. As a result of its deliberations, the Council has adopted a few general rules, keeping quite within the limit of its powers as fixed by the Board, the principal of which are as follows: *First,* all experimental undertakings in any department must first receive the sanction of the Council; and, *Second*, all wants in any department not provided for by direct action of the Board may only be supplied by purchases authorized by the Council.

Attendance upon the meetings of the Council has been well sustained, and action upon every question has been taken only after full investigation and discussion. So far with us, the method of government by the Council has been eminently successful. Instead of a half-dozen semi-independent and ofttimes rival departments, the Station force has acted through the Council as a unit.

Agreeable to section 4 of the congressional act, which provides “that bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall he sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same," editions of five different bulletins have been issued. Bulletin No. 1, issued in April, gives the organization, equipment, and to some extent, aims of the Station. No. 2, also issued in April, details the experiences of fourteen years with cultivated grasses and clovers at the College farm. In June, No. 3, giving the life history of two orchard pests, appeared; and in September, No. 4, giving experiments with varieties and methods of cultivating wheat, was issued. The latest bulletin published, No. 5, is devoted to a comparison of varieties of sorghum and observations on the sorghum blight. The bulletins have been issued in uniform editions of 7,000 copies, except in the case of No. 2, of which 9,000 copies were printed.

There has been a steadily increasing popular demand for the Station publications ever since the first bulletin was issued. At the present time our mailing list contains something over 5,000 names. If the present rate at which demands for Station publications are received is continued, it is plain that in the near future the editions of Station publications must be largely increased.

The work of printing the bulletins has been done by the Printing Department of the College in a manner creditable to the department and very satisfactory to the Council.

The duty of distributing the bulletins and maintaining the extensive correspondence awakened by the increasing interest in the Station shown throughout the State has been borne by the Director in all details, as contemplated by the Board. Full minutes of all meetings of the Council are kept by him in the record book provided for them, and all vouchers have required his approval before entry upon the books of the Secretary of the College.

For the work actually done and under way in the departments of the Station, you are referred to the subjoined reports. While these reports bring the work down to the end of 1888, the actual life of the Station has been less than eleven months. During this time apparatus and supplies of all kinds had to be procured, and one department — the Veterinary — created outright. One building, used for offices and laboratory by the Horticultural Department, has been erected, with extensive propagating pits complete in every respect; and barns and other buildings have been repaired and specially arranged for the new work. The Veterinary Department dates its existence from May 1st., at which time Dr. Burleigh entered upon his duties as Veterinarian of the Station. The facts that laboratory room and all apparatus had to be wholly provided for the new department, and the lack of proper subjects of work, due to the general healthfulness of farm stock, is a sufficient explanation of the absence of a report from the Department of Veterinary Science.

Assistants have been appointed in the several departments as fast as the services of competent men could be secured. Mr. H. M. Cottrell entered upon his duties as Assistant in Agriculture February 13th; Mr. S. C. Mason, Foreman of Gardens, March 14th; Mr. J. T. Willard, Assistant in Chemistry, July 1st; and Mr. W. T. Swingle, Assistant in Botany, March 1st. Wm. Shelton, Foreman of the Farm, and Chas. L. Marlatt, Assistant in Entomology, have been in the service of the Station since its organization.

For a full statement of the work on hand, incomplete, and so not reported herewith, you are referred to the accompanying reports of the heads of the several departments of the Station. These reports, however, it should be remembered, are but the record of beginnings. Not much may reasonably be expected in the way of results from the labors of a single season given to the work of experiment, particularly when that season has been largely one of preparation. The work of the year, as far as it has been carried to completion, has been to those having it in charge very satisfactory, and the Council feels justified in the full assurance that the Station will be a growing power for good to the agricultural community.

The Council points with satisfaction to the fact that a very large proportion of the work of the Station is done by students and graduates of the College. The College supplied without delay the trained minds and hands needed in the work of investigation peculiar to the Experiment Station.

We desire in conclusion to express our appreciation of the interest in the Station shown in many ways by the farming community, and to the press of the State for its generous aid in bringing to the notice of the public the character and aims of the Station, as well as results obtained.

GEO. T. FAIRCHILD.
E. M. SHELTON.
GEO. H. FAILYER.
E. A. POPENOE.
W. A. KELLERMAN.
R. F. BURLEIGH.

COLLEGE, December 31st, 1888.

ACKNOWLEDGMENTS.

The Council gladly acknowledges the receipt by the Station of donations of plants, seeds, *et cetera,* as noted below. These have been assigned to the different departments of the Station to which as shown by their character they seem to belong.

As far as is consistent with the regular work of the departments, articles of public interest donated to the Station will be tested in the Station department to which they belong, and reported upon in the regular Station publications:

F. BARTELDES & Co., Lawrence, Kas., seedsmen: A collection of foreign grass seeds, 2 packages of 2 varieties of field corn, 1 package each Espersette Clover and Teosinte.

JAMES BOUK, Greenwood, Neb., seedsman: 8 packages garden seeds, one ear each 5 varieties field corn and 1 lb each 7 varieties potatoes.

U. S. DEPARTMENT OF AGRICULTURE, Washington, D. C.: 8 packages 2 varieties sorghum, 5 packages field corn, 8 packages forage plants, 48 packages garden seeds and 90 packages tree seeds.

TRUMBULL, REYNOLDS & ALLEN, Kansas City, Mo., seedsmen: 1 package Teosinte.

PETER HENDERSON & Co., New York, seedsmen: 7 packages garden seeds.

H. L. RAGLAND, Hyco, Va.: 6 varieties tobacco seed.

PROF. WM. C. STUBBS, Kenner, La.: 5 varieties sorghum seed.

EX-GOV. G. W. GLICK, Atchison, Kas.: Field corn, 2 varieties.

R. T. PIERCE, Monaskon, Va.: 2 varieties wheat.

JAMES RILEY, Thorntown, Ind.: 5 varieties wheat.

W. P. CLEMENT, Sterling, Kas.: Seed of several varieties of sorghum.

W. ATLER BURPEE & Co., Philadelphia. Pa., seedsmen: 14 packages garden seeds, 18 packages flower seeds.

THE A. B. CLEVELAND Co., New York, seedsmen: 28 packages garden seeds.

J. A. EVERETT & Co., Indianapolis, Ind., seedsmen: 1 seed potato.

BASSLER BROS., Manhattan, Kas., seedsmen: 3 lb lots of seed potatoes.

B. T. SMITH, Lawrence, Kas.: 7 varieties of strawberry plants, 1 variety of raspberry.

A. H. GRIESA, Lawrence, Kas.: 2 pear trees.

NIXON MANUFACTURING Co., Dayton, 0.: 1 “Little Gem” machine,

P. C. LEWIS, Catskill, N. Y.: 1 Lewis combination force pump.

FINANCIAL STATEMENT

REPORT OF THE TREASURER.

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMEN—Herewith find my report of the Experiment Station fund for the fiscal year ending June 30th, 1888:

Received from the Treasurer of the United States	$15,000
Paid approved vouchers	15,000

Respectfully submitted. JNO. E. HESSIN, *Treasurer.*

MANHATTAN, KAS., December 31, 1888.

REPORT OF THE DIRECTOR.

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMEN — Herewith is submitted the financial report of the Experiment Station of the Kansas State Agricultural College, for the fiscal year ending June 30, 1888.

The accounts of the Station have been kept by Mr. I. D. Graham, Assistant Secretary of the Board of Regents, in books provided especially for this purpose, from which the subjoined summary has been made:

The several items here named have been paid out through distinct vouchers, duly approved as ordered by the resolution of the Board adopted February 8, 1888, which provided that "The funds of the Station shall be held strictly to the purposes contemplated in the act of Congress, in a separate account on the books of the Secretary and Treasurer, with distinct vouchers for all expenditures, which shall be audited and paid as other vouchers for special appropriations." Duplicate vouchers covering the entire expenditures of the year are on file in the office of the Secretary of the College.

DR.

1888. — To appropriating for the year ending June 30, 1888, under act of Congress, approved March 2, 1887	$15,000 00

CR.

June 30. By	Salaries	$3,341 83
"	Labor	579 32
"	Buildings	2,612 39
"	Apparatus	5,698 70
"	Supplies	846 74
"	Printing	419 90
"	Stationery	215 90
"	Postage	26 80
"	Library	80 50
"	Freight and expressage	356 37
"	Live stock	792 00
"	Traveling expenses	29 55
	Total	$15,000 00

Respectfully submitted. E. M. SHELTON, *Director.*

We, the Finance Committee of the Board of Regents of the Kansas State Agricultural College, having duly examined vouchers Nos. 1 to 286 for $15,000 received and expended on account of the Experiment Station during the fiscal year ending June 30, 1888, and having diligently compared the same with the books of the Secretary, hereby certify both books and vouchers to be correct, according to the statements furnished by the Treasurer and the Director.

THOS. HENSHALL,
E. N. SMITH,
JOSHUA WHEELER,
Committee.

REPORT OF THE FARM DEPARTMENT.

E. M. SHELTON, M. Sc., Director, *Professor of Agriculture.*
H. M. COTTRELL, M. Sc., *Assistant in Agriculture.*
WM. SHELTON, *Foreman of Farm.*

The thought underlying the work of this department has been to apply accurate tests, as far as possible, to all the operations of Kansas farming as practiced in this locality. To this end experiments were begun in different lines as follows:

Corn — Methods of planting, cultivating and harvesting.
Wheat — Varieties and methods of cultivation.
Grasses and forage plants.
Sorghum — Varieties and methods of cultivation, for forage and sugar.
Oats — Varieties and methods of cultivation.
Experiments with methods of preserving farm yard manure.
Experiments in feeding steers to test different foods.
Experiments in feeding pigs with different foods.
Experiments to show the influence of different foods, in milk and butter production.
Experiments with silos and in the making of ensilage.

The feeding experiments and those made with silos and ensilage must, on account of their incompleteness, be reserved for future publications of the Station. The experiment with oats was early brought to grief by an invasion of chinch bugs.

The tests of sorghum are fully reported by the professor of chemistry.

The work of the department has been apportioned among the assistants as follows: Mr. Wm. Shelton, foreman of the farm, has had the responsibility of all teams, tools, and the labor of all men and students concerned in the general operations of the farm: Mr. H. M. Cottrell, assistant in agriculture, has been responsible for the details of special experimental work in all the lines undertaken. Advanced students have in many cases proved efficient helpers in field and office work, often sharing responsibility as foremen and assistants in work demanding precision and scientific knowledge.

WASTE OF MANURE IN SUMMERING IT IN THE YARD.

It has always been a question with me which was the better policy — to haul manure soon after it was made, or at least in early spring or allow it to remain untouched in the yard or "corral" over summer, hauling it afield when work begins to slacken after wheat sowing in the fall.

There are valid arguments for both plans. Manure in the spring season is certain to be very bulky and very heavy. Besides this coarse, strawy manure, when plowed under — a difficult task always — leaves most Kansas soils too loose; and then this unfermented dung is "cold" and slow in action. On the other hand, the winter crop of manure carried through the summer season changes rapidly into a festering mass, making the barn-yard a quagmire of filth and a breeding place for insect pests and most important the waste of the manure in bulk and quality during one of our torrid summers is enormous. But how much? To answer this query, the experiment, the subject of this chapter, was planned and carried out.

There are nearly as many methods of preserving manure as there are barns and barn-yards. The all-too-popular method over the West is to leave the manure in the corral until it has accumulated in such masses that either the corral must be abandoned or the manure hauled somewhere. A number of cases have come under my observation where the location of the yard had been changed as the manure accumulated, it having been found easier to move the fence than the enclosed manure.

This fact simply serves to show the light esteem in which farm-yard manure is held by the pioneer. As the pioneer condition has passed away, the value of the product of the barn-yard, the principal source of soil fertility, has come to be better appreciated by our farmers.

Leaving out expensive methods of handling manure, as with box stalls, covered barn-yards and manure cellars, manures may be and ordinarily are carried in the barn-yard according to two principal ideas, which are variously modified to suit local conditions.

Manures are aften piled in loose flat or conical heaps against a building or fence. Such manures are certain to dry out rapidly, becoming "fire-fanged" and well nigh valueless within a couple of months. Farm-yard manures are often preserved by being allowed to accumulate evenly over the yard, and kept compact by the frequent passage over them of the farm animals, due precaution having been taken against "leaching."

This in our experience, I may say, has proved the cheapest and most satisfactory way of carrying manures for a time, greater or less, in the yard. Not unfrequently — especially where manures are to be carried in mass for a considerable time — gypsum is sprinkled liberally over the increasing accumulations of the barn-yard; the effect of the gypsum being, it is asserted, to prevent decomposition. To test the three methods of preserving manures outlined above, side by side with the familiar practice of placing the manure pile on a slope favorable to the leaching process was the object of this experiment.

Four small enclosures, each about ten feet square, with corner posts, and boarded up to the height of three feet, were made upon a level tract of ground near the barn-yard. From three of these — yards 1, 2 and 3 — the surface earth to the depth of about one foot was removed over the enclosed area. They were then floored with loose boards, for convenience in shoveling the manure from the yard, when the time of emptying should come. Yard 4 was located on the surface of a gentle and smooth slope which greatly favored the passage of surface water to a neighboring brook. The manure employed in this experiment was mostly from stable fed cattle. It was very rich and uniform in texture and quality throughout. In filling the yards received one load at a time in regular order, beginning with yard No. 1. In this way the work of filling the yards was completed in the case of each at the same time, practically.

The work of filling was begun April 7 and completed April 11.

The treatment given the contents of each yard is concisely stated as follows:

YARD No. 1. — Contents five (5) tons of manure thrown in loosely.

YARD No. 2. — Contents four and three-fourths (4¾) tons of manure loosely piled, intimately mixed with 500 lbs. of gypsum.

YARD No. 3. — Contents five (5) tons manure firmly packed in filling.

YARD No. 4. — Contents five (5) tons manure loosely piled, with excellent drainage at bottom.

The manure in the yards remained untouched — except as samples were taken for analysis — until October 31st, when the manures were taken from the yards and carefully weighed with results as stated below. The date October 31st was selected for the time of the final examination of the manures, because at that time they seemed, as nearly as could be judged, in the same condition as to moisture as when the experiment was begun.

I am indebted to Prof. G. H. Failyer, Chemist of the Station, for the chemical estimations of per cent. of water and nitrogen given in the subjoined table.

YARD No. 1.
(Manure piled loosely.)

	Gross weight, lbs	Per cent. of water	Dry substance of manure, lbs	Per cent. of nitrogen of dry substance ..	Contained nitrogen, lbs ....
Original manure, April 11, 1888	10,000	66.86	3,314	1.78	58.99
Manure October 31, 1888.................	5,170	71.29	1,484	2.52	37.40
Differences, gains (+), losses (—), in 203 days................................	-4,830	+4.43	-1,830	+0.74	-21.59
Per cent. of loss in 203 days............	48	....	55	....	38

YARD No. 2.
(Manure piled loosely, with 5.2 per cent of gypsum.)

	Gross weight, lbs	Per cent. of water	Dry substance of manure, lbs	Per cent. of nitrogen of dry substance	Contained nitrogen, lbs
Original manure, April 11, 1888, (Manure, 9,500 lbs., gypsum, 500 lbs.)	9,500	66.86	3.038	1.78	54.07
Manure. October 31, 1888	5,415	61.60	2.079	1.63	33.88
Differences, gains (+), losses (—), in 203 days..................................	-4,085	-5.26	-959	-0.15	-20.19
Per cent. of loss in 203 days...........	43	....	31	....	37

YARD No. 3.
(Manure packed solid.)

	Gross weight, lbs	Per cent. of water	Dry substance of manure, lbs	Per cent. of nitrogen of dry substance	Contained nitrogen, lbs
Original manure, April 11, 1888	10,000	66.86	3,314	1.78	58.99
Manure, October 31, 1888	6,180	69.35	1,895	1.96	37.14
Differences, gains (+), losses (—), in 203 days.................................	-3,820	+2.49	-1,419	+0.18	21.85
Per cent. of loss in 203 days...........	38	....	42	....	37

YARD No. 4.
(Manure loosely piled, wih free leaching.)

	Gross weight, lbs	Per cent. of water	Dry substance of manure, lbs	Per cent. of nitrogen of dry substance	Contained nitrogen, lbs
Original manure, April 11, 1888	10,000	66.86	3,314	1.78	58.99
Manure, October 31, 1888...............	4,730	66.69	1,576	2.28	35.93
Differences, gains (+), losses (—), in 203 days................................	-5,270	-0.17	-1,738	+0.50	23.06
Per cent. of loss in 203 days...........	53	....	52	....	39

We see from these tables that the outgo of nitrogen, the only element of farm-yard manure worth money, was not materially affected by any of the different methods of piling the manure. The loss of nitrogen was nearly the same in all the yards, the variation being so slight as to amount to nothing.

On the other hand, the shrinkage of the gross manure and of its dry substance varied very greatly in the different yards, the loss of manure in its ordinary condition being least where it was packed solid; while the loss of dry substance of manure was least where gypsum was mixed with the manure. The packing seems to have been influential alone in checking the escape of water.

It is an interesting question, but one upon which this experiment throws no light — whether the escape of nitrogen did not take place earlier in some of the yards than in others. In other words, did the special treatment in any case tend to check the outflow of nitrogen?

The moral which the experiment plainly emphasizes is, that farm-yard manures must be hauled to the field in the spring; otherwise the loss of manure is sure to be very great, the waste in the course of six months amounting to fully one-half the gross manure and nearly forty per cent of the nitrogen which it contained.

EXPERIMENTS IN THE CORN FIELD.

As a foundation of more scientific work, to be undertaken in coming years, it has seemed to me of first importance that the work of the farm should in the outset be largely devoted to securing accurate data regarding all local farm crops and methods. Without an accurate knowledge of the gains and losses of common practices, it is certain to be difficult, if not impossible, in many cases, to make a direct application of the lessons of science. How shall we speak certainly of the needs of agriculture, and how shall we apply the remedy, if we are ignorant of its present condition and the possibilities that lie concealed beneath the rubbish of existing methods?

With the object of learning more of the relative values of some of the common methods by which the corn crop is "made," experiments in the cultivation and management of the great western staple have been carried out at this station during the cropping season last past.

On many accounts Indian corn is likely to be a favorite crop with experimenters. The peculiarly flexible constitution of the plant, the possibility it offers of accurate planting, and of cultivation during the period of its growth, and its quick response to liberal treatment — to say nothing of the intrinsic importance of the crop — are some of the facts which make the crop most attractive to the systematic worker. A long and familiar acquaintance with the great cereal as cultivated in the West has convinced me, that very few farmers indeed cultivate this crop nearly up to its full capacity. A few facts regarding the simple process of planting will serve to illustrate my meaning.

INACCURACY IN PLANTING.

A field of twelve acres was drilled to corn, early in May, one of the standard drills, a machine in good order, having been used for this purpose. The soil was in excellent tilth, the ground having been plowed the previous fall, and again just before planting time. The drilling was as nearly as possible a continuous operation, the work having mostly been done on May 2d. The resulting "stand" of corn was pronounced by practical men to be an excellent one. There were very few considerable blank spaces in the rows, and not noticeable crowding. A closer examination, however, showed great irregularity in the spaces occupied by the corn plants. There was no semblance of that equal division of the ground among the different plants, of which this plant of all others is most capable. That this was due to faults in the action of the drill seems to be proved by the fact already stated, that the ground was in good tilth, and by the further fact, that the seed when tested in a germinating apparatus showed ninety-nine (99) per cent. of sound kernels. To test this variableness in the planting of the different rows, one hundred and fifty (150) feet of one hundred (100) rows on the two opposite sides of the field were measured off for examination. As soon as the plants had seemingly passed the ordinary exigencies of the early growing state (July 7th) and had secured a permanent hold upon the soil, the stalks in each were counted. The enumeration showed variations in the number of corn plants occupying each row, *extending all the way from sixty-two to one hundred and forty-three.*

To show something of the meaning of this variation, seventy-five (75) rows located upon the portion of the field most uniform as to soil were selected for further examination. These rows were carefully husked and weighed during the first week of October, and with the figures thus obtained as a basis, computations of the yield per acre as given in the subjoined table were made:

TABLE No. 1.

NUMBER OF ROW.	*No. of stalks in row (150 ft.)....*	*Yield of row in corn, lbs ....*	*Yield per acre, bush. of 75 lbs...*	NUMBER OF ROW.	*No. of stalks in row (150 ft.)....*	*Yield of row in corn, lbs ....*	*Yield per acre, bush. of 75 lbs...*
1..................	138	31	34.41	13..................	110	30	33.30
2..................	143	25½	28.30	14..................	107	40	44.40
3..................	128	36	28.86	15..................	91	39	43.29
4..................	119	32	35.52	16..................	92	35½	38.40
5..................	98	31	34.41	17..................	95	39	43.29
6..................	94	33	36.63	18..................	105	39	43.29
7..................	87	33	36.63	19..................	123	36	39.96
8..................	89	25	27.75	20..................	103	40½	44.95
9..................	96	30	33.30	21..................	98	37	41.07
10..................	106	33	36.63	22..................	101	40	44.40
11..................	111	35	38.85	23..................	100	40	44.40
12..................	97	31	34.41	24..................	100	38	42.18

TABLE NO. 1 - CONTINUED.

NUMBER OF ROW.	No. of stalks in row (150 ft.)....	Yield of row in corn, lbs	Yield per acre, bush. of 75 lbs....	NUMBER OF ROW.	No. of stalks in row (150 ft.)....	Yield of row in corn, lbs	Yield per acre, bush. of 75 lbs....
25..................	96	39	43.29	76................	108	53½	59.38
26..................	85	35	38.85	77................	128	51	56.61
27..................	100	40	44.40	78................	117	54	50.94
28..................	84	37½	41.62	79................	111	55	61.05
29..................	129	38	42.18	80................	108	49½	54.95
30..................	126	38	42.18	81................	122	60	66.60
31..................	104	38	42.18	82................	110	51½	57.17
32..................	107	33	36.63	83................	107	59½	66.05
33..................	94	29½	32.74	84................	98	47½	52.73
59..................	87	22	24.42	85................	92	49	54.39
60..................	94	26	28.86	86................	96	49½	54.95
61..................	86	22	24.42	87................	102	54½	60.50
62..................	84	31	34.41	88................	99	52½	58.28
63..................	75	27	29.97	89................	122	47½	52.73
64..................	97	38	42.18	90................	118	64	71.04
65..................	92	34	37.74	91................	110	56½	62.72
66..................	112	46	51.06	92................	128	59½	66.05
67..................	110	39	43.29	93................	127	56	62.16
68..................	119	52½	58.28	94................	108	60	66.60
69..................	118	46	51.06	95................	126	63½	70.49
70..................	121	54½	60.50	96................	117	53	58.83
71..................	142	56½	62.72	97................	112	51	56.61
72..................	119	53½	59.38	98................	106	55	61.05
73..................	118	52½	58.28	99................	117	67	74.37
74..................	108	54	59.94	100................	122	53	58.83
75..................	142	51	56.61				

SUMMARY.

NUMBER OF STALKS IN ROWS OF 150 FEET.	Av. space in. separating stalks	Yield of row, lbs	Yield per acre, bush
75	24	27.00	29.70
84– 89	17	29.35	32.28
91– 95	19	35.67	39.23
96–100	18	39.46	43.40
101–105	17	42.40	46.64
106–110	17	47.26	51.98
111–112	16	46.75	51.42
117–119	15	52.72	57.99
121–123	14	50.20	55.22
126–129	14	47.42	52.16
138–143	12	33.25	45.10

These figures certainly present a most striking and instructive array of facts bearing upon the fundamental operation of planting. We see in the summary groups of rows varying in their rate of yield all the way from nearly thirty (29 7/10) to almost fifty-eight (57 99/100) bushels per acre, the variation due seemingly to differences in planting alone. But as these figures are only the mean of a considerable number of rows, we must look to the original figures (Table No. 1) for the actual yield of the different rows. We here see sorts of variations between the extremes twenty-four and a fraction (24 42/100) and seventy-four and a fraction (74 37/100) bushels per acre. Nor do these facts, striking as they are, show the whole truth. We must remember that the seed, whether thickly or sparingly distributed, was irregularly strewn, a crowded area being succeeded by blank spaces, large or small, in perhaps every row; so that even where the correct or least correct amount of seed was used, the complete influence of the particular seeding is not shown. The figures show that, with the variety of corn here employed (a medium large Dent), the largest yield was obtained when the kernels of seed were placed fourteen to sixteen inches apart in the rows — the drill was set to deposit kernels sixteen inches apart — and slight deviations from this, whether in the direction of increased or diminished seeding, were promptly followed by a diminished yield.

Few will doubt that facts similar to the above can be furnished by every corn field in Kansas, and for that matter the entire West. It seems clear too, that the maximum yield shown in the summary (57 99/100 bushels) could with proper planting have been made the average yield of the entire field; and this might have been raised with as small cost in labor as was expended for the lowest yield (29 7/10 bushels) of the summary.

That we get from our corn fields nothing like what they ought to yield us, is the plain corollary of the above facts. If the single operation of planting, important as it is, affects the crop so materially, what may we expect when to faulty seeding is added insufficient plowing and imperfect cultivation. The average yield of corn in Kansas during such favorable seasons as 1885 is reported by the Secretary of the State Board of Agriculture (see report Secretary Kansas State Board of Agriculture, 1885–6, p. 600) at thirty-three bushels per acre. The average yield of the State during favorable seasons ought not to be less than forty-five bushels per acre, and a little more knowledge, with resultant better practices, would carry the average yield of the great staple in Kansas up to fifty bushels per acre.

EXPERIMENTS WITH VARIETIES.

The growing of numerous varieties of corn, with the view to an accurate comparison of results, is a most unsatisfactory task. If the sorts are planted side by side, they are sure to hybridize more or less, whatever precautions may have been taken; while any facts obtained from different varieties grown upon areas considerably separated must be explained in part by variations in soil used in the experiment. Moreover, different kinds of corn demand widely different areas of ground, and corresponding differences in cultivation and general treatment — requirements not easily supplied where equal plats of ground, ranged side by side, are used.

Thirty varieties of corn, exclusive of a few ensilage sorts and a few standard varieties, were grown upon the College farm during the past agricultural season. Four rows, each two hundred and thirty-three and a half (233 1/2) feet long were planted of each variety, and three and a half foot spaces separated the rows. The planting was done April 28th, with a drill set to drop a kernel of seed every twenty inches. The field (No. 4) in which this experiment was tried had grown miscellaneous crops almost continuously since the time when it was "broken up," in 1872. The portion used for this trial was fairly well suited to the purpose to which it was put. The soil - a strong clay loam of quite moderate fertility—was, however, quite foul, so that clean cultivation was very difficult. To avoid, as far as possible, the danger of hybridization, the sorts believed to differ most in habits of growth were placed in adjacent plats. Despite our care, however, there was considerable crossing of contiguous sorts. In table No. 2 is given, in statistical form, some of the facts observed in connection with each variety here employed. In regard to the omission of accurate data bearing on the yields obtained, it is sufficient here to say, that on account of the imperfect stand obtained with several varieties, and the necessity of employing several of the sorts in the investigation of other questions — notably the influence of cutting corn at different stages of ripeness — no perfectly accurate record could be made of the amount of the yield in each case.

TABLE No. 2.

NAME OF VARIETY.	When tasseled.	Grain in "milk" state.	Grain glazed.	Height of stalk, feet	Height of ear above ground.	REMARKS.
Southern Horse Tooth	July 15	Aug. 2	Aug. 30	9½	5½	Dent from Peter Henderson & Co.
Improved Shoe Peg	July 16	Aug. 5	Aug. 30	10	6	Dent from H. Sibley & Co.
Queen of the Prairie	July 9	Aug. 1	Aug. 13	9	4	Dent from Peter Henderson & Co.
White Giant Normandy	July 13	Aug. 2	Aug. 25	11	5½	Dent from F. Barteldes & Co.
Golden Beauty	July 10	July 30	Aug. 27	9	4½	Dent from U. S. Dept. of Agr.
Mammoth White Surprise	July 16	Aug. 2	Aug. 21	10½	5	Dent from Peter Henderson & Co.
Ellm's Early Yellow	June 23	July 26	Aug. 2	6	2	Dent from Parker & Woods.
Champion White Pearl	July 4	July 28	Aug. 5	7	4	Dent from F. Barteldes & Co.
Hickory King	July 13	Aug. 2	Aug. 25	9½	5	Dent from F. Barteldes & Co.
Pride of the North	July 6	Aug. 1	Aug. 6	9	4½	Dent from F. Barteldes & Co.
Early Golden Lenawee	July 4	July 26	Aug. 5	7	3½	Dent from D. M. Ferry & Co.
Bullock's White Prolific	July 16	Aug. 2	Aug. 29	11½	6	Dent from H. Sibley.
Leaming	July 6	Aug. 1	Aug. 7	9	4½	Dent from Peter Henderson & Co.
Early White Dent	July 10	July 31	Aug. 20	8½	4½	Dent from Mark W. Johnson.
Murdock's	July 6	Aug. 1	Aug. 14	10	4½	Dent from Plant Seed Co.

TABLE NO. 2—CONTINUED.

NAME OF VARIETY.	When tasseled.	Grain in "milk" state.	Grain glazed.	Height of stalk, feet.	Height of ear above ground.	REMARKS.
Compton's Early	June 23	July 26	Aug. 2	6	2	Flint from Peter Henderson & Co.
Farmer's Favorite Golden Dent	July 10	Aug. 1	Aug. 14	10	5	Dent from Peter Henderson & Co.
Shield's Stooling Flour	July 26	Aug. 29	Sept. 13	8	5	Soft from Plant Seed Co.
Yellow Mammoth	July 9	July 31	Aug. 25	10	4	Dent from Plant Seed Co.
Waushakum	June 29	July 25	Aug. 7	5	1½	Flint from Parker & Woods.
Early Yellow Hathaway	July 4	July 28	Aug. 6	7	3½	Dent from D. M. Ferry & Co.
Chester County Mammoth	July 10	Aug. 2	Aug. 18	9	4½	Dent from Peter Henderson & Co.
Self-Husking	June 22	July 24	July 31	5	1 $\frac{1}{6}$	Flint from Peter Henderson & Co.
Angel of Midnight	June 25	July 25	Aug. 1	5½	1½	Flint from Parker & Woods.
Johnson's Mammoth Early White	July 10	Aug. 2	Aug. 23	9½	4½	Dent from Mark W. Johnson.
Early Red Glazed	June 27	July 26	Aug. 5	7	3	Flint from D. M. Ferry & Co.
Brazilian Flour Corn	July 26	Aug. 29	Sept. 13	8½	5	Soft from Mark W. Johnson.
Longfellow	June 29	July 27	Aug. 1	6	2	Flint from Peter Henderson & Co.
King Philip	June 29	July 27	Aug. 5	6	2½	Flint from Peter Henderson & Co.
St. Charles	July 10	Aug. 1	Aug. 28	10	4½	Dent from Plant Seed Co.

Among the Dent varieties, the most valuable, basing judgment on quality of grain, productiveness and hardiness, and naming sorts in the order of merit, were: Yellow Mammoth, Leaming, Pride of the North, Murdock's, Farmer's Favorite Golden Dent, St. Charles, Queen of the Prairie, Early Yellow Hathaway and White Giant Normandy. Judging by the same standards, the most valuable of the early maturing Flint varieties were Early Red Blazed, Longfellow and Angel of Midnight. It should be observed, however, that in point of yield and quality of grain - so far as appearances go — none of these could approach the more vigorous growing Dents. A few tests made with moderate areas showed for even the best of the early maturing varieties a yield of two-thirds to one-half, and even less, of that had from the Dent sort growing in the adjoining plat.

PLANTING EARLY VARIETIES.

It seems worth while here to call attention to the quite popular demand, coming from those sections of the State in which the corn crop was a failure last year, that the familiar Dent sorts shall give place to the smaller-growing, early-maturing varieties of Flint or "Yankee corn." It is argued, that by planting the quick-growing, early-maturing sorts, a crop may be harvested before the hot winds of July and August have been able to do their deadly work. In reviewing this project in the light of our experience at the College, it seems proper to notice the general facts related to corn culture in Kansas. We have here almost universally the rich, deep, friable soil which the experience of all corn-growing communities has shown to be necessary to the perfect growth of the great staple. Moreover, here are the fervent summer heats and great length of growing season, so well calculated to bring the corn plant in all its parts, leaf, stalk and ear, to the greatest perfection. As a result of these natural influences, the corn plant in Kansas assumes the largest proportions; the stalks are coarse and very tall, the leaves are broad and long, if not numerous, while the ear is large and lifted far above ground, often above the tassels of the small-growing sorts, as was shown in our experiments. Small-growing, dwarfish corn is never seen in Kansas, except in cases where the seed used or its immediate ancestors has been introduced from the north. And even these small-growing foreign sorts, when grown for a series of years in Kansas, tend rapidily toward the normal type. A variety of King Philip corn, grown on the College farm since 1876, and in this vicinity since 1872 or 1873, and kept pure meanwhile, is no longer a Flint corn, while in size and habit of growth it more nearly resembles a medium Dent sort than the familiar New England variety from which it is descended.

All this shows clearly to my mind, that those natural forces which have chiefly to do with "making" the corn crop in Kansas all favor the plant of largest growth. As to avoiding the hot winds: these are possible during every summer month, and our table shows that not one of the Flint sorts grown by us last season would ordinarily escape them. Indeed, it is more than possible that the early maturing sorts would suffer most from this cause, as July is the (to the corn crop) critical month. So far as climate goes, these sorts would be in that fully-developed state in which the plant makes largest demands upon soil and climate, and suffers most from any failure to supply them.

Those who advocate the general culture as a field crop of the small, Flint sorts evidently are unacquainted with the behavior of these sorts as grown in Kansas. Most of the small-growing varieties cannot be relied on to yield much more than one-half of what constitutes a fair crop of the familiar Dent corn, and our experience with these sorts, covering many years, agrees with the facts as stated above, where it is shown that the yield of the small-growing sorts was often less than one-half of the yield of the Dent varieties growing in contiguous plats. The ears of the early corn, too, were poorly filled and very chaffy. There were large bare spaces of cob on nearly every ear. The first illustration, which represents six fair, average ears of as many different sorts, will make clear this defect of the early varieties. The Flint sorts suffered too, beyond anything known

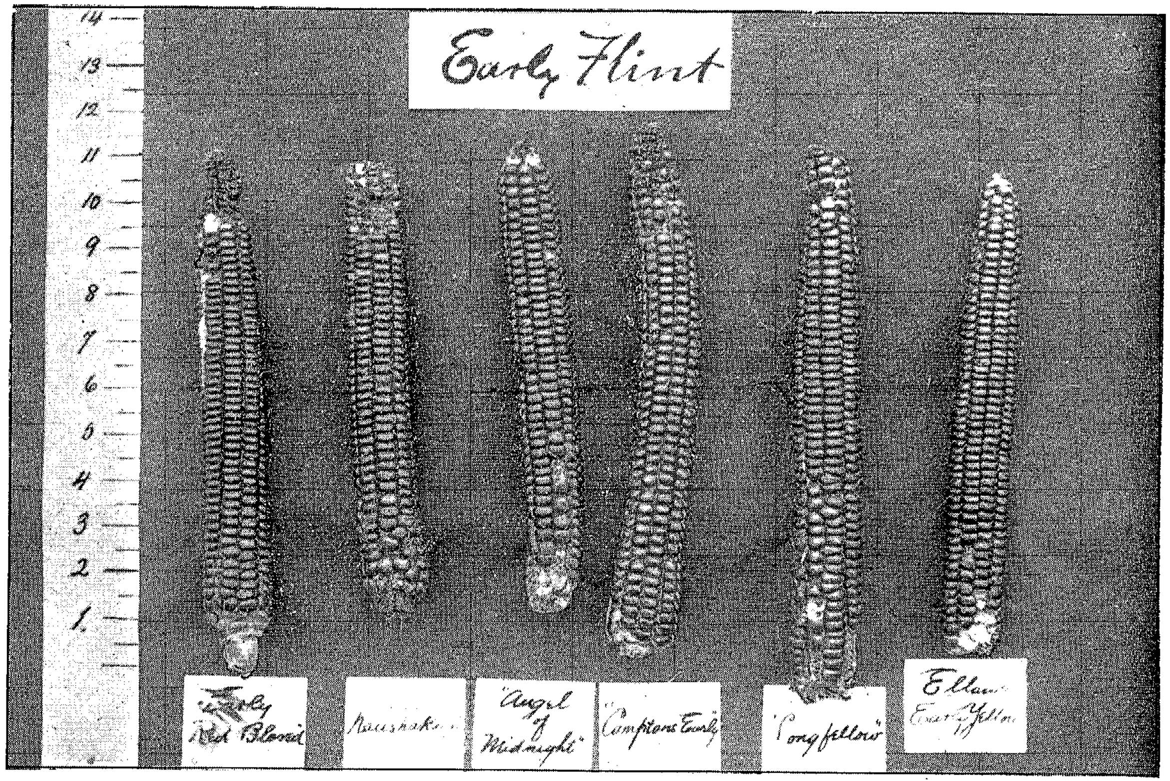
Early Flint
"Angel of Midnight"
"Comptons Early"
"Longfellow"
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PLATE I.

heretofore with familiar varieties, from the attacks of the corn worm *(Heliothis Armigera),* which has rarely proved a serious pest in this section except with very late sorts.

Taking the years together, the coarse, not necessarily the coarsest, or freest-growing varieties will prove the largest yielding, the safest and the most profitable for general cultivation. For all this, it is wise, I am firmly convinced, to plant a portion of the corn ground each season to the medium or small-growing varieties. These sorts afford both grain and fodder far in advance of the coarser-growing kinds, and it will occasionally happen that the smaller sorts make a crop when all others fail. We have for many years grown a modified King Philip with satisfaction and profit. It is ready for the harvest two or three weeks earlier than any of the commoner varieties; it yields well both of corn and fodder, but it must be admitted that it is very often caught by the hot winds.

TREATMENT OF GROWING CORN.

For the purpose of testing several questions involving the manipulation of growing corn, a portion of field D was selected which was very uniform in respect to soil and appearance and condition of the crop of corn which it bore. Thirty-one rows, each two hundred and seventy feet in length, were taken; the rows being numbered continuously without a break in the enumeration, from east to west. The special object of the experiment was to study the effect of removing the tassels or male flowers from the stalks as fast as they appeared, to note the influence of the lateral shoots (suckers) upon the crop, and the effect of removing, at the earliest ripening of the ears, all that portion of the stalk above the ear (topping). It was planned to reduce the crop of each row to a common level of one hundred and sixty (160) bearing plants; in the case of nine rows, however, it was found impossible to reach this standard. Of these nine rows, only four fell short of the one hundred and sixty, eight or nine plants, and of these four, two, Nos. 23 and

25, fell short fourteen plants; No. 26, sixteen plants, and No. 27, twenty-six plants. How great an influence this shortage in the number of experimental plants had upon the final results it is difficult to state. It seems likely, however, that its influence was considerable in the case of particular rows, although scarcely perceptible when distributed through the groups as is done in the summary.

The plan of the experiment is clearly shown in table No. 3, together with a full statement of results, including the yield of sound ears closely culled and "nubbins," together with the calculated yield per acre, while a compact summary gives the grouping of the specially-treated rows in each case. A word of explanation may seem needed regarding the "nothing" rows here used as a standard of comparison. These rows simply received no manipulation or special treatment whatever.

The tassels were removed as soon as they appeared — between July 9th and 24th; the suckers June 28th; while the topping was done much later — July 30th and 31st. The variety of corn here used was a medium sized yellow Dent. Here as elsewhere in the experiments with corn the bushel refers to seventy-five pounds of ears. The expressions "sound ears" and "nubbins," as used in the tabular headings, are quite likely misleading. The classification of the corn here, as elsewhere in the corn experiments, was made under the immediate supervision of Assistant H. M. Cottrell, who rigidly excluded from the sound ears every ear showing a blemish of any sort. Both the nubbins and sound ears of these experiments are therefore, in point of quality, greatly superior to the corn which ordinarily passes as sound corn and nubbins.

TABLE No. 3.

No. of plat	Treatment.	Yield of plat, lbs. Sound ears	Yield of plat, lbs. Nubbins	Yield per acre, bushels. Sound ears	Yield per acre, bushels. Nubbins	Yield per acre, bushels. Total	Yield per plant, corn, lbs.	Remarks.
1	Suckered	102	....	62.63	....	....	.63	Corn of good quality.
2	Nothing	119	....	73.06	....	....	.74	Corn of good quality.
3	Tasseled	63	30	38.68	18.42	57.10	.61	Corn poor.
4	Topped	82	16	50.34	9.82	60.16	.61	Corn not very good.
5	Suckered	82	12	50.34	7.36	57.70	.58	Corn good.
6	Nothing	72	13	44.30	7.98	52.18	.53	Corn good.
7	Tasseled	101	13	62.01	7.98	69.99	.71	Ears long and well filled.
8	Topped	89	16	54.64	9.82	64.46	.65	Corn not very good.
9	Suckered	94	7	57.71	4.29	62.00	.71	Corn very good; ears extra long, and well filled.
10	Nothing	94	16	57.71	9.82	67.53	.68	Corn fair; ears short, but well filled.
11	Tasseled	67	20	41.13	12.28	53.41	.54	Corn poor; ears short, poorly filled.
12	Topped	88	13	54.03	7.98	62.01	.63	Corn fair; ears small, well filled.
13	Suckered	87	6	53.41	3.68	57.09	.61	Corn very good; ears long, large, and well filled.
14	Nothing	83	13	50.96	7.98	58.94	.60	Corn good; ears well filled.
15	Tasseled	91	8	55.87	4.91	60.78	.62	Corn fair; ears small, well filled.

TABLE NO. 3—CONTINUED.

No. of Plat....	TREATMENT.	YIELD OF PLAT, LBS.		YIELD PER ACRE, BUSHELS			Yield per plant, corn, lbs	REMARKS.
		Sound ears. ...	Nubbins.	Sound ears	Nubbin	Total......		
16	Topped	82	11	50.34	6.75	57.09	.61	Corn good; ears well filled.
17	Suckered	80	7	49.12	4.29	53.41	.55	Corn good; ears long, well filled.
18	Nothing	104	15	63.85	9.21	73.06	.74	Corn fair; ears long, and moderately filled.
19	Tasseled	75	23	46.05	14.12	60.17	.63	Corn poor; ears small, poorly filled.
20	Topped	71	21	43.59	12.89	56.48	.60	Corn very poor; ears short, small, poorly filled.
21	Suckered	84	9	51.57	5.52	57.09	.61	Corn very good; ears long, large, and well filled.
22	Nothing	103	14	63.24	8.59	71.83	.73	Corn very good; ears long, large, and well filled.
23	Tasseled	64	22	39.29	13.50	52.79	.59	Corn very poor; ears small, poorly filled.
24	Topped	82	16	50.34	9.82	60.16	.61	Corn poor; ears short, poorly filled.
25	Suckered	83	15	50.96	9.21	60.17	.67	Corn good; ears long, well filled.
26	Nothing	82	13	50.34	7.98	58.32	.66	Corn good; ears large, well filled.
27	Tasseled	58	22	35.61	13.50	59.11	.59	Corn fair; ears small, well filled.
28	Topped	78	17	47.89	10.43	58.32	.59	Corn poor; ears small, poorly filled.
29	Nothing	82	16	50.34	9.82	60.16	.61	Corn very poor; ears short, poorly filled.
30	Suckered	89	8	54.64	4.91	59.55	.60	Corn good; ears long, and moderately filled.
31	Tasseled	64	30	39.29	18.42	57.71	.58	Corn very poor; ears small, and poorly filled.

SUMMARY.

No. of plat.	TREATMENT.	YIELD OF PLAT, LBS.		YIELD PER ACRE, BUSHELS.			Yield per plant, corn, lbs.
		Sound ears	Nubbins	Sound ears	Nubbins	Total	
1, 5, 9, 13, 17, 21, 25, 30	Suckered	87.62	9.12	53.80	5.60	59.40	.61
2, 6, 10, 14, 18, 22, 26, 29	Nothing adjacent, suckered	88.57	14.28	54.38	8.76	63.14	.67
3, 7, 11, 15, 19, 23, 27, 31	Tasseled	72.87	21.00	44.74	12.89	57.63	.61
2, 6, 10, 14, 18, 22, 26, 29	Nothing adjacent, tasseled	88.57	14.28	54.38	8.76	63.14	.67
4, 8, 12, 16, 20, 24, 28	Topped	81.71	15.71	50.16	9.64	59.80	.61

An examination of the table reveals some interesting and suggestive facts. The removal of the suckers was a positive loss to the crop in every respect save one. The yield per acre of the suckered rows was five bushels less than that obtained in the adjacent "nothing" rows, and there was a corresponding loss in the yield of each plant. This result agrees substantially with the facts shown in an extended experiment made upon the College farm in 1877, to test the same point. The quality of the corn yielded in the suckered rows was markedly superior to that obtained from the other specially treated areas. It was better than that had from the "nothing" rows, and greatly superior to the product of the tasseled and topped rows, which was often very poor. The reason for this superiority of the corn had from the suckered rows is easily explained by the absence of the lateral shoots and the consequent small ears which they bear.

The removal of the tassels was no benefit to the crop certainly, and almost certainly an injury. Besides the diminished yield as compared with the "nothing" areas, amounting to five and a half (5 1/2) bushels per acre, there was a considerable increase in the amount of poor corn or nubbins, so that the average as to quality of grain was very low.

All that has been said of the effects of removing the tassels from corn might be repeated truthfully enough of the effects of removing the entire top from growing corn, except that the quality of the corn produced by the topped rows was greatly inferior to that had from the rows which had been tasseled.

The lesson of this experiment plainly seems to be, that all manipulation, all cutting and hacking of that portion of the corn plant above ground, is worse than time wasted; that, in short, the corn plant does best when allowed to develop *without manipulation* or interference.

TREATMENT OF CORN GROUND.

During the twelve years last past our ideas and practices relative to the treatment of corn ground in Kansas have undergone a nearly complete revolution. A dozen years ago corn land was universally plowed and the seed was planted in the fashion known familiarly as " check-rowing. " At the present time, nearly or quite three-fourths of Kansas corn is raised by the method known as "listing," which I may say in explanation consists of drilling the seed in the bottoms of deep furrows struck at the usual intervals in ground not otherwise plowed. Even in those sections where the old practice of plowing prevails, the seed is nearly as often drilled as check-rowed.

Practical men make many claims for the new plan of corn culture, most of which, it must be confessed, seem to be well supported by the facts. It is claimed that listed corn endures dry weather much better than the surface planted; that it gives an increased yield; and this especially, that the labor of growing a crop of corn is reduced one-quarter to one-third by the new method.

From all the facts, listing seemed well worth a careful study at this Station. The method itself, like most agricultural operations, is far from being a simple one. As compared with the old methods, it presents the following points of difference: Listed corn is planted at the bottom of a deep furrow, and in otherwise unplowed land; the corn is drilled, perhaps less or more thickly than in surface planting.

To test the method of listing, in as nearly as possible every phase, the experiment hereinafter detailed was planned and carried out during the last season. Sixteen plats were laid off in field E, and these were grouped in four series, each of which contained two listed and two surface plats. The two listed plats were planted, one by the method of hills, the other in drills, as were the two surface-planted plats. Each plat consisted of eight rows of corn, and each row occupied space measuring 162x3½ feet. The table following (Table No. 4) shows the arrangement of the differently treated plats, as well as the yield of each in corn and fodder.

In order to remove every cause of variation except the particular treatment given in planting, the number of plants grown in every row was made the same throughout the entire experiment. The drilled plats were planted with the view to securing a stand of one plant to every sixteen inches, and plants in the hilled rows, whether "listed" or planted on the surface, were thinned out to a number exactly equal to that of the drilled rows. In this way, and only in this way, it seems to me, could we get a direct and unequivocal answer to the question: Will listing give a larger yield than surface cultivation? and if so, is it best to plant the furrows in hills or with the drill?

The soil of the field used in this experiment was a deep loam of extraordinary fertility. The corn employed was a yellow Dent of medium growth. The planting was done on May 5th, and the subsequent treatment given the plats amounted to good, "clean cultivation," and not much more. In the table, the bushel refers to seventy-five pounds of ears.

TABLE NO. 4

No. of plat.	TREATMENT.	YIELD OF PLAT, LBS.		YIELD PER ACRE.	
		Corn......	Fodder...	Corn, bush...	Fodder, tons....
1	Surface checkrowed	281	340	36.03	1.63
2	Listed drills	320	480	40.96	2.30
3	Surface drills	328	420	41.98	2.01
4	Surface checkrowed	302	360	38.65	1.72
5	Listed drills	333	410	42.62	1.96
6	Surface drills	288	430	36.86	2.06
7	Listed drills	311	430	39.80	2.06
8	Listed hills	308	470	39.42	2.25
9	Surface drills	296	400	37.88	1.92
10	Surface checkrowed	322	375	41.21	1.80
11	Listed drills	358	450	45.82	2.16
12	Listed hills	360	475	46.08	2.28
13	Surface drills	352	430	45.05	2.06
14	Surface checkrowed	356	440	45.56	2.11
15	Listed drills	499	620	63.87	2.97
16	Listed hills	409	493	52.44	2.36

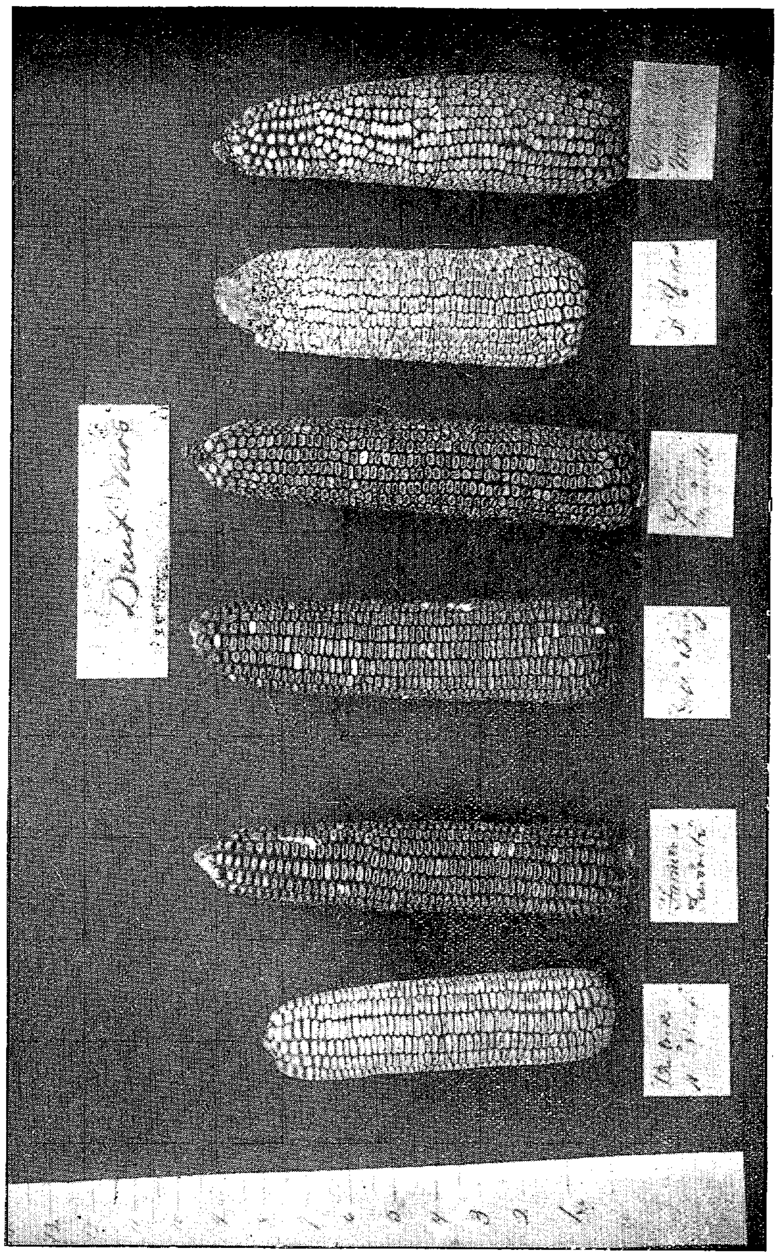


PLATE II.

SUMMARY.

No. of plat.	TREATMENT.	YIELD OF PLAT, LBS.		YIELD PER ACRE.		GAIN, LISTED OVER SURFACE PLANTED.	
		Corn.....	Fodder...	Corn bush...	Fodder, tons....	Corn, bush....	Fodder, tons....
2, 5, 7, 11 and 15.....	Listed drills	364	478	46.61	2.29	6.07	0.28
3, 6, 9 and 13.........	Surface drills	316	420	40.54	2.01	....	....
8, 12 and 16	Listed hills	359	479	45.98	2.30	5.52	0.49
1, 4, 10 and 14........	Surface check-rowed	315	370	40.46	1.81	....	....

There can be no doubt that the listing in itself was a real benefit to the crop. The figures given in the columns under "Grain listed over surface planted" may not altogether represent this advantage of the listing method — in the single element of yield — over the old practice, but the uniform gain in results obtained in the listed plats makes it plain that there was a gain, greater or less than that shown in the summary. It is an interesting fact, too, that the drilled plats show small advantage, other things equal, over the plats that were planted in "hills". There is a gain, but the advantage is too slight to be considered as necessarily due to the methods of planting.

THE CULTIVATION OF GROWING CORN.

One of the best reasons for corn raising is found in the fact that by its habit of growth it admits of more or less complete tillage or "cultivation" of the soil occupied by it, thus enabling the farmer to clear the land of weeds and otherwise put it in excellent shape for succeeding crops. This fact is too often lost sight of when an estimate is made of the value of the corn crop. In the minds of most men, cultivation is advantageous to the corn crop and not to the soil. The question how much cultivation is necessary to the full development of the corn plant is the one of chief interest to the growers of the great staple in the West. To aid in answering this question, an experiment was undertaken the past season in connection with that relating to listing and surface planting, before detailed. Sixteen plats continuous with those listed and surface planted were arranged, with the object of testing the different methods of cultivating the growing crop. Each plat consisted of four rows of corn, and each row occupied 162x3½ feet of space. The plats were all plowed, harrowed and otherwise prepared for planting on the same day, and the planting, done with a drill on the surface of the ground, was completed on May 5th. After the corn plants had become firmly rooted the plats were thinned out, leaving a uniform number of plants in the rows of the entire series.

The arrangement of the plats is made clear by the subjoined table (No. 5), but further explanation regarding the special treatment accorded the different series seems necessary. By "slight cultivation" was originally intended no cultivation at all. On account of the multitude of small weeds which sprung up, keeping pace with the corn in its early growth, it was found necessary to pass the cultivator back and forth lightly once in each row, because in this way the weeds could be killed with less cultivation than was possible with the hoe or other tillage implement. After this light dressing with the cultivator, the plats of light cultivation were kept clean with hand and hoe, but without "hoeing." The plats receiving surface culture were cultivated wholly with a new surface-acting machine known as the Tower surface cultivator. This machine is made on the general plan of the familiar two-horse walking cultivator. It differs from the ordinary implement in that each cultivator consists of a gang of sharp knives acting horizontally and set at an angle with the direction of the line of draft. It acts superficially as its name indicates, slicing the ground very thoroughly to the depth of one or two inches, as may be desired. The surface-cultivated plats were gone over thoroughly with this implement on June 7th and 13th, each operation being equivalent to going twice in a row with the single cultivator. On account of exigencies of weather, it was found impossible to get on the land at other times than those mentioned.

The plats of "ordinary cultivation" received two very thorough dressings on June 7th and 13th, with the ordinary two-horse walking cultivator.

The plats receiving excessive cultivation were thoroughly tilled on June 7th, 13th and July 7th. In this operation, the ordinary two-horse walking cultivator was used. It was run twice in a row at each operation, and was held to cut as deep and as close to the rows of corn as possible, with the object of doing all the good or harm the machine was capable of. The table on the following page gives in full detail the results of this trial:

TABLE No. 5.

No. of Plat.	TREATMENT.	YIELD OF PLAT, LBS.			YIELD PER ACRE.				REMARKS.
		Sound ears	Nubbins	Fodder	Sound ears, bu.	Nubbins bushels	Total corn, bu.	Fodder, tons	
1	Slight cultivation	179	35	220	45.82	8.96	54.78	2.11	Ears long, well filled.
2	Ordinary cultivation	203	47	230	51.96	12.03	64.00	2.20	Ears short, not well filled.
3	Surface cultivation	197	48	220	50.44	12.28	62.72	2.11	Ears medium length.
4	Excessive cultivation	185	72	270	47.48	18.56	66.04	2.59	Ears long, fairly filled.
5	Slight cultivation	155	75	115	39.68	19.20	58.88	1.00	Ears small, poorly filled.
6	Ordinary cultivation	186	76	180	47.74	19.58	67.32	1.72	Ears med'm, moderately filled.
7	Surface cultivation	197	57	180	50.43	14.59	65.02	1.72	Ears short, well filled.
8	Excessive cultivation	189	50	180	48.38	12.80	61.18	1.72	Ears large, well filled.
9	Slight cultivation	121	100	135	30.97	25.60	56.57	1.29	Ears small, poorly filled.
10	Ordinary cultivation	184	58	135	47.11	14.84	61.95	1.29	Ears long, large, well filled.
11	Surface cultivation	164	61	145	41.99	15.61	57.60	1.39	Ears medium, well filled.
12	Excessive cultivation	147	61	130	37.63	15.61	53.24	1.24	Ears small, poorly filled.
13	Slight cultivation	133	55	110	34.04	14.08	48.12	1.05	Ears long, well filled.
14	Ordinary cultivation	178	49	140	45.56	12.54	58.11	1.34	Ears long, large, well filled.
15	Surface cultivation	150	75	200	38.40	19.20	57.60	1.92	Ears small, well filled.
16	Excessive cultivation	131	73	170	33.54	18.68	52.22	1.63	Ears large, poorly filled.

SUMMARY.

No. of Plat.	TREATMENT.	YIELD OF PLAT, LBS.			YIELD PER ACRE.			
		Sound ears	Nubbins	Fodder	Sound ears, bu.	Nubbins, bushels	Total corn, bu.	Fodder, tons
1, 5, 9 and 13	Slight cultivation	147	66	145	37.63	16.96	54.59	1.39
2, 6, 10 and 14	Ordinary cultivation	187	57	171	48.09	14.75	62.84	1.64
3, 7, 11 and 15	Surface cultivation	177	60	186	45.31	15.42	60.73	1.78
4, 8, 12 and 16	Excessive cultivation	163	64	187	41.76	16.41	58.17	1.80

This experiment is not likely to satisfy the advocates of either of the four methods here tested. But while far from decisive, the results here detailed are almost exactly in line with accurately conducted experiments made here before, and with years of general experience had at the College farm. The moderate cultivation which kept the ground free from weeds, and prevented it from "baking," upon rich soil and during a favorable season supplied every requirement of the corn plant. Had the land used in this experiment been of poor quality, and the season a bad one, we might have expected very different results. In other words, cultivation may be made to help a bad soil or season, but when both are favorable, tillage sufficient to keep the ground free of weed pests and moderately porous is emphatically sufficient.

HARVESTING FOR FODDER AND CORN.

This history of experiments with corn is appropriately enough concluded with a statement of facts, gathered during the season, bearing upon the time of harvesting the crop, or rather, the condition, as to maturity, of the crop as effecting both fodder and corn.

Prof. Sanborn has shown (see Bulletin No. 22, Missouri Agricultural College) that when Flint and Dent varieties are cut with the grain in the same condition of under-ripeness, the shrinkage in the grain of the Flint sorts is much less than with the Dent varieties.

To test this and related matters, three varieties of most pronounced Flint corn and three of Dent were made the subjects of careful experiment, as hereinafter detailed. In nearly every case one hundred plants of several sorts were used — in three instances two hundred plants were employed and in three other cases a few less than one hundred; but in all these exceptional cases calculations were made for one hundred plants as indicated in the table. The Flint and Dent varieties were both cut when in the same condition of ripeness. There were chances for mistakes here it must be admitted. Corn is in the "milk" state, for example, several days, often weeks; and it is far from an easy task to decide when the two classes were in exactly this "same condition" of milkiness. There was much less trouble in reaching uniformity in doughiness, and none whatever in grouping the sorts in a common "ripe" state. The hundred plants were cut at the dates given, and at once, with accompanying suckers, were weighed, then tied in bundles, and on the day following shocked. A month or more later, when thoroughly cured and dry, the corn was husked and stored away for more perfect drying and the fodder weighed. The table below gives, in very full detail, the facts of this experiment. In the table, wherever it was possible without affecting final results, small fractions have been discarded:

TABLE No. 6.

Class, and name of variety.	Date of cutting.	Condition of corn	Number of stalks used	Stalks and ears, lbs.		Corn, lbs.		Weight of 70 lbs. ears.		No. ears to bushel (70 lbs.)
				Green	Thoroughly dried.	Sound ears	Soft ears and nubbins	Shelled corn, lbs.	Cobs, lbs.	
FLINT—First cutting:										
Ellm's Early yellow	July 27	Milk	100	172	30	3	7	56	14	420
Compton's Early	July 27	Milk	100	215	66	0	26	49	21	420
King Philip (Eastern)	July 27	Milk	100	166	34	6	6	56	14	420
Averages		Milk	100	184	43	3	13	54	16	420
DENT—First cutting:										
Pride of the North	Aug. 1	Milk	100	243	45	2	11	56	14	420
White Giant Normandy	Aug. 9	Milk	100	379	146	0	27	56	14	254
Murdock's	Aug. 9	Milk	100	332	95	0	30	58	11	233
Averages		Milk	100	318	95		22	57	13	302
Gains (+) or losses (—), as compared with Flint				+134	—52	-3.17	+9	+4	-3	-118

TABLE NO. 6.—CONTINUED.

CLASS, AND NAME OF VARIETY.	Date of cutting	Condition of corn	Number of stalks used	Stalks and ears, lbs.: Green	Stalks and ears, lbs.: Thoroughly dried	Corn, lbs.: Sound ears	Corn, lbs.: Soft ears and nubbins	Weight of 70 lbs. ears: Shelled corn, lbs.	Weight of 70 lbs. ears: Cobs, lbs.	No. ears to bushel (70 lbs.)
FLINT—Second cutting:										
Ellm's Early Yellow	Aug. 1	Dough	100	168	39	8	9	58	12	350
Compton's Early	Aug. 1	Dough	100	178	51	11	12	55	15	291
King Philip (Eastern)	Aug. 1	Dough	100	159	45	13	7	55	15	402
Averages		Dough	100	168	45	10	9	56	14	347
DENT—Second cutting:										
Pride of the North	Aug. 14	Dough	100	190	52	10	10	57	13	279
White Giant Normandy	Aug. 22	Dough	100	348	200	41	11	57	13	172
Murdock's	Aug. 14	Dough	100	334	158	11	27	60	10	199
Averages		Dough	100	290	133	20	16	58	12	216
Gains (+) or losses (—), as compared with Flint				+122	+88	+10	+7	+2	-2	-131

TABLE NO. 6.—CONTINUED.

CLASS, AND NAME OF VARIETY	Date of cutting	Condition of corn	No. of stalks used	STALKS AND EARS, LBS.		CORN, LBS.		WEIGHT OF 70 LBS. EARS.		No. ears to bush. (70 lbs.)
				Green	Thoroughly dried	Sound ears	Soft ears and nubbins	Shelled Corn, lbs.	Cobs, lbs.	
FLINT—Third cutting:										
Ellm's Early Yellow	Aug. 11	Ripe	100	144	47	9	11	58	12	350
Compton's Early	Aug. 11	Ripe	100	133	54	14	9	54	16	264
King Philip (Eastern)	Aug. 11	Ripe	100	134	58	17	19	58	12	350
Averages	....	Ripe	100	137	53	13	13	56	14	321
DENT—Third cutting:										
Pride of the North	Aug. 23	Ripe	100	132	53	12	9	59	11	250
White Giant Normandy	Sept. 7	Ripe	100	284	....	52	11	57	13	149
Murdock's	Sept. 7	Ripe	100	207	179	63	8	61	9	140
Averages	....	Ripe	100	207	116	42	9	59	11	179
Gains (+) or losses (—), as compared with Flint	....	....	......	+70	+63	+29	-4	+3	-2	-142
Average of all	....	Milk	100	251	69	1.8	14.5	55	14.5	361
	....	Dough	100	229	91	15	13	57	13	283
	....	Ripe	100	172	78	28	11	58	12	250

In every item of the table the Flint corn shows to great disadvantage except where cut in the "milk" state. Here it shows a larger proportion of sound ears than the Dent, but the yield of fodder was much less (58 per cent. of the Dent), the fodder wasted more by shrinkage, while the ears are very much smaller, and the proportion of cob is larger by four per cent. However, the quality of the fodder, which we are unable for obvious reasons to show here, was doubtless much better than that of the Dent corn; perhaps enough better to make up for its deficiencies in other respects. The gains and losses of the different cuttings are perhaps more plainly seen in a comparison of percentages, as shown — so far as the principal items of the table are concerned — in the subjoined statements. Here as before the unimportant fractions have been discarded.

VARIETIES.	*Per cent. of shrinkage from green to dry.*	*Per cent. of sound ears.*	*Per cent. of cob to corn.*
Average of Flints—first cutting	77	18	22
Average of Dents—first cutting	71	3	18
Average of Flints—second cutting	73	53	20
Average of Dents—second cutting	55	55	17
Average of Flints—third cutting	57	47	20
Average of Dents—third cutting	44	82	14

The plain facts of the experiment are, leaving out of the account the question of quality, that the Dent varieties are the most profitable sorts for cultivation where the object is fodder, even; and where there is a double purpose — fodder and corn — the Dent varieties, when cut as the corn begins to harden, have greatly the advantage in the quantity of fodder, in the amount of corn which it bears, and in the quality of corn as shown by the amount of sound ears and the proportion of cob.

Professor Sanborn's suggestion, that the Flint varieties will bear earlier cutting than the Dent, seems to be supported by the facts here presented. The failure of the Flints to keep even with the Dents when cut in the dough state and when ripe was clearly due to their intrinsic worthlessness for our soil and climate. They seemed out of harmony with their environment, and in process of naturalization, while the Dents from the start grew with a robustness that told plainly of their suitableness to the surroundings. It was impossible to select, as sound merchantable corn, ears—otherwise sound—having broad areas of cob without a covering of corn, as was very often the case with the Flints, as shown in Plate 1.

To still further test the question of the best time to cut standing corn with the view of securing the largest yield of corn and fodder, without much reference to varieties, a series of careful cuttings, and afterwards accurate weighings, was made in field E. Here rows of corn exactly equal as to length, and made by thinning exactly alike as to number of plants in a row, were measured off on opposite sides of the field. At one side, occupied by a yellow medium Dent, four cuttings were made when the corn was in as many different degrees of ripeness. On the opposite sides of the field, occupied by the King Philip sort—a greatly modified Flint—five different cuttings were made of corn in as many different stages of ripeness, as explained further on. The results obtained with the yellow Dent are stated in double rows, while the statements in reference to the King Philip are given by the single row. The plan was to have adjoining rows (or double rows) cut when the corn was in very different degrees of ripeness, so that any difference in the yield of the different rows would clearly be due to different times of cutting and not to differences in soil. Thus, row 1 and 2 were cut at the first cutting, 3 and 4 at the fourth, 5 and 6 at the second, 7 and 8 at the fourth again, and 9 and 10 at the third cutting. This plan was occasionally varied slightly, but only when errors seemed certain to result from following it too closely.

1st cutting, August 8th–Corn in “milk” state.

2d cutting, August 15th-Corn in “dough” state.

3d cutting, August 20th-Corn in hard “dough” state.

4th cutting, August 14th (King Philip)-Corn glazed and firm; September 4th (Yellow Dent)—Corn hard, stalks drying up.

5th cutting, September 4th (King Philip)-Corn hard, stalks drying up.

The corn was shocked as fast as it was cut, and remained undisturbed until it was thoroughly dry, when (October 13th) it was carefully husked, and after a few days' exposure to the sun, corn and stalks were weighed, with results as stated in the table following:

TABLE No. 7.
Medium Yellow Dent.

No. of rows.	*When cut.*	CONDITION OF GRAIN.	*Yield of dry corn, lbs.*	*Yield of dry fodder, lbs.*	REMARKS.
1 and 2	Aug. 8	Milk	30	95	Corn poor and shrunken.
3 and 4	Sept. 4	Hard; stalks drying	65	112	Corn fair.
5 and 6	Aug. 15	Dough	53	103	Corn poor.
7 and 8	Sept. 4	Hard; stalks drying	85	126	Corn good.
9 and 10	Aug. 20	Hard dough	66	110	Corn good.
11 and 12	Sept. 4	Hard; stalks drying	79	103	Corn fair.
13 and 14	Aug. 8	Milk	33	91	Corn very poor.
15 and 16	Sept. 4	Hard; stalks drying	81	113	Corn good.
17 and 18	Aug. 15	Dough	62	98	Corn poor.
19 and 20	Sept. 4	Hard; stalks drying	85	119	Corn good.
21 and 22	Aug. 20	Hard dough	61	118	Corn fair.
23 and 24	Sept. 4	Hard; stalks drying	87	110	Corn good.
25 and 26	Aug. 8	Milk	35	89	Corn very poor.
27 and 28	Sept. 4	Hard; stalks drying	72	113	Corn fair.
29 and 30	Aug. 15	Dough	55	99	Corn poor.
31 and 32	Sept. 4	Hard; stalks drying	77	120	Corn good.
33 and 34	Aug. 20	Hard dough	60	103	Corn fair.
35 and 36	Sept. 4	Hard; stalks drying	83	111	Corn good.
37 and 38	Aug. 8	Milk	30	101	Corn very poor.
39 and 40	Sept. 4	Hard: stalks drying	71	90	Corn poor.
41 and 42	Aug. 15	Dough	48	100	Corn poor.
43 and 44	Sept. 4	Hard; stalks drying	72	101	Corn fair.
45 and 46	Aug. 20	Hard dough	62	93	Corn fair.
47 and 48	Sept. 4	Hard; stalks drying	70	109	Corn good.
49 and 50	Aug. 8	Milk	24	102	Corn very poor.

SUMMARY.

No. of double rows used.	When cut.	CONDITION OF GRAIN	AVERAGE YIELD. DRY CORN. Per double row, lbs.	Per acre, bushels.	AVERAGE YIELD DRY FODDER. Per double row, lbs.	Per acre, tons.
5......	Aug. 8	Milk...........................	30	15.36	95	1.82
4......	Aug. 15	Dough.........................	55	28.16	100	1.92
4......	Aug. 20	Hard dough.................	62	31.74	106	2.03
12......	Sept. 4	Hard; stalks drying........	77	39.42	110	2.11

KING PHILIP (MODIFIED FLINT.)

No. of rows ..	When cut ...	CONDITION OF GRAIN.	Yield of dry corn, lbs	Yield of dry fodder, lbs....	REMARKS.
2	Aug. 8	Milk....................................	33	58	Corn very poor.
3	Aug. 15	Dough..................................	37	52	Corn poor.
5	Aug. 20	Hard dough.	41	57	Corn good.
7	Aug. 24	Glazed; firm..........................	44	48	Corn good.
10	Aug. 8	Milk....................................	25	46	Corn very poor.
11	Aug. 15	Dough..................................	40	44	Corn good.
13	Aug. 20	Hard dough.	46	63	Corn fair.
15	Aug. 24	Glazed; firm..........................	42	46	Corn good.
18	Aug. 8	Milk....	28	54	Corn very poor.
19	Aug. 15	Dough..................................	38	45	Corn fair.
21	Aug. 20	Hard dough...........................	44	57	Corn good.
23	Aug. 24	Glazed; firm..........................	57	49	Corn good.
26	Aug. 8	Milk....................................	25	48	Corn poor.
27	Aug. 15	Dough..................................	41	50	Corn good.
29	Aug. 20	Hard dough...........................	44	54	Corn good.
31	Aug. 24	Glazed; firm..........................	47	56	Corn very good.
34	Aug. 8	Milk....................................	29	56	Corn poor.
35	Aug. 15	Dough..................................	36	51	Corn poor.
36	Sept. 4	Hard; stalks drying..................	49	54	Corn very good.

KING PHILIP (MODIFIED FLINT.) — CONTINUED.

No. of rows.	*When cut.*	CONDITION OF GRAIN.	*Yield of dry corn, lbs.*	*Yield of dry fodder, lbs.*	REMARKS.
37	Aug. 20	Hard dough	46	50	Corn good.
38	Sept. 4	Hard; stalks drying	80	52	Corn very good.
39	Aug. 24	Glazed; firm	58	52	Corn good.
42	Aug. 8	Milk	27	43	Corn poor.
43	Aug. 15	Dough	41	57	Corn good.
44	Sept. 4	Hard; stalks drying	59	68	Corn very good.
45	Aug. 20	Hard dough	49	55	Corn very good.
46	Sept. 4	Hard; stalks drying	60	54	Corn very good.
47	Aug. 24	Glazed; firm	54	58	Corn very good.
50	Aug. 8	Milk	31	60	Corn poor.
51	Aug. 15	Dough	40	58	Corn fair.
52	Sept. 4	Hard; stalks drying	56	46	Corn good.
53	Aug. 20	Hard dough	52	64	Corn very good.
54	Sept. 4	Hard; stalks drying	58	68	Corn very good.
55	Aug. 24	Glazed; firm	49	49	Corn good.
58	Aug. 8	Milk	32	53	Corn poor.
59	Aug. 15	Dough	43	54	Corn good.
60	Sept. 4	Hard; stalks drying	58	52	Corn good.
61	Aug. 20	Hard dough	52	58	Corn good.
62	Sept. 4	Hard; stalks drying	55	60	Corn good.
63	Aug. 24	Glazed; firm	64	55	Corn very good.
66	Aug. 8	Milk	36	58	Corn poor.
37	Aug. 15	Dough	45	52	Corn good.
68	Sept. 4	Hard; stalks drying	65	53	Corn very good.
39	Aug. 20	Hard dough	57	58	Corn good.
70	Sept. 4	Hard; stalks drying	63	57	Corn very good.
71	Aug. 24	Glazed; firm	54	57	Corn good.
74	Aug. 8	Milk	31	52	Corn poor.
75	Aug. 15	Dough	44	47	Corn poor.

SUMMARY.

No. of rows used.	When cut.	CONDITION OF GRAIN.	AVERAGE YIELD DRY CORN.		AVERAGE YIELD DRY FODDER.	
			Per row, lbs.	Per acre, bushels.	Per row, lbs.	Per acre, tons.
10	Aug. 8	Milk	29	29.69	53	2.03
10	Aug. 15	Dough	40	40.96	51	1.95
9	Aug. 20	Hard dough	48	49.15	57	2.18
9	Aug. 24	Glazed; firm	52	53.24	52	1.99
10	Sept. 4	Hard; stalks drying	60	61.44	56	2.15

The results obtained by this trial were a great surprise to myself. I was fully prepared to expect a loss of corn in the early cuttings, but that this loss should amount to considerably more than fifty per cent., shown in the grouping in the case of both Dent and King Philip, seemed, until the original figures had been carefully examined, almost incredible. The facts as shown in the original table, however, support with almost complete unanimity the conclusions reached in the summary. We find, for example, in *nearly every case* that adjacent rows, cut at intervals of seven to twenty days, show variations, with only two or three exceptions, in seventy odd cases almost exactly proportionate to the difference in the time of cutting; the largest yield, of the best quality of corn, going with the row cut latest. Indeed, we are plainly taught here that corn continues to improve in weight until the very last — after the blades of the plant have been dried up, and quite likely blown away, and seemingly until the juices of the stalks have been completely sucked up. It is hard to resist the conviction that this cannot be a mere coincidence; that, in short, these figures point to a real principle in the growth of the crop which the farmer cannot afford to ignore.

It will be noticed, too, that the variation in the yield of fodder obtained in the different cuttings is very slight; so little, indeed, that it may safely be discarded. The quality of this fodder in the different cuttings cannot be stated in tabular form; but to judge by observation and common experience, the early cut fodder was greatly better than that cut when the corn was ripe. No experienced farmer will suppose for an instant that this improvement in the quality of the fodder obtained in the early cuttings nearly compensates for the great loss sustained, both in quantity and quality, of the yield of grain.

Considering, then, all the facts — the great labor of husking corn from the shock as compared with “picking” it from the standing stalks, the great difficulty in tying, hauling and stacking or otherwise securing the fodder crop, and the great waste of fodder in the field and ultimate loss in feeding (which we have demonstrated time and again to amount to twenty to sixty per cent. of the stalks)— it is perfectly clear to me that we must raise corn for corn, with no thought of fodder, and corn again which has no higher purpose than the production of fodder. We must, in short, have two corn fields on every farm, receiving radically different treatment, to correspond with the different purposes for which they are cultivated.

The weak point in the practice of Kansas farmers is the all but universal neglect of corn as a hay plant. It is far from my purpose to write in belittlement of the efforts so many of our best farmers are putting forth to secure grasses and clovers suited to our Kansas climate, but certainly the men who deplore the lack of tame grasses in Kansas forget that, so far as hay is concerned, they have in Indian corn and sorghum hay plants which, in our Kansas climate, are superior for most of the purposes for which hay is used to any of the so-called tame grasses in certainty of yield, quality and quantity of crop and ease in handling, if *properly handled.*

It is not my purpose here to dwell at length upon the different methods of growing and preserving fodder corn. That subject is properly reserved for presentation in a future bulletin of the Station. I only wish to say, that by planting corn thickly a large yield of the best fodder, together with a large crop of poor corn, may be had, and that very cheaply, as I have shown in the experiments of previous years. (See Report of the Professor of Agriculture, Kansas State Agricultural College, for 1883, p. 24.)

As to the best means of securing this fodder when grown, the silo doubtless is the cheapest and most satisfactory method of preserving the crop. But where the use of the silo may not be had, corn cut when the grain is in the dough state will cure perfectly, and may be preserved (fodder and grain) in the shock in almost perfect condition, until required for feeding in the winter.

EXPERIMENTS WITH WHEAT.

For several years experiments with wheat have been in progress at the College farm, having for their object (1) to show the comparative values of common and unusual sorts, and (2) to give expression to varying methods of treatment.

The results of our experience with something over one hundred sorts of winter wheat have abundantly satisfied me that the Kansas farmer can rely only upon the fine, early ripening red sorts — often of southern origin — of which early May and Zimmerman are types. These are usually reckoned light yielding sorts, but in Kansas soils, during favorable seasons, they often yield enormously. The coarse-growing, late-maturing sorts, like Clawson, Lancaster and Egyptian, sometimes do remarkably well, but much oftener they fail miserably.

On October 1, 1887, fifty-one varieties of winter wheat were sown — twenty-two in contiguous plats in field B, and twenty-nine in a connected series in field No. 6. The following is a complete list:

Bearded King.	Democrat.	Egyptian.
Big English.	Deitz.	Farquahar.
Deitz Longberry.	Early May.	Finley.
Deihl-Mediterranean.	Early Rice.	French Prairie.

Fulcaster.	Missouri Blue Stem.	Royal Red.
Fultz.	New Monarch.	Sibley's New Golden.
Genoese.	Nigger.	Silver Chaff.
German Emperor.	Oregon.	Surprise.
Gipsey.	Patagonian Trego.	Tasmanian Red.
Golden Prolific.	Poole.	The Good.
High Grade.	Raub's Black Prolific.	Theiss.
Hungarian.	Red Fultz.	Tuscan Island.
Jennings.	Red Line.	Valley.
Martin's Amber.	Red Odessa.	Velvet Chaff.
McGary.	Red Russian.	Walker.
Michigan Amber.	Rocky Mountain.	Wicks.
Miller's Prolific.	Royal Australian.	

Of these, Hungarian, Red Russian, Red Line, Genoese (wholly killed), Sibley's New Golden, The Good and Surprise suffered most from winter killing, the loss amounting to fully one-half of all the plants, in most cases. The varieties that sustained the least injuries were Theiss, Big English, Tuscan Island, Deihl-Mediterranean, Gipsey, Fultz, and Finley.

A CHINCH BUG EXPERIENCE.

Early in the spring chinch bugs began to congregate upon the vivid green wheat plants in great numbers, so that it was soon apparent that the complete destruction of the wheat was only the question of a very short time. Following the general practice, all the plats were plowed under on May 9th and 10th, and shortly afterwards harrowed and repeatedly rolled. This work was very thoroughly done, the wheat having been turned to the depth of eight inches. Nevertheless, thus imprisoned, an enormous brood of young bugs hatched, a large proportion — apparently — reaching the surface of the ground and passing directly to the adjacent crops, which received great damage from them. In the case of this brood of insects only, hatched under such peculiar circumstances, was noticeable damage done by chinch bugs upon the College farm the present year, although these pests were everywhere threatening in numbers and voracity.

WHEAT CONTINUOUSLY.

In the fall of 1880 a measured acre was prepared and sowed to wheat. This acre has, during each succeeding year, been sowed to winter wheat; and during all this time no fertilizer or renovating treatment of any kind has been given it. The results obtained with this acre are given by years in the subjoined tabular statement:

	Yield, bushels.	*Straw, pounds.*	*Straw to bushels of grain.*
1880–1—Variety, Early May—yield, estimated...	9.00	....	....
1881–2—Variety, Early May..........................	47.00	7,845	167
1882–3—Variety, Early May..........................	28.19	3,281	112
1883–4—Variety, Zimmerman.........................	37.00	4,525	122
1884–5—Variety, Zimmerman.........................	12.30	2,238	181
1885–6—Crop winter killed..........................	....	....	....
1886–7—Crop winter killed...........................	....	....	....
1887–8—Variety, Zimmerman.........................	30.31	3,766	124
Produce of seven years..................................	163.80	21,655	....
Average yearly yield......................................	23.40	3,092	132

We see from the above that during the past eight years this acre has made two complete failures with its crop, has given two light yields and four large ones. The average of nearly twenty-three and one-half bushels of wheat for seven years, obtained from an acre of upland, from a Kansas standpoint not naturally fertile, and which has received the worst possible treatment, shows in a rather striking way the "natural strength" of Kansas soil as well as the suitableness of both soil and climate to wheat culture.

PASTURING WHEAT.

With the object of learning the effect of moderately grazing winter wheat, both in fall and spring, a portion of field No. 3, a fair average of the entire wheat field, was selected for the purpose of this experiment. Here a measured acre was partitioned off from the remainder of the field by a barbed wire fence, and adjoining it, later on, an exact half acre, the former for fall grazing, and the latter for a like use in the spring. For the purpose of comparison, a quarter acre, uniform in growth and appearance with the pastured portion, was selected, and of course was not grazed.

Of the actual amount of grazing furnished by these areas, I have accurate data regarding only the half acre used for grazing in the spring. This area furnished the equivalent of 115 hours' steady grazing for one cow. This "steady grazing," it should be remembered, stands for much more than ordinary pasturing, which includes the time occupied by the cattle in rest. In grazing the half acre, cattle were held upon the wheat only so long as they fed. As soon as they seemed sated they were driven to the barn. I am confident that this half acre furnished the equivalent of one-half month's pasturing for one cow. The acre supplied more than twice that given by the half acre; from one to three cows — I cannot speak more accurately — having been kept upon it during nearly every day of November. In the tabular statement given below, the results of this experiment are concisely stated:

ITEMS.	YIELD PER ACRE.		*Straw, lbs., to bush. of grain.*
	Grain, bushels.	*Straw, pounds.*	
One acre grazed in fall	25.70	3,766	146
One-half acre grazed in spring—yield, 13 1 bushels grain, 1,662 pounds straw	26.20	3,324	127
One-fourth acre not grazed—yield, 6.4 bushels grain, 825 pounds straw	25.60	3,300	128

It is not supposed, for a moment, that these figures *prove* that the grazed plats were not injured in their ultimate crop by the grazing. They do, however, establish a strong presumption that such was the case. The fact that, to the eye, the pastured areas, when cut, showed, in all respects, as strong and vigorous a growth of wheat as that borne by the ungrazed area, strengthens this view. There was only this noticeable difference — and this was slight — between the grazed and ungrazed areas: the former, particularly that used for fall pasturage, bore a considerably more leafy straw, as indicated in the table, and it seemed a little slower in ripening, although the time of cutting the three areas was the same.

It savors somewhat of attempting to "eat one's cake and have it," in pasturing growing wheat without diminishing its yield of grain. However, the practice can only be recommended in the case of wheat that was sown early in the fall and thus has been enabled to make a luxuriant growth. It is a matter of common observation and experience, that this excess growth is often a cause of disaster to the crop. A further precaution that will occur to most practical men: pasturing of the wheat fields ought never to be permitted when the ground is muddy or even soft from rains.

CULTIVATION AND USE OF FERTILIZERS.

Twenty-one plats, each an exact one twenty-fifth of an acre, were laid off in a connected series, ranging north and south, in field No. 3. with the object of noting the effects of different fertilizing substances and methods of cultivation upon growing wheat. Field No. 3 grew a light crop of oats in the season of 1887. Early in September it was plowed, and on the 22d seeded to winter wheat of the Zimmerman variety. Seed to the amount of one and a quarter bushels per acre was used; drilled in rows five inches apart. The field is a strong clay of moderate fertility, having a quite pronounced easterly slope.

A few facts additional to those given in the plan of the experiment figured further on remain to be stated. The "zero" plats, which, through the entire series, alternate with those specially treated, received only ordinary field treatment. They furnish the criteria by which to estimate the influence of the special treatment accorded the adjacent plats.

Plats 2 and 4 received an application of salt at the rate of 300 pounds per acre; plats 6 and 8 were top-dressed with rich, partly-rotted dung at the rate of 30 tons per acre; and land plaster was sown on plats 10 and 12 upon the basis of 200 pounds to the acre.

These fertilizers were applied March 30th and 31st. Plats 14 and 16 were thoroughly harrowed twice with the smoothing harrow.

From the "hoed" plats — 18 and 20 — each alternate row of wheat was removed, preliminary to the hoeing, leaving the inter-spaces of the rows ten inches wide; these were thoroughly hoed three times at intervals of ten days, beginning April 5th. The subjoined table gives the yield of every plat, omitting unimportant fractions, together with a summary of the results of the special treatment in each case in comparison with the zero plats adjacent:

	YIELD OF PLAT.		YIELD PER ACRE.		Straw, lbs., to bushel of grain
	Cleaned grain, pounds	Straw, lbs.	Cleaned grain, bushels	Straw, lbs.	
Plat 1—Zero	83	165	34.00	4,125	121
Plat 2—Salt, 300 pounds per acre	96	212	40.00	5,300	132
Plat 3—Zero	86	173	36.00	4,325	120
Plat 4—Salt, 300 pounds per acre	92	177	38.00	4,415	126
Plat 5—Zero	80	149	33.00	3,725	112
Plat 6—Manure, 30 tons per acre	86	153	36.00	3,825	106
Plat 7—Zero	84	170	35.00	4,250	121
Plat 8—Manure, 30 tons per acre	92	178	38.00	4,450	117
Plat 9—Zero	88	176	36.00	4,400	122
Plat 10—Plaster, 200 pounds per acre	89	180	37.00	4,500	121
Plat 11—Zero	87	181	36.00	4,525	125
Plat 12—Plaster, 200 pounds per acre	89	184	37.00	4,600	121
Plat 13—Zero	88	180	36.00	4,500	125
Plat 14—Harrowed	78	145	33.00	3,625	109
Plat 15—Zero	87	166	36.00	4,150	112

	Yield of plat.		Yield per acre.		Straw, lbs., to bushel of grain
	Cleaned grain, pounds	Straw, lbs.	Cleaned grain, bushels	Straw, lbs.	
Plat 16—Harrowed	79	168	33.00	4,200	127
Plat 17—Zero	93	176	38.00	4,400	116
Plat 18—Hoed, alternate rows removed	75	109	31.00	2,725	88
Plat 19—Zero	83	155	34.00	3,875	114
Plat 20—Hoed, alternate rows removed	76	132	31.00	3,300	106
Plat 21—Zero	89	164	37.00	4,100	110
SUMMARY.					
Plats 2 and 4—Salt applied	94	194	39.00	4,857	124
Plats 1, 3 and 5—Adjacent 2 and 4	83	162	34.00	4,058	119
Differences—Gains and losses*	11	32	4.58	799	......
Plats 6 and 8—Manured	89	165	37.00	4,137	111
Plats 5, 7 and 9—Adjacent 6 and 8	84	165	35.00	4,125	117
Differences—Gains and losses	5	....	2.08	12	......
Plats 10 and 12—Plastered	89	182	37.00	4,550	123
Plats 9, 11 and 13—Adjacent 10 and 12	88	179	36.00	4,475	124
Differences—Gains and losses	1	3	.41	75	......
Plats 14 and 16—Harrowed	79	156	33.00	3,912	118
Plats 13, 15 and 17—Adjacent 14 and 16	89	174	37.00	4,350	117
Differences—Gains and losses	-10	-18	-4.16	-438	......
Plats 18 and 20—Hoed	76	120	31.00	3,012	97
Plats 17, 19 and 21—Adjacent 18 and 20	88	165	36.00	4,125	114
Differences—Gains and losses	-12	-45	-5.00	-1,123	......

*The minus sign (-) preceding a number indicates a loss for the particular method.

PLAN OF EXPERIMENT.—*Size of Plats, 87 feet 1 1-2 inches by 20 feet = 1-25 acre.*

21—Zero.
20—Hoed, alternate rows removed.
19—Zero.
18—Hoed, alternate rows removed.
17—Zero.
16—Harrowed.
15—Zero.
14—Harrowed.
13—Zero.
12—Plaster, 200 lbs. per acre.
11—Zero.
10—Plaster, 200 lbs. per acre.
9—Zero.
8—Manure, 30 tons per acre.
7—Zero.
6—Manure, 30 tons per acre.
5—Zero.
4—Salt, 300 lbs. per acre.
3—Zero.
2—Salt, 300 lbs. per acre.
1—Zero.

The general average of these experimental plats proves that the soil was rich and productive, furnishing every element needed for the development of the wheat plants. In such soils it is impossible to make many applications “tell” for what they are really worth, however carefully we may guard the experiment from extraneous influences. The problem in such cases is a simple one in appearance only. Take, for example, the manured plats: they gave so slight an increase as compared with the adjacent zero plats that we are forced to conclude that the application in every case was not a benefit to the crop. The soil, or rather the crop, needed neither the gypsum nor the manure. No one will suppose that a like answer would have been received had the same questions been put to poor, "hungry" soils. It is not unlikely, too, that had the special applications been made in the fall, at the time of seeding, the effects would have been much more strikingly shown. This scheme, with some added features, will be given effect the coming year, the fertilizers having been applied just before sowing the wheat.

The application of the salt was an undoubted benefit to the crop, as the tables plainly show. The effect of the salt was also strikingly shown in the peculiar bright color of the straw of the salted plats. This brightness of the straw was noticeable upon the haulm weeks after the wheat had been harvested.

The injury evidently done by the harrowing was perhaps chiefly due to the fact that the weighted harrow was dragged across the wheat rows, it being impossible, from the arrangement of the plats, to work the harrow in line with the rows of wheat. The use of the hoe in plats 18 and 20 was apparently strikingly influential with the crop. In these plats alternate rows were cut out early in April, leaving inter-spaces ten inches wide. These were thoroughly flat-hoed April 5th, 12th and 17th. That these hoed plats, with one-half the wheat plants of the adjacent zero plats, should fall short of them, in yield, only five bushels of grain and 1,125 lbs. of straw per acre, proves that the zero plats were too thickly seeded, or else the hoeing was most beneficial. The heads of wheat were better filled and fully one-third larger than those of the adjacent zero plats.

FORAGE CROPS.

COW PEAS (*Dolichos chinensis*).— Seed obtained from M. W. Johnson Seed Company, Atlanta, Ga. Three varieties — the Clay, the White Prolific and the Whippoorwill — were planted in separate plats, in rows 30 inches apart, May 29, 1888. The seeds germinated well and the plants grew rapidly from the start. The peas were cultivated June 9th, 30th and July 11th, with a one-horse cultivator. The plants resemble beans rather than peas. The vines are similar to those of running beans, and bear bean-like pods a foot or more in length. The growth of foliage seemed to be unaffected by the drouth, but the development of seeds was greatly checked from this cause. During the latter part of the season the vines covered the space between the rows with a thick mat of vegetation, while but few plants bore pods. The Clay and Whippoorwill varieties made a coarse, heavy growth; the vines of the White Prolific were slender and the leaves small. Our cattle refused to eat this forage, either green or cured, although no attempt was made to starve them to it. Ensilage made from the vines was black and slimy and had a peculiar, disagreeable odor. None of our cattle could be persuaded to eat it. The cow pea is doubtless as valuable in Kansas as it has proved elsewhere as a cheap and very excellent green manure.

RURAL BRANCHING SORGHUM *(Sorghum vulgare).* — Seed obtained from M. W. Johnson Seed Company. Planted May 30th, in drills 30 inches apart. A drouth succeeded planting and only a few seeds germinated, making a poor stand. June 24th and 25th a heavy rain fell and the remaining seeds grew, making a perfect stand. The plat was cultivated June 15th, 30th and July 11th, with a one-horse cultivator. Early in July the plants were attacked by the sorghum disease and their growth somewhat checked, but none of them were killed. The plants grew to a heighth of 7 feet, with a slender stalk, having a large number of leaves. The plat was cut October 4th, and yielded at the rate of 11 tons per acre, weighed green. The product was fed to cattle, both green and cured, and eaten by them with greater relish than any other forage crop fed this season. They ate the entire stalks, leaving nothing.

KAFIR CORN *(Sorghum vulgare).* — Seed obtained from F. Barteldes & Co., Lawrence, Kas. Planted May 30 in drills — one-half the rows 30 inches apart, and one-half 3 feet 9 inches apart. A drouth succeeded planting, and the seeds gave a poor stand. The plat was captivated June 15, 30, and July 11, with a one-horse cultivator. The plants grew slowly, until the advent of hot weather, when the growth was rapid. It resists drouth perfectly. The plat was attacked July 9 with the sorghum disease, and the growth of the young plants greatly checked, although few were killed. The plants grew 4 to 5 feet high, having a very thick stalk, and leaves large but few on a stalk, and the seed head very large. The stalk is very strong, and will withstand any amount of wind. Owing to the inroads of the sorghum disease, the yield could not be determined, but, from other trials, it is known that this variety yields from 30 to 60 bushels per acre. The stalks have a harder shell than the other sorghums, and our cattle refused to eat them.

YELLOW MILO MAIZE *(Sorghum vulgare).* — Seed obtained from T. W. Wood & Son, Richmond, Va. Seed planted May 30 and germinated well, making a good stand. The plants grew well until July 9, when they were attacked by the sorghum disease, and every plant killed.

PEARL MILLET *(Penicellaria spicata).* — Seed obtained from Mark W. Johnson Seed Co. Planted May 29, and made a fair stand. The plants were attacked by the sorghum disease, and nine-tenths of them killed. The remaining plants made a poor growth, a few of them only maturing seed. No opinion could be formed of its value.

AFRICAN MILLET *(Sorghum vulgare).* — Seed obtained from Barteldes; apparently identical with Dhoura seed obtained from Johnson Seed Co. Seeds planted May 29, 1888, in drills 3 feet 9 inches apart, germinated slowly owing to drouth, making a very poor stand. The plants grew well until attacked early in July by the sorghum disease. About one-half of the plants were killed, and the growth of the remainder badly checked. Those that survived grew to about 7 feet in height. The stalks are small, like those of the Rural Branching sorghum, but do not have nearly as many leaves. A considerable area was sown broadcast June 30, and gave a fair yield of forage. The inroads of the sorghum disease were so great that no attempt was made to ascertain the yield per acre.

JAPAN MAIZE *(Zea mays).* — Seed obtained from M. W. Johnson Seed Co. Planted May 29, 1888, in drills. Cultivated the same as Teosinte. The plants grew to a height of about 4 feet, and proved to be a dwarfed variety of Flint corn. This plant possesses no value whatever for feed.

TEOSINTE *(Euchloena luxurians).* — Seed obtained from Mark W. Johnson Seed Co. Planted May 29, 1888, in drills 3 feet 9 inches apart. Single seeds were dropped one foot apart in the drills. The seed germinated well. The plants grew slowly at first. After hot weather began, the growth was vigorous, and continued until the plants were cut off by frost. The plat was thoroughly cultivated June 15, 22, and July 11 with a one-horse cultivator. This plant resembles corn, but has broader leaves. It has a remarkable tillering habit. From 12 to 30 stalks grew from each seed, and these stalks were 7 feet high and still growing when killed by frost. A part of the plat was cut August 24 — the plants standing 5 feet high — and yielded at the rate of 10.8 tons green feed per acre. The remaining portion was cut October 4th — the stalks averaging 7 feet in height — and yielded at the rate of 17 tons green feed per acre. The yield would have been much greater had the rows been planted closer. The plants were not affected by the sorghum disease. The plants cut first made a second growth, but this was killed by frost before growing large enough to be of any value. The green forage was fed to cattle, and, while eaten, was not relished as well as the sorghum, previously fed. This plant is a good drouth resister — although not equal in this respect to sorghum; and promises to give a greater yield per acre than any other forage plant tested at this Station. The feed is poor in quality, as the plants do not reach maturity in this climate. Teosinte has the additional disadvantage of remaining green later in the season than other plants, so that chinch bugs from all the surrounding fields gather on it late in the fall, there to find, among its dense roots, safe winter quarters. One year's trial is not sufficient to determine, positively, the merits of this variety.

From the knowledge we now have, it seems that Cow peas cannot be raised profitably for forage, owing to the small yield of peas and poor character of the forage it yields.

The non-saccharine sorghums are worth a careful trial. They resist drouth well and will give a sure crop of both grain and forage in a season when corn will entirely fail. They will also give fair crops on very poor land. Rural Branching sorghum has been the most satisfactory variety grown this season, African millet standing second. African millet has been tried for a number of years on the College farm, and has always been a favorite variety.

Kaffir corn has been tried here for two years. It grows quite surely and yields more seed per acre than the other varieties of sorghum. The forage has not proved valuable with us for feeding, and it is doubtful if this variety is equal in value to either Rural Branching sorghum or African millet.

Teosinte, if tried at all, should be planted very sparingly until the farmer has settled for himself its value. The high price of the seed ($2.75 per pound), the protection which it affords for chinch bugs, and the immature condition in which the crop must be harvested, render Teosinte of doubtful value.

VARIETIES OF ENSILAGE CORN.

Seven sorts of corn especially adapted to ensilage were planted in separate plats, adjoining a field of Yellow Field corn planted for ensilage. The ground was plowed, thoroughly harrowed, and marked off in rows 3 feet 6 inches apart. The seed was planted May 16, 1888, with a one-horse corn drill, set to drop one kernel every 12 inches. All the varieties gave a good stand except Parker & Woods' Perfect Ensilage. The seeds of this variety germinated very poorly. All the varieties were cultivated June 11th, with Tower's Surface Cultivator, and June 21st and July 3d with the ordinary two-horse cultivator. The table on the following page gives the main facts concerning each variety as noted during this season:

NAME OF VARIETY.	Number of rows planted	Date of tasseling	Weight of 100 stalks, green, lbs	Per cent. leaves green	Per cent. ears and husks, green	Per cent. stalks, green	Average number of ears to stalk	SEED OBTAINED FROM.
Sanford's Ensilage	3	July 9	1,140	24.45	38.86	36.69	1.27	Parker & Woods.
Sheep's Tooth	2	" 21	2,020	23.78	28.88	47.34	.94	H. Sibley & Co.
Breck's Boston Market Ensilage	2	" 23	2,050	16.86	29.07	54.07	1.02	U. S. Department of Agriculture.
Parker & Woods' Perfect Ensilage	6	" 23	2,270	19.67	31.40	48.93	1.24	Parker & Woods.
Blunt's Prolific Ensilage	3	" 25	2,480	19.13	25.83	55.04	.92	Parker & Woods.
White Flat Ensilage	5	" 23	2,750	20.12	25.61	54.27	1.27	Parker & Woods.
Southern Horse Tooth	4	" 23	3,140	20.59	23.04	56.37	1.02	P. Henderson & Co.

One thousand stalks of each variety were cut August 21, and weighed green with the results as given in the table. All the varieties were in the milk stage except Sanford's Ensilage, which had reached the dough stage. One thousand stalks of the Yellow Field corn planted for ensilage were taken from the rows immediately adjoining these varieties, and weighed 1,540 pounds. The stalks stood considerably thicker in the row, and hence no accurate comparison can be made between them. It was evident, however, that most of the varieties would have given a greater yield than the Yellow corn, had they been planted as thickly. The Yellow corn gave a yield of 16 tons per acre weighed green.

In feeding ensilage, the leaf is of greater value than the stalk, and that variety which produces the greatest weight of leaves per acre, other things being equal, is the best variety to plant for ensilage. Of the sorts tested this year, the choice lies between the White Flat Ensilage and the Southern Horse Tooth Ensilage.

THE MILK AND BUTTER PRODUCT AS INFLUENCED BY THE GRAIN RATION WHEN FED WITH AMPLE PASTURAGE.

In general practice we rest content when our herds and flocks are provided with abundant nutritious pasturage. Few will deny that productive perennial pastures furnish the cheapest food for cattle, whether kept for milk or beef. Nevertheless, in the case of cattle under process of fattening, the practice of supplementing pasturage with more or less of grain food finds favor with a constantly increasing number of careful managers. They recognize the fact that the profit in farming, as in other lines of activity, come from doing a little more and better than we really seem compelled by circumstances to do. With this thought in mind, it seemed worth while to inquire into the advantages, if any, of adding to the common summer pasturage of milch cows a liberal feed of grain.

For the purposes of this experiment, six cows were at first employed - four three-year-old Jerseys, and two six-year-old grades. The Jerseys were good average specimens of the breed, perhaps something better than the ordinary, but certainly they were not remarkable as milk or butter producers. The grades were strongly tinctured with Shorthorn blood, and both animals were reckoned "good milkers." The essential facts regarding each cow may be stated as follows:

JERSEYS — Eva: milked since April 24, 1888: due to calve April, 1889. Prudie: milked since April 6, 1888: due to calve May, 1889. Pansy: milked since May 30, 1888; due to calve February, 1889. Pixley III: milked since April 3, 1888; due to calve March, 1889.

GRADES — White: milked since October 24, 1887: due to calve December, 1888, Ruby : milked since April, 1888; due to calve March, 1889.

The cows were first divided into three sets of two each, as indicated above. The experience of a week, however, showed that the Jersey cow, Pixley III, was not in condition to be continued the experiment. She developed a variable appetite, eating sparingly at all times and often refusing grain of any kind. Doubtless she was suffering from over-work, having been a milker steadily since the time of her first calving, May 16, 1887. For this reason she was withdrawn from the experiment July 22d.

The general plan of the experiment was as stated below. The cows were fed in sets of two each, each pair receiving a particular kind of feed for the space of seven days, when feed of another kind was used for seven days, and so on in the case of each pair to the end of the experiment. Thus, the cows Eva and Prudie began the experiment with pasture alone; the simple pasture was succeeded by bran and bran by oats, which in turn was followed by pasture alone. The subjoined tabular history of the experiment shows the order of the changes of feed in the case of each set. The grain referred to was fed in quantities to suit the appetite of each cow, and always was given in addition to ample pasturage, consisting for the most part of orchard grass and red clover. On the first day of each period (Saturday) no record was made either of the food consumed or milk yielded, and during the last two periods only the records of the last three days of each were taken.

The experiment really began July 11th, but on account of unavoidable mistakes and accidents, made in learning the best methods of work, the results of the first four days' work are omitted.

The milking was done at intervals of almost twelve hours, the same men doing the work throughout with scarcely an interruption. As soon as possible after milking, the milk was weighed and thoroughly mixed, and samples from each cow selected for testing. For the cream test, a graduated glass jar was filled as required; for the butter test, two pounds of milk were at first used, and afterwards one kilogram (2.2 pounds avoirdupois, nearly). The milk, under examination for butter, was placed in glass fruit jars, and these with the graduated jars were promptly set in a large tank holding water at 60°, deep enough to submerge the milk. After considerable experience, it became clearly apparent that more butter of better quality was obtained when the milk was set about forty-eight hours. If the setting was prolonged much past sixty hours, an inevitable loss followed, as was also the case when the churning was performed before the milk had stood forty-eight hours. It will be borne in mind that in dealing with the small quantities of milk, which alone could be used in the experiment, the setting of the milk had reference to ripening as well as raising the cream. The rule, with very few exceptions, was to churn morning and evening's milk at the same time, the former having stood forty-eight hours and the latter sixty.

At first (to July 20), the whole milk was churned, but the difficulty encountered in separating accurately and completely the small amount of butter contained in the proportionately large mass of milk made it necessary to return to the practice of skimming the samples and churning the cream with a portion of water added sufficient to reduce the cream to the required temperature.

The churning was done with a Cherry test churn, a device quite extensively used in creameries, for testing the milk of patrons. It consists of a strong frame having seats for a dozen two-quart cans, each held in place by the steady pressure of a spiral spring. The frame and its load of cans is given an oscillating movement by a crank and pitman, and the motion thus obtained is controlled by a balance wheel. Accompanying the machine was a set of metallic two-quart cans for use in churning. These we attempted to use for the purpose for which they were designed, but, by reason of inferior workmanship, they proved worthless, leaking so badly that we were forced to substitute for them two-quart glass fruit jars, which we found to answer our purpose well. The glass jars had the additional advantage over the metallic cans, in that the condition of the cream, at any stage of the churning process, could be seen at a glance without uncorking the jars.

The process of gathering and working the butter was necessarily a simple one. The buttermilk contained in each jar, as soon as churned, was separated from the butter by straining through a six inch square piece of cheese cloth, previously dampened, and accurately weighed. The retained butter was then washed in cold water, and thoroughly kneaded with the hand, until the moisture was very thoroughly eliminated. The thought was to bring the butter to as nearly as possible the condition of a good marketable product.

The weight of each of the sets of cows was taken weekly, beginning August 12th. The change in the condition of the cows from week to week was very slight, if anything. Thus, the united weights of Eva and Prudie, August 12th, were 1,435 pounds, and at the conclusion of the experiment 1,465. In the same time Pansy gained the difference between 835 and 890 pounds, while the two grades changed in weight from 2,310 to 2,355. These figures show that the cows certainly lost no flesh, and the difference in the contents of the stomachs of the cows at the first and last weighings seems a quite sufficient explanation of the apparent gain.

On August 3d, and henceforth daily throughout the experiment, the churning was supplemented by analysis made after Short's method of determining fat in milk; a method devised by Mr. F. C. Short, assistant chemist of the Wisconsin Experiment Station.* In the case of nearly every sample thus treated, the analysis was made in duplicate, and for the object of correcting any errors that otherwise might be passed unobserved. During the fifty-odd days of the experiment, no fewer than two hundred and thirty-seven (237) different samples of milk were churned, and one hundred and fifty-three (153) samples were analyzed, mostly in duplicate.

In the subjoined table, the facts are given as they appear on the daily records of the experiment. The occasional blanks which appear in the record must be charged to those accidents certain to occur in an experiment of this sort, which do not, however, affect the general results, and so require no fuller explanation at my hands.

* See Bulletin No. 16, Wisconsin Experiment Station, or page 124, Fifth Annual Report of the Wisconsin Experiment Station, for the year ending June 30, 1888.

DAILY RECORD.

Date.	NAME	Feed lbs	Milk, total lbs.	Cream, per cent	Temperature churning, F.	Time of churning, in minutes	Butter per cent.	Fat content, Short's method	REMARKS
1888.									
July 15	Eva and Prudie—Jersey........	Pasture alone	A. M., 17	10	70	......	4 52	......	......
		Pasture alone...	P. M., 16½	10	74	120	4 12	......	......
	Pansy and Pixey III—Jersey.	Meal, 10 lbs......	A. M., 18½	11	70	.. ...	3 59	......	......
		Meal, 10 lbs......	P. M., 19	12	70	95	5 94	......	......
	White and Ruby—Grade.......	Bran, 6 lbs.......	A. M., 15½	16	70	....	4 85	......	......
		Bran, 6 lbs.......	P. M., 15	12	70	85	3 27	......	......
July 16	Eva and Prudie—Jersey.......	Pasture alone...	A. M., 18½	9½	73	47	3 54	......	......
		Pasture alone...	P. M., 18½	10	72	55	2.89	......	......
	Pansy and Pixey III—Jersey,	Meal, 10 lbs......	A. M., 21	13	74	65	5 09	......	......
		Meal, 10 lbs......	P. M., 20	12	72	75	4 49	......	......
	White and Ruby—Grade.......	Bran, 6 lbs.......	A. M., 18	15	72	40	3 94	......	......
		Bran, 6 lbs.......	P. M., 18	12	73	60	3 08	......	......
July 17	Eva and Prudie—Jersey........	Pasture alone...	A. M., 19	10	71	25	3 50	......	......
		Pasture alone...	P. M., 20	10	70	40	2 22	......	......
	Pansy and Pixey III—Jersey,	Meal, 10 lbs......	A. M., 20	10	78	80	3 58	......	......
		Meal, 10 lbs......	P. M., 21½	12	70	44	2.40	......	......
	White and Ruby—Grade.......	Bran, 6 lbs.......	A. M., 18¼	11	74	60	3 87	......	......
		Bran, 6 lbs......	P. M., 20¼	10	71	45	2 67	......	......

Date.	NAME.	*Feed, lbs.*	*Milk, total lbs.....*	*Cream, per cent . . . .*	*Temperature churning, F°.....*	*Time of churning in minutes . . . .*	*Butter, per cent.....*	*Fat content, Short's method..*	REMARKS.
1888.									
July 18	Eva and Prudie—Jersey........	Pasture alone...	A. M., 18½	11	71	25	3 85	....	....
		Pasture alone...	P. M., 17½	11	72	20	4 43	....	....
	Pansy and Pixey III—Jersey.	Meal, 10 lbs.....	A. M., 19½	10	73	53	2 22	....	....
		Meal, 6 lbs.......	P. M.. 20	10	76	35	4 49	....	....
	White and Ruby—Grade.......	Bran, 6 lbs.......	A. M., 20½	12	71	42	3 56	....	....
		Bran, 6 lbs.......	P. M., 20¼	12	71	35	4 63	....	....
July 19	Eva and Prudie—Jersey........	Pasture alone...	A. M., 20	9½	74	55	5 25	....	....
		Pasture alone...	P. M., 20½	10	78	77	3 94	....	....
	Pansy and Pixey III—Jersey.	Meal, 6 lbs.......	A. M., 20½	10	79	69	5 67	....	....
		Meal, 6 lbs.......	P. M., 21	12	77	68	3 44	....	....
	White and Ruby—Grade.......	Bran, 6 lbs......	A. M., 21¼	11	78	65	1.25	....	....
		Bran, 6 lbs......	P. M., 19½	11	78	60	3 72	....	....
July 20	Eva and Prudie—Jersey........	Pasture alone...	A. M., 20	12	77	40	3 48	....	....
		Pasture alone...	P. M., 19½	12	70	20	3.73	....	Butter, granular.
	Pansy and Pixey III—Jersey.	Meal, 6 lbs......	A. M., 20½	13	79	68	2 40	....	....
		Meal, 6 lbs......	P. M., 20½	10	70	20	5 81	....	Butter, soft, white.
	White and Ruby—Grade.......	Bran, 6 lbs......	A. M., 23½	14	78	60	2.66	....	....
		Bran, 6 lbs......	P. M., 20½	11	70	20	4 05	....	Butter, granular, hard.

DAILY RECORD — CONTINUED.

Date	Name	Feed, lbs.	Milk, total lbs.	Cream per cent.	Temperature churning, F.	Time of churning, in minutes.	Butter per cent.	Fat content, Short's method	Remarks.
1888.									
July 22	Eva and Prudie — Jersey	Bran, 6 lbs.	A. M., 20	19	70	20	2.06	....	Butter, granular, hard.
		Bran, 6 lbs.	P. M., 21½	3	72	33	5.83	....	Butter, yellow, granular.
	Pansy — Jersey	Pasture alone	A. M., 10	9	70	20	3.26	....	Butter, granular.
		Pasture alone	P. M., 10	11	72	30	4.87	....	Butter, granular.
	White and Ruby — Grade	Meal, 6 lbs.	A. M., 29	11	70	20	2.09	....	Butter, soft, white.
		Meal, 6 lbs.	P. M., 21	14	70	33	5.88	....	Butter, white, granular.
July 23	Eva and Prudie — Jersey	Bran, 6 lbs.	A. M., 21½	11	72	33	4.61	....	Butter, yellow, granular.
		Bran, 6 lbs.	P. M., 22½	10	76	28	4.80	....	Butter, white, granular.
	Pansy — Jersey	Pasture alone	A. M., 10	10	72	35	4.28	....	Butter, yellow, granular.
		Pasture alone	P. M., 11½	11	76	38	4.86	....	Butter, yellow, granular.
	White and Ruby — Grade	Meal, 6 lbs.	A. M., 23	13	74	35	4.84	....	Butter, soft white, in flakes.
		Meal, 6 lbs.	P. M., 21	10	76	38	3.54	....	Butter, white, poor quality.
July 24	Eva and Prudie — Jersey	Bran, 6 lbs.	A. M., 21½	11	76	38	4.49	....	Butter, yellow, granular.
		Bran, 6 lbs.	P. M., 20	8	72	16	2.89	....	Butter, yellow, granular.
	Pansy — Jersey	Pasture alone	A. M., 10½	12	74	32	5.16	....	Butter, white, poor.
		Pasture alone	P. M., 10½	10	72	13	4.09	....	Butter, white, soft.
	White and Ruby — Grade	Meal, 6 lbs.	A. M., 23	13	76	42	4.63	....	Butter, white, granular.
		Meal, 6 lbs.	P. M., 20	9	73	17	2.01	....	Butter, white, granular.

DAILY RECORD—CONTINUED.

Date.	NAME.	Feed, lbs.	Milk, total lbs.	Cream, per cent.	Temperature churning, F°.	Time of churning, in minutes.	Butter, per cent.	Fat content, Short's method.	REMARKS.
1888.									
July 25	Eva and Prudie—Jersey	Bran, 6 lbs.	A. M., 20	10	72	15	4.79	....	Butter, yellow, granular.
		Bran, 8 lbs.	P. M., 17½	10	74	16	4 60	....	Butter, yellow, granular.
	Pansy—Jersey	Pasture alone.	A. M., 9	11	78	12	4.05	....	Butter, yellow, granular.
		Pasture alone.	P. M., 8	11	72	18	1.74	....	Butter, white.
	White and Ruby—Grade	Meal, 6 lbs.	A. M., 24½	11	74	18	3.39	....	Butter, white, granular.
		Meal, 8 lbs.	P. M., 20½	12	72	24	3.66	....	Butter, white, soft.
July 26	Eva and Prudie—Jersey	Bran, 8 lbs.	A. M., 19½	10	76	16	4.16	....	Butter, white, soft.
		Bran, 8 lbs.	P. M., 20	10	74	16	2 34	....	Butter, yellow, granular.
	Pansy—Jersey	Pasture alone.	A. M., 9	10	72	16	4.42	....	Butter, granular, yellow.
		Pasture alone.	P. M., 8½	10	70	18	2 58	....	Butter, granular, yellow.
	White and Ruby—Grade	Meal, 8 lbs.	A. M., 20½	15	75	27	4.03	....	Butter, white, granular.
		Meal, 8 lbs.	P. M., 20½	10½	71	22	2.02	....	Butter, white, granular.
July 27	Eva and Prudie—Jersey	Bran, 8 lbs.	A. M., 21	10	75	19	4.46	....	Butter, white, soft.
		Bran, 8 lbs.	P. M., 18	10	73	11	3.02	....	Butter, yellow, granular.
	Pansy—Jersey	Pasture alone.	A. M., 8	10	72	16	5.03	....	Butter, yellow, granular.
		Pasture alone.	P. M., 7½	11	76	10	4 00	....	Butter, yellow, granular.
	White and Ruby—Grade	Meal, 8 lbs.	A. M., 21½	11	80	24	3.60	....	Butter, white, granular.
		Meal, 8 lbs.	P. M., 20¼	10	75	16	3.69	....	Butter, white, granular.

Date	NAME.	Feed, lbs.	Milk, total lbs	Cream, per cent.. ..	Temperature churning, F°......	Time of churning, in minutes....	Butter, per cent.	Fat content, Short's method ..	REMARKS
1888.									
July 29	Eva and Prudie—Jersey........	Oats gr., 8 lbs...	A. M., 18½	11	76	22	4 73	....	Butter, white, granular.
		Oats gr., 8 lbs. .	P. M., 21¼	9	75	18	4 15	....	Butter, white, granular.
	Pansy—Jersey..	Bran, 8 lbs.......	A. M., 10	9	76	23	4 60	....	Butter, yellow, granular.
		Bran, 8 lbs.......	P. M., 10½	8	75	18	3 82	....	Butter, yellow, granular.
	White and Ruby—Grade.......	Pasture alone...	A. M., 17½	10½	76	23	2 28	....	Butter, soft, white.
		Pasture alone...	P. M., 17¼	9	77	22	2 69	....	Butter, white, granular.
July 30	Eva and Prudie—Jersey........	Oats gr., 8 lbs...	A. M., 21	11	76	12	4 68	....	Butter, yellow, granular.
		Oats gr., 8 lbs...	P. M., 19½	8½	76	20	4 11	....	Butter, yellow, granular.
	Pansy—Jersey.....................	Bran, 8 lbs.......	A. M., 10¼	12	76	18	5 44	....	Butter, white, granular.
		Bran, 8 lbs.......	P. M., 9½	11	76	19	4.98	....	Butter, yellow, granular.
	White and Ruby—Grade.......	Pasture alone...	A. M., 19½	18	76	15	6 47	....	Butter, white, granular.
		Pasture alone...	P. M., 15	9½	76	19	2.84	....	Butter, white, granular.
July 31	Eva and Prudie—Jersey........	Oats gr., 8 lbs...	A. M., 22	10	76	21	4.56	....	Butter, yellow, granular.
		Oats gr., 8 lbs...	P. M., 21	12	73	17	4 55	....	Butter, yellow, granular.
	Pansy—Jersey	Bran, 8 lbs.......	A. M., 10	9	77	21	3 74	....	Butter, white, soft.
		Bran, 8 lbs.......	P. M., 10	13	74	20	6.37	....	Butter, yellow, granular.
	White and Ruby—Grade.......	Pasture alone...	A. M., 17	10½	76	24	2.20	....	Butter, white, granular.
		Pasture alone...	P. M., 14½	9	73	17	2.48	....	Butter, white, soft.

DAILY RECORD—CONTINUED.

Date.	NAME.	Feed, lbs.	Milk. total lbs.	Cream, per cent	Temperature churning, F°	Time of churning, in minutes	Butter, per cent	Fat content, Short's method	REMARKS.
1888.									
Aug. 1	Eva and Prudie—Jersey	Oats, 8 lbs.	A. M., 21½	13	75	25	5.41	....	Butter, yellow, granular.
		Oats, 8 lbs.	P. M., 20	11	72	30	5 75	....	Butter, yellow, granular.
	Pansy—Jersey	Bran, 8 lbs.	A. M., 10½	11	75	30	5.01	....	Butter, yellow, granular.
		Bran, 7 lbs.	P. M., 10	9	72	25	4.38	....	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 14	12	74	21	2.22	....	Butter, white, granular.
		Pasture alone	P. M., 13	10	72	33	2 98	....	Butter, white, granular.
Aug. 2	Eva and Prudie—Jersey	Oats gr., 8 lbs.	A. M., 21	11	72	44	4.10	....	Butter, yellow, granular.
		Oats gr., 8 lbs.	P. M., 20½	10	67	63	6.03	....	Butter, yellow, granular.
	Pansy—Jersey	Bran, 7 lbs.	A. M., 11	11	76	26	4.13	....	Butter, yellow, granular.
		Bran, 7 lbs.	P. M., 10½	10½	66	54	4.47	....	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 13½	15	73	28	3.09	....	Butter, white, granular.
		Pasture alone	P. M., 12	10	67	42	4.80	....	Butter, white, granular.
Aug. 3	Eva and Prudie—Jersey	Oats gr., 8 lbs.	A. M., 20	9	67	66	6.07	5.09	Butter, yellow, granular.
		Oats gr., 8 lbs.	P. M., 20	10	67	59	6.02	5 85	Butter, yellow, granular.
	Pansy—Jersey	Bran, 7 lbs.	A. M., 11	9½	66	47	5.26	4.33	Butter, yellow, granular.
		Bran, 7 lbs.	P. M., 10½	10½	66	52	5.62	4.98	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 12	11½	68	30	4.86	5.09	Butter, white, granular.
		Pasture alone	P. M., 12	11	66	36	4 34	4.63	Butter, white, granular.

DAILY RECORD — CONTINUED.

Date.	Name.	Feed lbs.	Milk, total lbs.	Cream, per cent.	Temperature churning, F°.	Time of churning, in minutes.	Butter, per cent.	Fat content, Short's method.	Remarks.
1888.									
Aug. 5	Eva and Prudie—Jersey	Pasture alone	A. M., 21¼	9½	70	24	5.26	5.59	Butter, yellow, granular.
		Pasture alone	P. M., 17	11	63	44	6.00	5.60	Butter, yellow, granular.
	Pansy—Jersey	Oats, gr., 5 lbs.	A. M., 13¼	11	74	42	4.73	4.83	Butter, yellow, granular.
		Oats, gr., 5 lbs.	P. M., 9¾	12	74	74	5.60	5.59	Butter, yellow, granular.
	White and Ruby—Grade	Bran, 16 lbs.	A. M., 13¾	9	73	38	2.48	3.35	Butter, white, granular.
		Bran, 16 lbs.	P. M., 17¾	9½	63	46	3.82	3.71	Butter, white, granular.
Aug. 6	Eva and Prudie—Jersey	Pasture alone	A. M., 21	9	64	62	5.39	4.58	Butter, yellow, granular.
		Pasture alone	P. M., 18½	10	66	40	4.56	4.63	Butter, yellow, granular.
	Pansy—Jersey	Oats, gr., 5 lbs.	A. M., 12	10	63	87	4.95	4.37	Butter, yellow, granular.
		Oats, gr., 5 lbs.	P. M., 10½	9	65	80	5.15	4.22	Butter, yellow, granular.
	White and Ruby—Grade	Bran, 16 lbs.	A. M., 22¼	18	65	38	5.84	5.99	Butter, white, granular.
		Bran, 16 lbs.	P. M., 16¾	10½	63	40	4.37	4.43	Butter, white, granular.
Aug. 7	Eva and Prudie—Jersey	Pasture alone	A. M., 20½	9	65	45	4.39	4.35	Butter, yellow, granular.
		Pasture alone	P. M., 18½	10	71	23	4.56	5.09	Butter, yellow, granular.
	Pansy—Jersey	Oats, gr., 5 lbs.	A. M., 12	9	65	80	5.05	4.32	Butter, yellow, granular.
		Oats, gr., 5 lbs.	P. M., 10½	9	70	30	5.38	4.76	Butter, yellow, granular.
	White and Ruby—Grade	Bran, 16 lbs.	A. M., 21½	9	67	65	3.35	3.87	Butter, white, granular.
		Bran, 16 lbs.	P. M., 19	......	74	27	2.46	3.59	Butter, white, granular.

DAILY RECORD—CONTINUED.

Date.	NAME.	Feed, lbs.	Milk, total lbs.	Cream, per cent.	Temperature churning, F°.	Time of churning, in minutes.	Butter, per cent.	Fat content, Short's method.	REMARKS.
1888.									
Aug. 8	Eva and Prudie—Jersey	Pasture alone	A. M., 20½	10	68	23	5.18	4.81	Butter, yellow, granular.
		Pasture alone	P. M., 18½	10	70	18	5.34	4.90	Butter, yellow, granular.
	Pansy—Jersey	Oats, 9 lbs.	A. M., 11½	8½	72	27	4.56	3.94	Butter, yellow, soft.
		Oats, 5 lbs.	P. M., 10½	11	72	25	5.16	4.73	Butter, yellow, soft.
	White and Ruby—Grade	Bran, 16 lbs.	A. M., 22¼	10	71	27	2.96	3.96	Butter, white, granular.
		Bran, 16 lbs.	P. M., 20¼	11	71	25	3.40	3.28	Butter, white, granular.
Aug. 9	Eva and Prudie—Jersey	Pasture alone	A. M., 19	16	70	18	3.87	4.93	Butter, yellow, granular.
		Pasture alone	P. M., 17½	10	66	23	5.16	5.09	Butter, yellow, granular.
	Pansy—Jersey	Oats, 9 lbs.	A. M., 12	10	70	25	5.03	4.66	Butter, yellow, granular.
		Oats, 5 lbs.	P. M., 10½	9½	66	43	5.45	4.76	Butter, yellow, granular.
	White and Ruby—Grade	Bran, 16 lbs.	A. M., 21¼	12	70	18	1.95	4.10	Butter, yellow, granular.
		Bran, 16 lbs.	P. M., 19½	10	66	33	4.02	3.91	Butter, white, granular.
Aug. 10	Eva and Prudie—Jersey	Pasture alone	A. M., 19½	10	66	19	5.54	4.53	Butter, yellow, granular.
		Pasture alone	P. M., 17½	10	64	19	4.40	5.09	Butter, yellow, granular.
	Pansy—Jersey	Oats, 9 lbs.	A. M., 11½	9	66	43	5.25	4.42	Butter, yellow, granular.
		Oats, 5 lbs.	P. M., 11	9	68	49	4.99	4.93	Butter, yellow, granular.
	White and Ruby—Grade	Bran, 16 lbs.	A. M., 22½	9½	65	19	4.79	4.07	Butter, white, granular.
		Bran, 16 lbs.	P. M., 21	10½	60	25	3.81	3.96	Butter, yellow, granular.

DAILY RECORD—CONTINUED.

Date.	Name.	Feed, lbs.	Milk, total lbs.	Cream, per cent.	Temperature churning, F°.	Time of churning, in minutes.	Butter, per cent.	Fat content, Short's method.	Remarks.
1888.									
Aug. 12	Eva and Prudie—Jersey	Bran, 16 lbs.	A. M., 21	10	72	17	4.23	5.49	Butter, yellow, granular.
		Bran, 16 lbs.	P. M., 17	10	71	13	5.30	5.58	Butter, yellow, granular.
	Pansy—Jersey	Pasture alone	A. M., 10	9	71	21	4.35	4.35	Butter, yellow, granular.
		Pasture alone	P. M., 8½	9½	71	13	5.61	5.59	Butter, yellow, granular.
	White and Ruby—Grade	Meal, 10 lbs.	A. M., 24	10	73	21	2.41	4.68	Butter, white, granular.
		Meal, 10 lbs.	P. M., 20	10½	71	13	4.14	4.32	Butter, white, granular.
Aug. 13	Eva and Prudie—Jersey	Bran, 16 lbs.	A. M., 21½	11	72	13	4.66	4.68	Butter, yellow, granular.
		Bran, 16 lbs.	P. M., 16½	10	72	25	5.23	5.16	Butter, yellow, granular.
	Pansy—Jersey	Pasture alone	A. M., 10½	9½	71	13	3.78	4.17	Butter, yellow, granular.
		Pasture alone	P. M., 8½	10	74	25	5.77	5.24	Butter, yellow, granular.
	White and Ruby—Grade	Meal, 10 lbs.	A. M., 25	10	71	13	2.93	4.07	Butter, yellow, granular.
		Meal, 10 lbs.	P. M., 21	10	72	23	3.28	4.32	Butter, white, granular.
Aug. 14	Eva and Prudie—Jersey	Bran, 16 lbs.	A. M., 19	9½	72	30	5.60	5.14	Butter, yellow, granular.
		Bran, 12 lbs.	P. M., 16½	10	70	24	6.52	4.53	Butter, yellow, granular.
	Pansy—Jersey	Pasture alone	A. M., 10	9	72	19	2.77	4.10	Butter, yellow, granular.
		Pasture alone	P. M., 8½	9	69	17	3.59	4.71	Butter, yellow, granular.
	White and Ruby—Grade	Meal, 10 lbs.	A. M., 27	9½	72	25	3.42	4.52	Butter, white, granular.
		Meal, 10 lbs.	P. M., 18¼	10	70	20	2.84	3.43	Butter, white, granular.

DAILY RECORD—CONTINUED.

Date.	NAME.	Feed, lbs.	Milk total lbs....	Cream, per cent....	Temperature churning, F°...	Time of churning, in minutes....	Butter, per cent...	Fat content, Short's method..	REMARKS.
1888.									
Aug. 15	Eva and Prudie—Jersey........	Bran, 0 lbs.......	A. M., 16½	10	68	24	4.90	4.56	Butter, yellow, granular.
		Bran, 0 lbs.......	P. M., 10¼	15	68	15	9.48	6.88	Butter, yellow, granular.
	Pansy—Jersey.....................	Pasture alone...	A. M., 9½	8	68	17	3.62	4.07	Butter, yellow, granular.
		Pasture alone...	P. M., 9¼	12	69	15	5.46	5.62	Butter, yellow, granular.
	White and Ruby—Grade.......	Meal, 10 lbs......	A. M., 29	11	68	20	2.09	4.60	Butter, white, granular.
		Meal, 10 lbs......	P. M., 20¾	10	67	15	4.10	4.56	Butter, white, granular.
Aug. 16	Eva and Prudie—Jersey........	Bran, 0 lbs.......	A. M., 13	11	73	42	5.32	5.14	Butter, yellow, granular.
		Bran, 0 lbs.......	P. M., 14½	9	74	23	4.72	4.68	Butter, white, granular.
	Pansy—Jersey.....................	Pasture alone...	A. M., 9	10	67	19	5.46	4.83	Butter, yellow, granular.
		Pasture alone..	P. M., 9	8½	72	18	4.91	4.60	Butter, yellow, granular.
	White and Ruby—Grade.......	Meal, 10 lbs......	A. M., 24¾	12½	68	19	4.81	4.78	Butter, white, granular.
		Meal, 10 lbs......	P. M., 22¾	9	70	18	3.93	4.17	Butter, white, granular.
Aug. 17	Eva and Prudie—Jersey........	Bran, 2 lbs.......	A. M., 18½	8½	73	20	5.71	4.87	Butter, yellow, granular.
		Bran, 0 lbs.......	P. M., 17½	10	72	18	5.30	5.08	Butter, yellow, granular.
	Pansy—Jersey.....................	Pasture alone...	A. M., 9½	10	72	20	5.17	5.09	Butter, yellow, granular.
		Pasture alone...	P. M., 8½	11	73	23	6.17	5.10	Butter, yellow, granular.
	White and Ruby—Grade.......	Meal, 10 lbs......	A. M., 25½	11½	lost	......	....	4.88	....
		Meal, 10 lbs......	P. M., 21	10½	76	18	3.97	5.19	Butter, yellow, granular.

DAILY RECORD—CONTINUED.

Date.	NAME.	Feed, lbs	Milk total lbs	Cream, per cent.	Temperature churning, F°	Time of churning, in minutes.	Butter, per cent.	Fat content, Short's method	REMARKS.
1888.									
Aug. 19	Eva and Prudie—Jersey	Meal, 8 lbs	A. M., 19½	10	70	38	4.95	4.07	Butter, yellow, granular.
		Meal, 8 lbs	P. M., 17½	11	72	29	5.78	4.58	Butter, yellow, granular.
	Pansy—Jersey	Oats, 5 lbs	A. M., 11	10	74	56	4.65	4.37	Butter, yellow, granular.
		Oats, 5 lbs	P. M., 9	9	72	48	4.74	4.38	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 26½	12	70	45	2.91	4.58	Butter, yellow, granular.
		Pasture alone	P. M., 22½	13	70	20	3.85	4.57	Butter, white, granular.
Aug. 20	Eva and Prudie—Jersey	Meal, 8 lbs	A. M., 18¾	12	71	36	6.96	5.03	Butter, yellow, granular.
		Meal, 8 lbs	P. M., 18½	10	68	38	6.77	4.68	Butter, yellow, granular.
	Pansy—Jersey	Oats gr, 5 lbs	A. M., 11	10½	72	48	4.62	4.07	Butter, yellow, granular.
		Oats gr, 6 lbs	P. M., 10	9	72	68	5.71	4.73	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 20	13	69	26	4.19	4.78	Butter, yellow, soft.
		Pasture alone	P. M., 18½	8	68	25	4.24	4.52	Butter, yellow, granular.
Aug. 21	Eva and Prudie—Jersey	Meal, 10 lbs	A. M., 21	11	67	38	6.21	4.22	Butter, yellow, granular.
		Meal, 10 lbs	P. M., 18	9½	71	27	5.09	4.52	Butter, yellow, granular.
	Pansy—Jersey	Oats gr., 6 lbs	A. M., 11½	11	69	70	5.59	4.63	Butter, yellow, granular.
		Oats gr., 6 lbs	P. M., 9	10	72	51	5.58	4.52	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 20½	8½	70	38	3.16	4.01	Butter, white, granular.
		Pasture alone	P. M., 17½	10	71	31	3.10	3.91	Butter, white, granular.

DAILY RECORD—CONTINUED.

Date.	NAME.	*Feed, lbs.*	*Milk, total lbs.*	*Cream, per cent.*	*Temperature churning F°.*	*Time of churning, in minutes.*	*Butter, per cent.*	*Fat content, Short's method.*	REMARKS.
1888.									
Aug. 22	Eva and Prudie—Jersey	Meal, 10 lbs.	A. M., 21½	10	70	35	4.19	4.47	Butter, yellow, granular.
		Meal, 12 lbs.	P. M., 19¼	10½	68	16	4.58	5.19	Butter, yellow, granular.
	Pansy—Jersey	Oats gr., 6 lbs.	A. M., 12	10	71	55	5.14	4.58	Butter, yellow, granular.
		Oats gr., 7 lbs.	P. M., 11¼	12½	73	25	6.26	5.89	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 20¼	11	68	20	1.23	4.83	Butter, white, granular.
		Pasture alone	P. M., 17	10	71	20	3.04	4.12	Butter, white, granular.
Aug. 23	Eva and Prudie—Jersey	Meal, 12 lbs.	A. M., 21¼	12	72	24	4.86	5.08	Butter, yellow, granular.
		Meal, 12 lbs.	P. M., 19	11	74	24	5.33	5.14	Butter, yellow, granular.
	Pansy—Jersey	Oats gr., 7 lbs.	A. M., 11	9	71	24	4.57	4.88	Butter, yellow, granular.
		Oats gr., 7 lbs.	P. M., 9½	9	73	36	5.18	4.37	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 20¾	13	72	20	3.62	4.73	Butter, white.
		Pasture alone	P. M., 18¾	11½	72	27	4.42	5.03	Butter, white, very poor.
Aug. 24	Eva and Prudie—Jersey	Meal, 14 lbs.	A. M., 22	10	76	20	5.00	5.14	Butter, yellow, granular.
		Meal, 14 lbs.	P. M., 19½	11	72	12	5.23	4.93	Butter, yellow, granular.
	Pansy—Jersey	Oats gr., 7 lbs.	A. M., 12	8	75	44	4.50	4.22	Butter, yellow, granular.
		Oats gr., 7 lbs.	P. M., 9½	8½	72	46	4.23	4.32	Butter, yellow, granular.
	White and Ruby—Grade	Pasture alone	A. M., 19	11½	lost	—	—	4.47	......
		Pasture alone	P. M., 18¾	11	73	26	4.37	4.68	Butter, white, soft, poor.

DAILY RECORD—CONTINUED.

Date.	NAME.	Feed, lbs.	Milk, total lbs.	Cream, per cent.	Temperature churning, F.	Time of churning, in minutes.	Butter, per cent.	Fat content, Short's method.	REMARKS.
1888.									
Aug. 26	Eva and Prudie—Jersey	Pasture alone	A. M., 18½	......	......	......	......	5.24	Butter not churned.
		Pasture alone	P. M., 14	......	......	......	......	5.59	A change was made, and only last three days of each period taken; August 26 first day of period.
	Pansy—Jersey	Meal, 8 lbs.	A. M., 10½	......	......	......	......	4.52	
		Meal, 8 lbs.	P. M., 10	......	......	......	......	5.99	
	White and Ruby—Grade	Oats gr., 18 lbs.	A. M., 23	......	......	......	......	3.86	
		Oats gr., 18 lbs.	P. M., 19	......	......	......	......	4.17	
Aug. 29	Eva and Prudie—Jersey	Pasture alone	A. M., 16	10	63	36	4.68	5.14	Butter, yellow, granular.
		Pasture alone	P. M., 13½	10	66	35	4.58	5.03	Butter, yellow, granular.
	Pansy—Jersey	Meal, 8 lbs.	A. M., 12	10	66	52	6.85	4.52	Butter, yellow, granular.
		Meal, 8 lbs.	P. M., 9½	10	66	60	5.19	5.19	Butter, yellow, granular.
	White and Ruby—Grade	Oats gr., 18 lbs.	A. M., 22½	9½	66	84	4.25	4.52	Butter, light yellow, granular.
		Oats gr., 18 lbs.	P. M., 22	10	67	86	3.92	4.58	Butter, light yellow, granular.
Aug. 30	Eva and Prudie—Jersey	Pasture alone	A. M., 14½	12	63	37	5.26	5.59	Butter, yellow, granular.
		Pasture alone	P. M., 12½	13	65	15	5.14	5.14	Butter, yellow, granular.
	Pansy—Jersey	Meal, 8 lbs.	A. M., 11	7	67	60	4.54	4.12	Butter, yellow, granular.
		Meal, 8 lbs.	P. M., 9	11	66	45	4.84	4.32	Butter, yellow, granular.
	White and Ruby—Grade	Oats gr., 18 lbs.	A. M., 23½	10	67	86	3.48	4.32	Butter, light yellow, granular.
		Oats gr., 18 lbs.	P. M., 20	10	69	38	4.39	4.12	Butter, light yellow, granular.

DAILY RECORD—CONTINUED.

Date.	NAME.	Feed, lbs.	Milk, total lbs.	Cream, per cent.	Temperature churning, F°.	Time of churning, in minutes.	Butter, per cent.	Fat content, Short's method.	REMARKS.
1888.									
Aug. 31	Eva and Prudie—Jersey	Pasture alone	A. M., 14½	14	64	22	7.33	5 19	Butter, yellow, granular.
		Pasture alone	P. M., 12	14	64	23	5.35	5 39	Butter, yellow, granular.
	Pansy—Jersey	Meal, 8 lbs.	A. M., 11	8	63	47	4.93	4.27	Butter, yellow, granular.
		Meal, 8 lbs.	P. M., 10	9	66	48	5.46	4.47	Butter, yellow, granular.
	White and Ruby—Grade	Oats gr., 18 lbs.	A. M., 21	13	64	52	4.31	4.07	Butter, light yellow, granular.
		Oats gr., 18 lbs.	P. M., 19½	12	65	52	5.07	4.37	Butter, light yellow, granular.
Sept. 5	Eva and Prudie—Jersey	Bran, 12 lbs.	A. M., 15	10	70	18	5.56	5.34	Butter, yellow, granular.
		Bran, 12 lbs.	P. M., 14	10½	70	18	5.08	5.29	Butter, yellow, granular.
	Pansy—Jersey	Pasture alone	A. M., 8	9	71	15	4.44	5.19	Butter, yellow, granular.
		Pasture alone	P. M., 5½	9	69	12	4 16	4 98	Butter, yellow, granular.
	White and Ruby—Grade	Meal, 16 lbs.	A. M., 26	10	75	32	4.21	4.12	Butter, white, soft, very poor.
		Meal, 16 lbs.	P. M., 20	9½	73	22	4.35	4.07	Butter, white, soft, very poor.
Sept. 6	Eva and Prudie—Jersey	Bran, 12 lbs.	A. M., 17	10	72	18	4.61	5.04	Butter, light yellow, granular.
		Bran, 12 lbs.	P. M., 14	11	73	17	4.07	5 04	Butter, light yellow, granular.
	Pansy—Jersey	Pasture alone	A. M., 8	10	72	15	4.49	4.93	Butter, yellow, granular.
		Pasture alone	P. M., 6½	10	72	12	4 74	6.10	Butter, yellow, granular.
	White and Ruby—Grade	Meal, 18 lbs.	A. M., 24	11	73	22	3.43	5.14	Butter, light yellow, granular.
		Meal, 18 lbs.	P. M., 16	6	76	26	1.43	2.79	Butter, white, granular.

DAILY RECORD—CONCLUDED.

Date.	NAME.	Feed, lbs.	Milk, total lbs.	Cream, per cent	Temperature churning, F°	Time of churning, in minutes	Butter, per cent	Fat content, Short's method	REMARKS.
1888. Sept. 7	Eva and Prudie—Jersey	Bran, 12 lbs	A. M., 17	13	73	12	3.72	5.09	Butter, yellow, granular.
		Bran, 12 lbs	P. M., 12½	11	72	12	4.59	....	Butter, yellow, granular.
	Pansy—Jersey	Pasture alone	A. M., 7	10	71	12	3.87	4.83	Butter, yellow, granular.
		Pasture alone	P. M., 5	12	76	12	4.66	....	Butter, yellow, granular.
	White and Ruby—Grade	Meal, 18 lbs	A. M., 23	10	73	12	3.72	5.09	Butter, white, granular.
		Meal, 18 lbs	P. M., 22	13	76	15	5.01	....	Butter, yellow, very soft and greasy.

DAILY FEED, LBS.	MILK.		CREAM, PER CENT.		BUTTER, PER CENT.		FAT, PER CENT. (SHORT'S METHOD.)	
	Daily yield per cow, lbs.	*Per cent. of gain (+), or loss (—), compared with pasture alone.*	*Average yield, (bulk.)*	*Gain (+), or loss (—), compared with pasture alone.*	*Average yield.*	*Gain (+), or loss (—), compared with pasture alone.*	*Average yield.*	*Gain (+), or loss (—), compared with pasture alone.*
EVA AND PRUDIE:								
Pasture alone	17.30	....	11.02	....	4.81	....	5.06	....
Corn meal, 10.66	20.41	+17.97	10.75	—2 45	4.86	+1 03	4.99	—1.38
Bran, 9.83	17.12	—1.05	10 45	—5.17	4 25	—11 64	5.16	+1.97
Oats gr., 8.00	20.50	+18.49	10.66	—3 26	5 56	+15.59	5.47	+8.10
PANSY:								
Pasture alone	16.08	....	10.13	....	4 38	....	5 03	....
Corn meal, 16.00	20.83	+29.54	10 00	—1 28	4 63	+5.71	4 48	—10.93
Bran, 14.33	21.16	+31.59	10.25	+1.18	4.81	+9 81	4.65	—7.55
Oats gr., 11.83	22.04	+37.06	9.50	—6.22	5.02	+14 61	4.81	—4.37
WHITE AND RUBY:								
Pasture alone	16.00	....	11 45	....	3 61	....	4.69	....
Corn meal, 11.66	22 36	+39.75	10.19	—11.05	3.63	+.55	4.49	—4.26
Bran, 11.00	21.00	+31.25	11.16	—2 53	3.40	—5.81	3.88	—17.27
Oats gr., 18.8	21.41	+33.81	10.75	—6.11	4.23	+17.17	4.33	—7.67

TABLE NO. 2—CONCLUDED.

DAILY FEED, LBS.	MILK.		CREAM, PER CENT.		BUTTER, PER CENT.		FAT, PER CENT. (SHORT'S METHOD.)	
	Daily yield per cow, lbs.	*Per cent. of gain (+), or loss (—), compared with pasture alone.*	*Average yield, (bulk.)*	*Gain (+), or loss (—), compared with pasture alone.*	*Average yield.*	*Gain (+), or loss (—), compared with pasture alone.*	*Average yield.*	*Gain (+), or loss (—), compared with pasture alone.*
TOTALS AND AVERAGES:								
Pasture alone	16.62	....	10.80	....	4.35	....	4.95	....
Corn Meal, 11.93	21.90	+31.76	10.20	—5.55	4.17	—4.13	4.61	—6.86
Bran, 10.85	19.29	+16.07	10.66	—1.29	4.01	—7.81	4.48	—9.49
Oats gr., 12.64	21.31	+28.22	10.10	—6.48	4.96	+14.02	4.73	—4.44

The lesson taught by the above table (No. 2) plainly is, that the grain, in the case of corn meal, bran and oats, was fed at a considerable loss. The grain feed added materially to the milk yield, corn meal showing the largest increase, the gain in this case amounting to more than thirty-one per cent. But that this gain did not nearly pay expenses, is shown in the summary of table No. 2. We here see, that while the flow of milk was considerably increased, the gain — amounting to more than thirty-one per cent. of the yield obtained from pasture alone — was quite incommensurate with the cost of the supplementary grain ration. This is further shown by the fact that the cream per cent. was considerably diminished, the per cent. of butter churned out was also decreased, except in the case of ground oats fed, when a considerable increase in the per cent. of churned butter was noticed, accompanied by a gain in the amount of fat obtained by analysis, although even then the per cent. of fat yielded was 4.41 less than that given when pasture alone was the feed of the cows.

These figures, representing, as they do, per cents. of the milk yielded are, however, misleading when considered by themselves. It is not to be supposed that the cows gave less butter when fed on grain and pasture than was obtained when pasture alone was the feed: they really gave much more. The diminished per cents. simply show that the milk increased rapidly as a result of the extra feeding, while the increase in the amount of butter and other products of milk was made much less rapidly. This fact will be clearly seen in the subjoined table, which shows the actual daily products of the milk in pounds of cream, butter and fat:

	MILK.		CREAM.		BUTTER.		FAT.	
	Daily yield per cow, lbs.	*Gain for grain fed, lbs.*	*Daily yield per cow, lbs.*	*Gain for grain fed, lbs.*	*Daily yield per cow, lbs.*	*Gain for grain fed, lbs.*	*Daily yield per cow, lbs.*	*Gain for grain fed, lbs.*
Pasture alone	16.62	....	1.79	....	0.72	....	0.82	....
Corn meal, 11.93 lbs.	21.90	5.28	2.23	0.44	0.91	0.19	1.01	0.19
Bran, 10.85 lbs.	19.29	2.67	2.05	0.26	0.77	0.05	0.86	0.04
Ground oats, 12.64 lbs.	21.31	4.69	2.15	0.36	1.05	0.33	1.00	0.18

The amount of cream thrown up by the milk, and its relation to the yield of butter and fat, are somewhat strangely shown in this experiment. Popularly the notion is held, that the cream yielded by milk is a safe index of its butter capacity. It is of course true that rich milk throws up heavy and abundant cream, while thin and watery milk gives a light skimming of cream; but what is plainly not true, according to the facts of this experiment, is the assumption that the milk is valuable in proportion to the cream it yields, implying that cream is everywhere alike in value. In the common practice of buying cream by the "gauge," it is supposed that the product of cream in butter is uniform. In this experiment of ours, cream was the one discordant element. In the case of every cow employed, and with each kind of feed, the milk giving the largest display of cream often gave the least butter product, and the reverse. As far as we could judge, the character of the cream varies quite as much as the milk does in its original condition. In proof of this, we submit the following tabular statement, in which the average yield of butter and fat of all of the different cream per cents. obtained in the entire experiment is given in horizontal columns:

TABLE No. 3.

	CREAM PER CENTS.						
	8	9	10	11	12	13	14
Butter, per cent.	4.45	4.86	4.42	4.03	4.20	4.21	5.11
Fat, per cent	4.24	4.28	4.83	4.74	5.06	4.75	5.29
Theoretical fat, proportion to cream		4.77	5.30	5.83	6.36	6.89	7.42

It seems scarcely necessary to add anything in the way of comment to the plain facts of the table. We see here that milk showing eight per cent. of cream gives a larger yield of butter than is obtained from milk giving 10, 11, 12 or even 13 per cent of cream; and while the column of fat per cents. shows a slight increase as the amount of cream increases, this gain comes far short of what it should be to keep pace with the increased amount of cream. This is seen at a glance in the column of "Theoretical Fat," where is given the calculated amount of fat for each per cent. of cream, taking as the basis of comparison the fat yielded by the least per cent. of cream (8). These facts are, if possible, brought out more strikingly in particular cases exhibited in the table giving the daily record of the experiment, where the neutralizing effect of the group averages is not seen. The truth is, that the man who buys the milk of a large number of herds, good, bad and indifferent, paying for it by the gauges of cream which it yields, is probably not greatly the loser or gainer thereby. Experience has taught him the amount of butter he has reason to expect from the composite cream; but the loss to patrons, especially those whose herds have been bred up in dairy lines, must often be very great in the averaging process. The farmer whose Jerseys, as in the case of our "Pansy," gave 9½ to 10 per cent. of cream, yielding nearly five per cent. of butter, must, if all patrons are paid alike, contribute in the course of a year a very pretty sum towards the support of his neighbor's herd of scrubs, which, like our "White" and "Ruby," gave nearly 11 per cent. of cream and and only 3¾ per cent. of butter.

The new method (Short's)* of ascertaining the fat contents of the milk, employed in this experiment, is essentially a simple, easy, and not altogether accurate, chemical analysis, and as such is open to most of the objections urged where the attempt is made to use chemical facts as a basis of commercial transactions. The more accurate the results obtained, the greater the difficulty experienced in giving them a business application. We here encounter the difficulty felt in applying science in other departments of farm labor. There is science enough, and its authority is rarely questioned, but the trouble is that art lags in the rear. If our breeds and methods of feeding were perfect, our system of setting and handling milk all that they ought

* See Bulletin No. 16, Wisconsin Experiment Station; or page 124, Fifth Annual Report Wisconsin Experiment Station for 1888.

to be, and our churns perfect machines, so that we might surely extract in the shape of butter all the fat contained in milk, then chemistry alone could tell us truthfully by small samples the value of large masses of milk.

We have found this new method of milk analysis reasonably accurate as compared with the results of ordinary analysis made by the chemist of the Station. The method is easily learned and as easily applied, even with persons without special chemical knowledge or skill. Nevertheless we are confident that the new method will not, in the esteem of practical men, supplant the oil test and churning of samples, now so generally in vogue. The length of time required to make the analysis (4 hours), even though the workman's attention need not to be wholly occupied by the analysis, is an awkward break in the routine of dairy work. But the serious objection to a chemical analysis of any sort, when given this application, is, that chemistry takes no account of the churnableness of milk. The most refractory milk, equally with the most tractable, yields the chemist its entire fat. If butter making meant to the dairyman this same complete separation of the butter fat, then the chemical test of samples would be a safe guide, and fair alike to milk producer and butter maker. As it is, we see everywhere in the facts of this experiment wide variations, plus and minus, of fat from butter actually churned; and while the average of very many cases shows, as in table No. 3, a tolerably uniform relation of fat to butter, yet to apply these ratios to particular cases would be equivalent to dividing among mongrel herds the profits of the carefully bred ones.

The use of pure Jerseys and common Shorthorn grades in this experiment was purely a matter of convenience. These cows were all in about the same state as to flow of milk, and on this account, and no other, they were employed. There was no thought of making a comparison of breeds, or even of individuals. Nevertheless the distinction of the milk of the grades is so clear as to seem to call for special comment. The average milk yield of the grades quite equaled that of a corresponding number of the Jerseys. This milk threw up rather more of cream than was given by the Jerseys, and it gave an amount of fat not greatly less than that obtained from the Jersey milk. The yield of churned butter, however, was much less than that of the Jerseys: in other words, it lacked the churning quality possessed by the milk of the dairy breed. The uniformity and persistence with which these negative qualities appear in the milk of the grades seem to indicate that these are race characteristics, and as such are not likely to be much affected by the ordinary influences which affect milk in other ways. The milk of the Jerseys used in this experiment seems not to have been more abundant or much richer than that had from the grades, but the fat in it was easily got at, and by ordinary means.

It is interesting to observe the influence of the different foods upon this churning quality of milk. The "pasture alone," the bran and corn meal, seem to have had about an equal influence upon the churnableness of milk, or rather these grains had no influence at all. On the other hand, the ration of ground oats, with every cow, during every feeding period in which oats were used, added markedly to the accessibility of the fat of the milk. It mattered not whether the oats were consumed liberally, as by "White and Ruby," or sparingly, as in the case of "Eva and Prudie" without increasing the flow of milk or the total fat, this grain always and without delay added largely to the butter product.

THE PRESSURE OF CONTAINED ENSILAGE UPON THE WALLS OF THE SILO.*

In planning the construction of a silo for the Kansas Experiment Station, during the present summer (1888), the question of the proper strength of walls arose in the very outset. The two essential facts in the structure of the silo are: (1) the walls must be so constructed as to exclude both air and cold, and (2)

* This paper was read before the Society for the Promotion of Agricultural Science, at the Cleveland meeting, 1888.

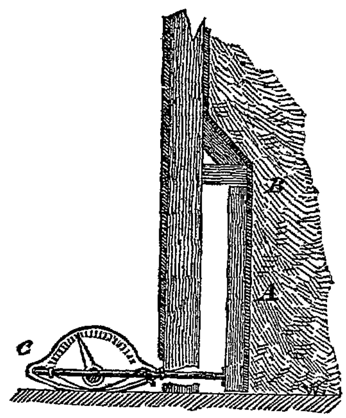
they must be sufficiently strong to resist the pressure of the enclosed ensilage. To make the silo what it should be, as regards the first fact, it was only necessary to follow certain familiar mechanical practices; just what was necessary to make it sufficiently strong without wasting building materials was quite another matter. I have been surprised to notice the conflicting opinions current on this point. One writer advises the use of 2x12-inch joists, set eighteen inches apart; another considers 2x10-inch studding sixteen inches apart strong enough; another writer is satisfied with 2x6-inch timbers; and yet another would use 2x4-inch joists, set as in the walls of an ordinary room.

With these conflicting statements in mind, the middle course seemed a safe one; so, in the construction of the Station silo, 2x8-inch hard pine joists, set sixteen inches apart, were used, and these, so far, have been deflected but slightly by the contained ensilage. It should be said that the silo here referred to, and employed in the experiment herein detailed, is 13x18 feet, floor area, and twenty-one feet in height. Midway up, it passes through the barn floor, which supports it rigidly at this point.

In view of the — so far as I know — entire absence of facts bearing on the question of the pressure of ensilage upon the walls of the silo, the question seemed well worthy of investigation.

The subject at first appeared easily approachable from the theoretical side. Having given the angle of repose of the silage, and its weight, the mathematical formula used by engineers in the case of embankments would seem to have application to the contents of the silo. However, the very variable condition of silage, both in and out of the silo, made it difficult, if not impossible, to use mathematical rules in the solution of the problem. For this reason the apparatus here figured was devised by the writer, with the object of establishing empirically facts relating to the side pressure of ensilage.

In the cut, A is a diaphragm 3x5 feet, strongly made, which is hinged vertically at B, at a point on the interior of the silo, about six inches from the wall. The diaphragm bears upon the strong rod — in this case two small gas pipes, united at their outer ends — which moves freely through the walls of the silo. A Fairbanks dynamometer is secured to the connected gas pipes at C and to the silo wall at D in such a manner that any pressure upon the diaphragm is instantly shown by the dynamometer. It should be stated, too, that a pressure upon the diaphragm of one thousand pounds would only move its lower edge one-eighth of an inch out of the vertical.



The ensilage material used was Indian corn, cut when the grain was in the "milk" state. The corn was hauled to the silo without preliminary drying, often without even wilting, and quickly cut into half-inch lengths and stowed away in the silo.

The following table shows the readings of the dynamometer at different times, and with different heights of ensilage, together with certain deductions therefrom. The column headed "Total pressure on diaphragm" is a series of calculations based on the fact that the upper edge of the diaphragm is fixed, and the pressure upon the diaphragm is carried to the gas pipes at a point three inches above the lower edge of the diaphragm.

Date of observation.	Hour of observation.	Depth of ensilage, feet.	Reading of dynamometer, lbs.	Total pressure of diaphragm, lbs.	Pressure per square foot, lbs.	REMARKS.
Aug. 13	1 P. M.	4	125	229	15	Filling the silo begun.
Aug. 13	6 P. M.	7	325	596	40	
Aug. 14	7 A. M.	6	300	550	37	
Aug. 14	1 P. M.	9	350	642	43	
Aug. 14	6 P. M.	12	435	798	53	
Aug. 15	7 A. M.	11	410	752	50	Filling suspended one day.
Aug. 15	1 P. M.	10	400	733	49	
Aug. 15	6 P. M.	10	340	622	41	
Aug. 16	7 A. M.	10	400	733	49	
Aug. 16	6 P. M.	16	460	842	56	
Aug. 17	7 A. M.	15	460	842	56	
Aug. 17	1 P. M.	18	425	779	52	
Aug. 17	6 P. M.	21	455	834	55	
Aug. 18	7 A. M.	20	460	842	56	Filling suspended during 18th and 19th.
Aug. 18	1 P. M.	19	465	852	57	
Aug. 18	6 P. M.	19	460	842	56	
Aug. 19	7 A. M.	19	460	842	56	
Aug. 19	1 P. M.	19	450	825	55	
Aug. 19	6 P. M.	18	450	825	55	
Aug. 20	7 A. M.	18	450	825	55	
Aug. 20	1 P. M.	22	448	821	55	Filling concluded.
Aug. 20	6 P. M.	21	445	814	54	
Aug. 21	7 A. M.	20	445	814	54	
Aug. 21	1 P. M.	20	440	807	54	
Aug. 21	6 P. M.	20	440	807	54	
Aug. 22	7 A. M.	20	440	807	54	

NOTE.-For about two weeks after August 22d the pressure gradually diminished, the diminution amounting to about five pounds daily.

These facts show that the pressure upon the silo walls by contained ensilage is very great. A silo usually has a long life, and during its existence supports a great variety of vegetable substance. Like the wagon, the walls of the silo must be equal to the task of supporting the heaviest burden that will be put upon them. The writer is fully of the opinion that facts like the above, obtained with reference to different ensilage material, in different physical and chemical conditions, will show with tolerable accuracy the most that is likely to be required of the silo wall; and by an easy calculation we may determine what its proper strength is.

RELATION OF RAINFALL TO THE CORN CROP.

The inquiry detailed below owes its inception to the frequent question, "How much rainfall is required to make the corn crop in Kansas?" Our record on the rainfall at this point extends back uninterruptedly to January 1, 1859, but we have no reliable statistics relating to the corn crop of the College farm earlier than 1874. For this reason, that year is fixed upon as the beginning of the series of years the facts of which are detailed below.

Through the courtesy of Mr. F. J. Rogers, of the Department of Physics, I have been enabled to complete the meteorological facts here given. The agricultural facts are taken from the farm records—the day-book of the farm, department reports and the record of experiments. The bushel of the yield of corn given in every case is seventy pounds of ear corn or its equivalent. This yield, it should be said, is probably not nearly equal to the yield, in corresponding years, of bottom land farms. The College farm is made up of nearly equal parts of high, rough and poor lands and lands in excellent condition as to fertility. Our corn crops have been grown pretty equally upon poor and good lands, a fact which offers an easy explanation of the moderate yields — for Kansas — so frequently reported.

The tabular statements following are perhaps in most cases self-explanatory. The column giving the rainfall of March and April serves to indicate the condition of the soil as to moisture at planting time. By the "growing months," is here everywhere meant May, June, July and August, although it must be admitted that the month of May plays a somewhat insignificant part among the months in which the corn crop is made.

1874.	March and April......	WEEK ENDING— May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	12	20	27	3	10
Rainfall in inches, by weeks....................	......	.30	1.66	.85	.00	1.18	.99	2.27	.00	.04	.00	.04	.14	.00	.04	.13	.06	.02	.93	.20
Total rainfall for month, in inches....	1.40	2.98*				4.31				.18					.25				4.53	

*The numerous discrepancies of "Total rainfall of month," and footings of columns of weeks of that month, are explained by the fact that the first week of that month may have included days of the preceding month with its precipitation. By the month, is in all cases meant the entire month, while the first week of that month may include a portion of the preceding month.

Total rainfall for growing months—May, June, July and August, 7.72 inches.

Yield of corn per acre, bushels, 00.

This was a year of total failure of the corn crop, although wheat and oats — fairly well provided for by the rains of May and June — were excellent crops. Up to July 1st, corn was in perfect condition, promising a great yield, but the continuous absence of rain during July rapidly brought the crop to grief.

1875.	March and April	WEEK ENDING— May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall by inches, by weeks	......	.03	.80	1.52	.08	.32	.63	.00	.00	1.30	2.13	.57	.05	.44	.50	.44	.10	.26	1.20	.00
Total rainfall for month, in inches	2.71	2.46				2.06				3.23					1.40				2.85	

Total rainfall for growing months—May, June, July and August, 9.15 inches.
Yield of corn per acre—bushels, 27½.

The partial failure of all crops in 1875 was due to a variety of causes. The drouth of the previous season had been followed by a very dry winter and spring, on account of which the insufficiency of the light rainfall of May and June was emphasized. Moreover, an immense swarm of young grasshoppers hatched out in early spring and did great damage to all growing crops. However, the season's rainfall was a scant one, and to this fact chiefly must be attributed the light corn crop of the year. It was the even distribution of the rain through the season, and especially the liberal supply of July, that made the corn crop of 1875 such as it was.

1876.	March and April	WEEK ENDING—																	
		May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall in inches, by weeks	....	4.13	.00	.61	.55	.00	1.75	1.25	.00	1.60	.25	.70	1.20	3.58	.20	.27	8.45	1.78	.30	.00
Total rainfall for month, in inches	11.48	5.73				4.60				5.65					10.70				3.11	

Total rainfall for growing months—May, June, July and August, 26.68 inches.
Yield of corn per acre, bushels, 56⅝.

The enormous total rainfall of the growing season, and its even distribution through the year, explain sufficiently the large yield of corn obtained. Even barley, a crop which has rarely succeeded with us, this year gave a yield of 31½ bushels per acre. The great rains were in many respects a damage to growing crops, preventing the proper cultivation of the corn, and inducing rust, particularly in wheat and oats.

1877.	March and April*	Week ending— May. 7	14	21	28	June. 4	11	18	25	July. 2	9	16	23	30	August. 6	13	20	27	Sept. 3	10
Rainfall in inches, by weeks	......	.05	1.63	2.42	.40	1.65	4.53	.00	1.16	.52	1.37	1.25	.50	.64	1.00	.00	.45	1.33	.00	.55
Total rainfall for month, in inches	2.70	5.20				6.76				4.16					2.78				1.52	

*No record of rainfall made for April, 1877.

Total rainfall for growing months—May, June, July and August, 18.90 inches.

Yield of corn per acre, bushels, 48.

This year had the general characteristics of the one immediately preceding it. The heavy rainfall of June was a serious obstacle to the cultivation of the crop, a fact which explains the diminished yield as compared with that of the previous season.

1878.	March and April......	WEEK ENDING— May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall in inches, by weeks......	......	1.73	.99	.94	.17	.23	1.26	1.41	.36	1.99	2.45	.99	2.70	6.57	1.07	1.09	.00	.50	.00	2.44
Total rainfall for month, in inches....................	3.79	4.04				5.02				12.71					2.66				3.22	

Total rainfall for growing months—May, June, July and August, 24.43 inches.
Yield of corn per acre, bushels, 45.

The agricultural season of 1878 was very like the two immediately preceding. The yield of corn, however, was not large. The truth is, in these three years we had too much rain during the growing months. Cultivation was necessarily imperfect. Severe storms often damaged the crop, so that husking time only brought a moderate crop.

1879.	March and April	WEEK ENDING— May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall in inches, by weeks..........	......	.06	.02	1.05	.08	.68	1.07	2.63	1.25	3.53	1.05	.14	3.67	.05	.32	.00	1.08	.21	.00	.45
Total rainfall for month, in inches............................	3.21	1.79				8.48				4.91					1.61				4.30	

Total rainfall for growing months—May, June, July and August, 16.79 inches.
Yield of corn per acre, 47 bushels.

The above statement of the yield of corn does imperfect justice to the season, which furnished conditions well-nigh perfect for the growth of the great staple. Our corn this year was grown in three fields, which yielded respectively, 41 7/10, 53 and 63 bushels per acre. The field giving the light yield was a large one having a very poor soil, hence the low average. Corn this year grew from the very start, while the light rains at the close of May and early in June permitted ample cultivation. If we estimate influences other than the season unfavorable to this year's crop, the yield of the season should be put at fifty-five (55) bushels, at least.

1880.	March and April	WEEK ENDING— May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall in inches, by weeks	......	.00	.27	.00	3.02	2.73	.82	.00	.45	1.89	.53	.00	.56	1.35	.00	.00	1.60	5.34	3.21	.16
Total rainfall for month, in inches	1.58	3.74				3.92				3.78					8.51				2.52	

Total rainfall for growing months—May, June, July and August, 19.95 inches.
Yield of corn per acre, 55 bushels.

This season had an ample rainfall, which was quite evenly distributed through the season of growth, while the comparatively dry weather of the middle and latter portions of June permitted thorough cultivation. The result of it all was seen in a large yield of corn of the best quality.

1881.	March and April	WEEK ENDING—																
		May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall in inches, by weeks	......	.61	.91	3.88	.95	.32	.71	.23	1.51	.93	.00	.30	.00	1.02	.00	.30	.13	.00	.00	1.65
Total rainfall for month, in inches	2.31	6.67				3.38				1.32					.43				4.92	

Total rainfall for growing months—May, June, July and August, 11.80 inches.
Yield of corn per acre, 13 bushels.

Abundant rains early in the spring were succeeded by a dry June and a dryer July and August. The total rainfall seems to have been ample for the development of a crop, but the drouth of July and August was fatal.

1882.	March and April	May. 7	May. 14	May. 21	May. 28	June. 4	June. 11	June. 18	June. 25	July. 2	July. 9	July. 16	July. 23	July. 30	August. 6	August. 13	August. 20	August. 27	Sept. 3	Sept. 10
Rainfall in inches, by weeks	......	1.08	.48	1.67	1.97	.32	.30	2.64	.10	.03	1.09	1.62	.00	5.02	.29	.00	.38	.00	.20	.00
Total rainfall for month, in inches	4.27	5.43				3.08				7.73					.87				1.30	

Total rainfall for growing months—May, June, July and August, 17.11 inches. Yield of corn per acre, 50 bushels.

1883.	March and April	May. 7	May. 14	May. 21	May. 28	June. 4	June. 11	June. 18	June. 25	July. 2	July. 9	July. 16	July. 23	July. 30	August. 6	August. 13	August. 20	August. 27	Sept. 3	Sept. 10
Rainfall in inches, by weeks	......	.00	1.57	1.33	1.41	2.47	2.23	1.45	3.95	.00	1.29	.30	.00	2.56	.11	1.33	2.50	.00	.00	.00
Total rainfall for month, in inches	3.41	4.83				9.58				4.15					3.94				1.26	

Total rainfall for growing months—May, June, July and August, 22.50 inches. Yield of corn per acre, 40 bushels.

Here we have another illustration of the disastrous effects upon the corn crop of a shortening of the rain supply in July, even when the season otherwise is one of abundant precipitation. This fact, however, only in part explains the shortage in the corn crop of 1883. The season was one of *low temperature* generally throughout the country.

1884.	March and April......	WEEK ENDING—																		
		May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall in inches, by weeks.........	......	.78	1.75	.00	.16	1.94	1.93	.00	1.55	1.34	.00	3.47	.92	.25	.00	1.23	2.57	2.41	.01	.06
Total rainfall for month, in inches..........................	5.59	4.63				3.82				5.54					6.21				3.33	

Total rainfall for growing months—May, June, July and August, 20.20 inches.
Yield of corn per acre, 55 bushels.

This was probably as nearly an absolutely perfect season as was ever known in this section, or I had nearly said elsewhere. Wheat this year averaged 34 bushels per acre, and cost 32 cents per bushel; oats yielded 40 bushels per acre; millet hay $2\frac{87}{100}$ tons per acre, while the yield of prairie hay was very large, the crop from less than 30 acres aggregating 75 tons.

1885.	March and April......	WEEK ENDING— May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall in inches, by weeks..................	......	.10	.55	2.58	1.07	.02	.00	.00	.90	1.83	.11	.52	.13	2.15	.00	.21	.13	.55	.64	3.16
Total rainfall for month, in inches,	4.03	4.30				1.67				4.99					.89				4.38	

Total rainfall for growing months—May, June, July and August, 11.85 inches.
Yield of corn per acre, 47½ bushels.

We here again have a striking influence of a full rain supply in the month of July. The crop was just "made," with scarcely a superfluous ounce of moisture.

1886.	March and April......	WEEK ENDING—																		
		May.				June.				July.					August.				Sept.	
		7	*14*	*21*	*28*	*4*	*11*	*18*	*25*	*2*	*9*	*16*	*23*	*30*	*6*	*13*	*20*	*27*	*3*	*10*
Rainfall in inches, by weeks..........	......	1.60	1.90	.00	.00	1.37	.00	1.51	1.42	2.50	.00	.00	.99	1.85	.26	1.06	.23	.05	.46	.74
Total rainfall for month, in inches..........................	6.31	4.87				5.38				2.84					2.06				1.14	

Total rainfall for growing months—May, June, July and August, 15.15 inches.
Yield of *corn* per acre, 30 bushels.

The above yield of corn is an estimate, and so only approximately accurate. The season was one of almost continuous dry weather from July 1. The result was a fair half crop upon the best lands.

1887.	March and April......	WEEK ENDING—																		
		May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall in inches, by weeks............	......	.00	.64	.50	1.40	.40	3.21	.36	.30	.79	.20	.00	.10	.05	3.17	.15	1.58	1.06	3.93	1.68
Total rainfall for month, in inches,	3.27	2.54				4.57				.90					6.66				6.88	

Total rainfall for growing months—May, June, July and August, 14.67 inches.
Yield of corn per acre, 00 bushels.

The twenty-five acres planted to corn in 1887, which up to July 1 was full of promise, gave only a very small crop of nubbins, the exact amount of which cannot be stated in figures. The year was one of well-nigh complete failure of every farm crop, due to a combination of causes, the principal of which were drouth and chinch bugs.

1888.	March and April.	WEEK ENDING— May.				June.				July.					August.				Sept.	
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10
Rainfall by weeks, in inches	......	.22	.70	.07	1.26	.07	.03	.39	4.51	.22	.00	.00	.22	.00	1.93	.25	.24	2.00	.04	.00
Total rainfall for month, in inches	3.85	2.25				5.22				.22					4.46				2.88	

Total rainfall for growing months—May, June, July and August, 12.15 inches.
Yield of corn per acre, 40 bushels.

The year was very like that of '85, climatically, and in results obtained. The corn crop—barely an average one in this section—was made without the waste of a single atom of moisture. The very heavy rains of the last week of June, and the first week of August, reduced the effects of the July drouth to a minimum, but the escape from a complete failure of the corn crop was a narrow one.

SUMMARY.

YEAR.	*Rainfall of March and April, inches.*	RAINFALL OF GROWING MONTHS, INCHES. *May.*	*June.*	*July.*	*August.*	*Total rainfall for growing months, inches.*	*Yield of corn per acre, bus.*
1874	1.40	2.98	4.31	.18	.25	7.72	00
1875	2.71	2.46	2.06	3.23	1.40	9.15	27½
1876	11.48	5.73	4.60	5.65	10.70	26.68	56⅝
1877	2.70	5.20	6.76	4.16	2.78	18.90	48
1878	3.79	4.04	5.02	12.71	2.66	24.43	45
1879	3.21	1.79	8.48	4.91	1.61	16.79	47
1880	1.58	3.74	3.92	3.78	8.51	19.95	55
1881	2.31	6.67	3.38	1.32	.43	11.80	13
1882	4.27	5.43	3.08	7.73	.87	17.11	50
1883	3.41	4.83	9.58	4.15	3.94	22.50	40
1884	5.59	4.63	3.82	5.54	6.21	20.20	55
1885	4.03	4.30	1.67	4.99	.89	11.85	47½
1886	6.31	4.87	5.38	2.84	2.06	15.15	30
1887	3.27	2.54	4.57	.90	6.66	14.67	00
1888	3.85	2.25	5.22	.22	4.46	12.15	40
Averages	3.99	4.09	4.78	4.13	3.56	16.60	....

The fact of this summary that strikes one most forcibly is the tremendous volume of water that falls upon Kansas fields during the ordinary season of growth. We here see that in “drouthy Kansas” the average rainfall of four months is more than 16½ inches — but little less than the total precipitation of rainy England for the entire year.*

If the facts above do not tell us in precise terms the rainfall required to produce our standard Kansas farm crop during a season in all other respects an average one, they indicate certain facts bearing thereon, of general interest and importance,

* Prothero in his “The Pioneers and Progress of English Farming” says (p. 40): “The climate worsened after 1764; the mean average rainfall from 1741 to 1750 was 18½ inches; from 1771 to 1780 it averaged twenty-six inches.

1. We see that the months of July and August are the weak ones as to rainfall: showing the widest fluctuations from the average, as well as the lowest average of the growing months.

2. In July, the crop shows the greatest sensitiveness to the influence of the rain supply, a dry July being always accompanied by a short corn crop, except in the rare cases where the influence of the July drouth has been lessened by abundant rains late in June and early in August.

3. With a full July average, as in 1885, or where the rainfall of June and August is abundant, as in 1888, twelve inches of rain for the growing months will "make" the crop, although it is certain often to be brought perilously near a season of drouth.

REPORT OF CHEMICAL DEPARTMENT.

G. H. FAILYER, *Chemist.*
J. T. WILLARD, *Assistant Chemist.*

The work reported upon below is that which has been completed to date. It comprises:

An inquiry into the shrinkage of hay when stacked in the mow.
A comparison of varieties of sorghum.
A test of the keeping qualities of sorghum.
An examination of individual stalks of sorghum with a view to improving the plant.
A trial of fertilizers on sorghum.
The working out of a new method of analyzing milk, with a comparison of results by the churn.

Work under way, but upon which no report is made because of incompleteness, includes analyses of grains, grasses and fodders; an investigation into the sources of the nitrogen of plants, and a determination of the nitrogen compounds of rain waters.

SHRINKAGE OF HAY IN THE MOW.

Assertions made by dealers in hay as to the shrinkage of hay in the stack or mow, when placed there in the condition in which it is usually hauled from the field, suggested the propriety of making some observations upon the subject. Accordingly, as opportunity presented, thirteen samples of hay were secured for the purpose.

The plan of the experiment was to fill a bag of very thin muslin with the hay while it was being hauled from the field and to bury it in a mow of hay and leave it until the whole was certainly air dry, when the bag of hay was to be weighed and its per cent. of loss or gain determined. Accompanying this, and as a necessary part of the experiment, determination was made of the total amount of water in the hay at the time it was hauled in and the sample taken; and also that yet contained in it at the conclusion of the experiment. The thirteen samples were buried at the dates given in the accompanying table, and eleven of them were taken out on the fifteenth day of December. It will be seen that the samples first buried were kept in the mow for a period of almost exactly six months while the shortest time any was kept was four months. Of course all had much more than ample time to dry out as much as they would.

The hay in which the bags were buried was not always of the same kind as that which the bags contained, since we had a limited number of kinds of hay at our disposal for the reception of the samples. The kinds of hay in which the samples were buried were, millet, clover, and clover mixed with more or less orchard grass and blue grass. No prairie hay was available for the purpose, so our bags of prairie hay were placed in a mow of millet. It might be thought that the surrounding hay would influence the moisture in the samples, and hence that the use of hay of a different kind from that of the sample would vitiate the results of such an experiment. But if the matter is considered carefully, it must be concluded that this supposition will fail where the time has been long enough for both the sample and the hay in contact with it to have come into equilibrium with each other and with the air. It seems that such a theory can originate only from a partial view of the facts. If it be thought, for example, that a hay which is more hygroscopic, and, hence, which retains at the same temperature more water than the sample, would give up water to the latter, causing it to contain more water than it would retain alone in the air at that temperature, a sufficient answer would seem to be, that if one has a greater absorptive power than the other, so that it will retain more water in the air, this greater absorptive power will prevent the less absorptive power of the second from taking water from the first. Besides, it is a well known fact that bodies in contact share water between them in the order of their hygroscopic properties. So that the amount of water retained by any one depends upon its individual properties, and not upon those of its neighbor. But if this were not true, the various kinds of hay differ so little in their hygroscopic character as to make their effect upon each other too small to consider. It may be further remarked, that the bags containing the hay were so thin as to be without sensible effect upon the result. So, all considered, there seems to be no other valid objection to this method of experimenting upon the shrinkage of hay than that incident to sampling. It would not be difficult at all to procure a fair sample of cured hay, but in the transition stage, from green grass to hay, there will be very marked differences in the degree of dryness reached by the surface and the interior, or under portions. In operating upon as much as six or ten pounds, and by taking a little here and a little there, a reasonably fair sample could be secured; but in selecting the small sample for drying, to ascertain the water contained, much less accuracy was attainable. Were the experiment repeated, a much greater quantity of fresh hay would be desiccated to determine the total water. There was no such trouble in sampling at the close of the experiment, at which time there was practical uniformity throughout the hay.

The following table gives the facts of the experiment. The two samples of millet, 4 and 5, were in a mow, so buried under corn fodder that they could not be reached when the others were taken out and weighed. It is therefore impossible to give the final figures on these; but the quantity of water in the millet hay is shown in the table; this is the object in including the samples in the table.

No. of sample.	KIND OF HAY.	Date when cut.	Date when put in mow.	Date when taken from mow.	Weight, in pounds when put in mow.	Weight, in pounds, when taken from mow.	Per cent. of loss (—), or gain (+).	Per cent. of water in hay when put in mow.	Per cent of water in hay when taken from mow.	Per cent. of water in hay when put in mow, calculated from columns 8 and 10.
1	Mixture of orchard grass, clover and a little blue grass	June 4	June 12*	Dec. 15	7 44	6 90	—5 71	14 32	10.54	15.65
2	Blue grass	June 4	June 12	Dec. 15	9 06	8 16	—10 05	18 21	10.60	19 59
3	Orchard grass and clover	June 8	June 12	Dec. 15	6.69	6.08	—9 01	16.50	11.80	19.75
4	Millet	....	July 21	Mar. 11‡	6.63	5.68	—14.25	24.42	8.89	21.86
5	Millet	....	July 27	....	....	....	....	23.10	....	....
6	Clover	July 30	July 31	Dec. 15	5.06	5.22	+3.17	9.82	11.87	9.08
7	Prairie hay	....	Aug. 11	Dec. 15	5.06	4.87	—3.55	15.30	10.64	13.81
8	Prairie hay	Aug. 11	Aug. 11	Dec. 15	6.06	5 85	—3 52	12.85	10.73	13.87
9	Prairie hay	Aug. 15	Aug. 16	Dec. 15	6.62	6.40	—3 42	10.88	10.04	13.11
10	Prairie hay	Aug. 13	Aug. 16	Dec. 15	4.87	4.86	—.29	10.81	10.77	11.03
11	Prairie hay	Aug. 14	Aug. 16	Dec. 15	6.06	6.03	—.58	10 83	10.75	11 26
12	Prairie hay	Aug. 14	Aug. 16	Dec. 15	4.56	4 58	+ 40	10.02	10.72	10 36
13	Prairie hay†	Aug. 9	Aug. 16	Dec. 15	6.00	5.56	—7.33	17.13	10.63	15.51

*The hay was put in on the 5th, but sample not taken until 12th. †Very coarse.

‡Owing to the accident by which this report is delayed in coming out, opportunity is given to present further facts upon one of the samples of millet hay. It will be observed that the loss of water by the millet while in mow is large, amounting to one-sixth. Owing to the slowness with which the stems of millet dry out, this hay seems to be very liable to be hauled in before it is well cured.

The eighth column in the above table shows the per cent. of loss or gain of the several samples from drying in a mow until they had reached their lowest point; excepting Nos. 1, 2, 3 and 13, the loss is too trifling to be of moment. Even in these excepted cases the shrinkage is much less than many suppose. Number 2 lost ten per cent. This means that a ton of the hay as hauled in would weigh only 1,800 pounds in the winter, and that if a ton of this hay weighed in midwinter is worth four dollars, the ton weighed at the time the sample was buried would have been worth three dollars and sixty cents. This would be worth considering; but in most cases the loss is much less than this. In two cases the sample weighed more when taken out than when put in. It is nothing more than might be expected, that a very hot sun and a brisk, dry wind would so dry out the hay that it would absorb moisture from the air, when placed in a barn. The conclusion to be drawn from these results is, that if the hay is not obviously green and illy cured no great shrinkage need be feared. Column 11 is the original water of the hay as calculated from the loss in the mow and the water still found in the hay when it was taken out. Had perfect samples been taken for all the determinations, columns nine and eleven should be alike, experimental errors omitted. Since they are not so, it may be taken as evidence that the hay was not uniform, and that the small sample of fresh hay dried to determine the water was not an average. Column eleven probably more nearly represents the true amount of water in the hay when it was put in the mow; but taking column nine as correctly representing the water present in the hay when it was buried, a comparison of this with the amount present when it was taken out will lead to the same practical conclusion. As before, there is no great loss in weight from drying. In case the hay is coarse or has many large stems, greater care and time are obviously required in curing it.

Mr. Breese, the assistant in the Chemical Department of the College, gave valuable aid in this work.

A COMPARISON OF VARIETIES OF SORGHUM.

The Farm Department grew thirty-nine different kinds of sorghum. In two or three instances the seed was obtained under the same name from different sources, or had originally come from different sources. This will be seen by an inspection of the list below. The seed was planted on the nineteenth of May. The soil was a sandy loam, of average fertility for our second bottoms. Ordinary good tillage was given the crop. This sorghum was turned over to us for such investigations as we might find desirable. For our first season's work, it was planned to collect data upon the varieties at command, and to prepare for future efforts at improving sorghum as a sugar plant. The first of these objects included as its most important feature the determination of the sucrose, or cane sugar, and the so-called glucose, or reducing sugar of the chemist. But as a very important part of the work, full data upon the physical characters of the canes were obtained. The nature of this will be seen by reference to the accompanying table. One column is headed "Number of Dead Leaves." It was learned during a previous season's work on sorghum that stalks and portions of stalks having dead blades average poorer in quality than similar stalks that are not thus defective. Hence, the observation was made. But stalks that had many dead blades, or that were much bent, were entirely rejected in taking samples for analysis. The juice was extracted from the canes by a one-horse three-roll mill. The mill was kept at the same adjustment throughout the season. The proportion of the juice extracted probably varied with the size of the stalks. Large stalks would be pressed harder than smaller ones. The tables give our analyses of sorghum for the season.

In all cases where the cane ripened early enough and we had sufficient cane, three analyses were made; in a few cases a greater number of analyses were made for special reasons. Since it has been well established that the immature sorghum is not in proper condition for sugar making, and is in poor condition for making syrup, our work began upon the several plants when they were approaching maturity. As a suitable stage of development for the first analysis, that when the seed is dry, but yet easily split, was chosen. This condition was reached about a week after the seed passed out of the dough state. Other analyses were made to study the development of the plant and to learn how well the quality is maintained while standing in the field after ripening. A fair comparison of the order in which the varieties ripened may be had from the table, since it was the intention to make the several "first analyses" at the same degree of development. The height as given in the table includes the seed top. The weight is of the whole can. The per cent. of top includes the seed head proper with about six inches of stalk attached. The per cent. of juice extracted is calculated upon the weight of clean cane. "Reducing sugar" includes what is frequently reported as glucose.

VARIETIES OF SORGHUM COMPARED.

VARIETIES.	Date of Analysis.	No. of stalks	Average height in feet	Average weight in pounds	Average No. of joints	Average No. of dead leaves	Per cent. of tops	Per cent. of leaves	Per cent. of clean cane	Per cent. of juice calculated on clean cane	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice	Per cent. of total sugars in juice
African	Sept. 22	10	9.00	2.12	13.1	2.1	11.37	25.21	63.42	47.69	1.0657	8.65	5.00	13.65
African	Oct. 13	10	7.68	1.73	12.7	6.9	11.72	22.37	65.91	44.95	1.0738	10.11	4.38	14.49
African	Oct. 18	1	9.25	1.97	11.0	3.0	....	....	....	49.19	1.0717	11.05	7.05	18.10
Gooseneck	Sept. 22	10	8.88	2.18	13.3	2.5	12.08	26.17	61.75	41.32	1.0658	9.14	4.71	13.85
Liberian, from Alabama	Sept. 26	6	8.10	2.79	13.6	4.0	13.28	28.01	58.71	49.44	1.0701	11.15	3.31	14.46
Liberian, from Missouri	Sept. 26	6	7.75	2.37	13.2	3.7	13.85	25.96	60.19	46.49	1.0742	11.98	3.13	15.11
Liberian, from Missouri	Oct. 16	5	7.74	1.53	11.8	5.8	19.58	16.71	63.71	46.72	1.0717	11.65	2.88	14.53
Chinese sugar cane, small variety	Aug. 29	8	8.12	1.10	6.6	0.8	34.05		65.95	47.85	1.0417	5.01	3.35	8.36
Chinese sugar cane, small variety	Sept. 24	10	7.93	.84	6.2	1.4	8.44	23.96	67.66	47.98	1.0563	9.90	2.01	11.91
Chinese sugar cane, variety	Sept. 24	2	8.21	.96	5.5	0.	12.50	22.40	65.10	45.60	1.0382	3.14	1.42	4.56
Chinese sugar cane, variety	Sept. 24	1	9.92	2.36	9.0	3.0	10.17	11.02	78.81	54.84	1.0523	6.71	4.22	10.93
Chinese sugar cane, variety	Sept. 24	2	10.08	1.24	9.5	1.0	10.86	17.91	71.23	46.55	1.0563	7.50	3.91	11.41
Chinese sugar cane, variety	Oct. 2	6	12.06	3.24	13.8	1.0	13.99	21.25	64.76	47.49	1.0729	10.90	4.38	15.18
Chinese sugar cane, large variety, seed removed	Oct. 13	3	13.94	3.71	16.0	6.7	29.83		70.17	30.60	1.0722	12.02	0.91	12.93
Chinese sugar cane, large variety, seed removed	Oct. 20	4	....	......	......	.....	24.34		75.66	34.14	1.0571	8.78	1.88	10.66

VARIETIES OF SORGHUM COMPARED—CONTINUED.

VARIETIES.	Date of Analysis.	No. of stalks.	Average height in feet.	Average weight in pounds.	Average No. of joints.	Average No. of dead leaves.	Per cent. of tops.	Per cent. of leaves.	Per cent. of clean cane.	Per cent. of juice calculated on clean cane.	Specific gravity of juice.	Per cent. of cane sugar in juice.	Per cent. of reducing sugar in juice.	Per cent. of total sugars in juice.
Chinese sugar cane, large variety, seed not removed	Oct. 13	3	15.25	4.05	16.7	5.0	10.77	20.89	68.34	37.39	1.0665	10.86	1.48	12.34
Chinese sugar cane, large variety, seed not removed	Oct. 20	4	15.50	4.58	17.0	.....	24.80		75.20	32.88	1.0666	10.66	2.46	13.12
Cross between Amber and Orange	Sept. 4	8	7.75	1.93	9.3	1.5	35.94		64.06	49.84	1.0565	9.50	2.25	11.75
Cross between Amber and Orange	Sept. 22	10	8.69	1.57	9.8	1.6	12.17	24.16	63.67	45.90	1.0691	12.71	1.57	14.28
Cross between Amber and Orange	Oct. 15	10	8.39	1.45	9.0	3.8	14.02	23.42	62.56	43.63	1.0699	12.69	1.33	14.02
Cross between Amber and Orange	Sept. 12	1	8.42	1.99	10.0	2.0	37.24		62.76	53.60	1.0744	14.18	1.70	15.88
Cross between Amber and Orange	Sept. 12	1	7.92	1.64	9.0	1.0	35.97		64.03	50.00	1.0533	7.92	2.95	10.87
Dutcher's Hybrid	Aug. 29	7	7.90	1.49	7.7	.7	36.79		63.21	53.54	1.0497	6.32	4.44	10.76
Dutcher's Hybrid	Sept. 17	10	7.28	1.23	7.1	1.1	12.19	23.07	64.74	51.47	1.0613	9.36	2.89	12.25
Dutcher's Hybrid	Oct. 6	10	7.49	1.05	7.5	2.0	38.10		61.90	46.61	1.0621	9.59	2.43	12.02
Dutcher's Hybrid	Sept. 19	1	8.00	1.21	9.0	1.0	42.15		57.85	41.43	1.0702	12.19	....	....
Early Amber	Aug. 29	7	6.96	1.13	6.5	0.9	30.09		69.91	53.77	1.0537	7.97	2.65	10.62
Medium Orange	Aug. 28	9	7.52	1.11	7.7	1.0	36.79		63.21	49.52	1.0508	8.75	1.64	10.39
Medium Orange	Sept. 15	10	7.49	1.12	7.8	2.4	36.10		63.90	45.44	1.0667	12.32	1.07	13.39
Medium Orange	Sept. 18	1	7.00	1.24	8.0	2.0	35.49		64.51	37.50	1.0873	16.25	0.45	16.70

11

VARIETIES OF SORGHUM COMPARED—CONTINUED.

VARIETIES.	Date of Analysis.	No. of stalks.	Average height in feet.	Average weight in pounds.	Average No. of joints.	Average No. of dead leaves.	Per cent. of tops.	Per cent. of leaves.	Per cent. of clean cane.	Per cent. of juice calculated on clean cane.	Specific gravity of juice.	Per cent. of cane sugar in juice.	Per cent. of reducing sugar in juice.	Per cent. of total sugars in juice.
Medium Orange	Sept. 18	1	7.00	1.06	9.0	3.0	31.13		68.87	43.83	1.0409	6.00	1.72	7.72
Enyama	Sept. 22	8	9.53	1.98	13.9	5.4	11.23	14.88	73.89	48.48	1.0628	10.84	2.23	13.07
Enyama	Oct. 12	10	9.26	1.96	13.0	7.2	13.47	12.05	74.48	47.15	1.0670	11.59	1.85	13.44
Golden Rod, variety	Sept. 25	3	9.83	*.88	......	....	....	....	....	40.75	1.0684	12.09	2.07	14.16
Golden Rod, variety	Sept. 25	6	8.00	*.61	......	....	....	....	....	30.70	1.0634	10.56	1.81	12.37
Golden Rod, variety	Sept. 25	2	12.00	*1.46	12.5	....	....	....	....	25.77	1.0791	14.69	.83	15.52
Golden Rod, tall variety	Oct. 12	6	10.56	1.74	13.5	4.7	42.94		57.06	35.80	1.0686	10.56	1.47	12.03
Honduras	Oct. 4	10	9.27	2.07	12.4	5.4	10.86	16.75	72.39	49.60	1.0624	9.36	3.29	12.65
Honey Cane	Oct. 20	3	8.92	1.10	10.0	.....	16.33		83.67	43.32	1.0661	10.92	......	....
Honey Cane	Oct. 20	1	9.25	2.00	12.0	.....	20.00		80.00	48.75	1.0520	6.48	6.46	12.94
Honey Dew	Sept. 4	10	8.35	1.38	8.0	1.0	34.83		65.17	48.11	1.0525	7.42	3.07	10.49
Honey Dew	Sept. 22	10	8.24	1.22	8.8	1.7	†4.35	26.41	69.24	43.84	1.0634	10.70	2.20	12.90
Honey Dew	Oct. 15	10	8.16	1.15	8.3	3.4	†5.76	24.15	70.09	42.84	1.0641	10.18	1.53	11.71

* Stripped. † Empty.

VARIETIES OF SORGHUM COMPARED—CONTINUED.

VARIETIES.	Date of Analysis.	No. of stalks	Average height in feet	Average weight in pounds	Average No. of joints	Average No. of dead leaves	Per cent. of tops	Per cent. of leaves	Per cent. of clean cane	Per cent. of juice calculated on clean cane	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice	Per cent. of total sugars in juice
Honey Drip	Sept. 13	10	7.92	1.76	12.1	2.3	38.68		61.32	50.92	1.0562	8.41	2.91	11.32
Honey Drip	Sept. 28	10	8.00	1.77	12.1	2.3	13.60	26.25	60.15	45.97	1.0709	12.10	1.98	14.08
Honey Drip	Oct. 16	10	8.00	1.85	12.6	8.2	13.86	18.14	68.00	47.61	1.0666	11.88	2.34	14.22
Honey Drip	Sept. 13	1	8.58	2.33	14.0	2.0	37.34		62.66	50.67	1.0638	10.41	2.70	13.11
Honey Drip	Sept. 13	1	8.42	2.09	13.0	2.0	37.09		62.91	51.71	1.0633	10.13	....	....
Honey Drip	Sept. 13	1	7.67	2.19	13.0	2.0	36.08		63.92	50.71	1.0395	2.92	4.41	7.33
Kansas Orange (I)	Sept. 10	7	7.33	1.89	9.8	1.7	36.78		63.22	50.47	1.0439	4.62	4.63	9.25
Kansas Orange (I)	Sept. 20	10	8.96	1.57	11.6	1.8	10.40	26.96	62.64	49.23	1.0623	9.65	3.74	13.39
Kansas Orange (I)	Oct. 3	10	9.04	1.74	11.7	1.7	10.07	28.42	61.51	46.11	1.0739	12.62	2.90	15.52
Kansas Orange (I)	Oct. 4	1	8.50	2.00	12.0	3.0	41.00		59.00	45.76	1.0815	15.51	1.69	17.20
Kansas Orange (I)	Oct. 4	1	9.33	1.92	13.0	2.0	33.68		66.32	44.09	1.0815	15.17	2.24	17.41
Kansas Orange (I)	Oct. 17	9	8.46	1.12	11.1	3.5	13.97	24.98	61.05	45.94	1.0773	13.79	3.78	17.57
Kansas Orange (I)	Oct. 18	9	8.77	2.01	12.9	5.7	11.88	19.05	70.07	49.01	1.0656	11.24	4.68	15.92
Kansas Orange (I)	Oct. 19	10	8.99	1.59	12.2	5.4	11.21	18.32	70.47	45.66	1.0734	12.95	4.38	17.33

VARIETIES OF SORGHUM COMPARED—CONTINUED.

VARIETIES.	Date of Analysis.	No. of stalks.	Average height in feet.	Average weight in pounds.	Average No. of joints.	Average No. of dead leaves.	Per cent. of tops.	Per cent. of leaves.	Per cent. of clean cane.	Per cent. of juice calculated on clean cane.	Specific gravity of juice.	Per cent. of cane sugar in juice.	Per cent of reducing sugar in juice.	Per cent. of total sugars in juice.
Kansas Orange (I)	Oct. 27	10	....	*1.06	....	....	....	....	....	44.70	1.0645	9.47	5.68	15.15
Kansas Orange (II)	Oct. 2	10	8.02	2.01	13.2	4.8	14.93	18.17	66.90	48.14	1.0694	12.64	1.30	13.94
Kansas Orange (II)	Sept. 12	1	7.33	2.68	13.0	5.0	34.33		65.67	50.00	1.0518	8.42	2.12	10.54
Kansas Orange (II)	Sept. 12	1	7.75	2.53	13.0	4.0	32.01		67.99	51.10	1.0647	12.12	1.57	13.69
Kansas Orange (II)	Sept. 14	1	9.17	1.48	12.0	1.0	31.08		68.92	43.13	1.0764	14.44	1.32	15.76
Kansas Orange (II)	Sept. 14	1	8.83	1.30	11.0	5.0	27.00		73.00	46.31	1.0523	8.13	2.49	10.62
Kansas Orange (II)	Sept. 14	1	9.17	1.92	12.0	3.0	27.61		72.39	56.83	1.0754	14.54	1.32	15.86
Kansas Orange (II)	Sept. 14	1	8.17	1.28	10.0	3.0	33.60		66.40	42.35	1.0791	15.49	.96	16.45
Kansas Orange (II)	Sept. 14	1	8.17	1.73	12.0	3.0	33.00		67.00	41.38	1.0835	16.44	.95	17.39
Late Orange	Sept. 10	6	7.10	1.83	9.0	2.0	33.70		66.60	46.78	1.0567	8.70	3.38	12.08
Late Orange	Sept. 20	10	8.35	1.65	11.4	1.8	12.16	25.50	62.34	46.53	1.0752	13.87	3.28	17.15
Late Orange	Oct. 3	10	8.35	1.59	11.9	2.3	8.23	27.35	64.42	40.68	1.0814	15.04	1.69	16.73
Late Orange	Oct. 3	1	8.25	2.42	16.0	8.0	24.40		75.60	46.12	1.0795	13.47	1.74	15.21

*Stripped.

VARIETIES OF SORGHUM COMPARED — CONTINUED.

VARIETIES.	Date of Analysis.	No. of stalks	Average height in feet	Average weight in pounds	Average No. of joints	Average No. of dead leaves	Per cent. of tops	Per cent. of leaves	Per cent. of clean cane	Per cent. of juice calculated on clean cane	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice	Per cent. of total sugars in juice
Late Orange	Oct. 3	1	9.58	2.07	15.0	2.0	35.75		64.25	48.49	1.0834	15.37	2.01	17.39
Late Orange	Oct. 3	1	8.25	1.04	11.0	3.0	29.81		70.19	43.15	1.0867	16.56	1.22	17.78
Early Gooseneck	Sept. 7	2	7.50	2.14	10.5	1.0	35.05		64.95	50.36	1.0442	4.84	4.85	9.69
Early Gooseneck	Sept. 20	10	8.94	1.78	12.0	1.2	8.95	29.22	61.83	47.23	1.0732	15.66	3.20	18.86
Early Gooseneck	Oct. 6	10	8.68	1.73	11.9	2.0	37.38		62.62	46.21	1.0765	13.44	2.32	15.76
Early Gooseneck	Oct. 22	12	....	......	......	.....	....	....	....	41.20	1.0753	12.84	4.14	16.98
Early Gooseneck	Oct. 27	10	....	......	......	.....	....	....	....	41.66	1.0657	10.22	5.27	15.49
New Orange	Sept. 7	10	6.58	1.52	8.7	1.1	41.81		58.19	48.41	1.0530	6.69	4.91	11.60
New Orange	Sept. 26	10	7.71	1.24	10.5	1.8	18.61	30.55	50.84	47.07	1.0804	14.07	2.80	16.87
New Orange	Oct. 15	10	7.21	1.24	10.0	4.8	18.33	19.61	62.06	41.58	1.0774	13.33	2.12	15.45
S. C. Early Orange	Sept. 10	9	9.33	1.73	9.6	2.0	35.80		64.20	50.00	1.0505	6.49	4.41	10.90
S. C. Early Orange	Sept. 28	11	8.18	1.48	11.2	2.6	35.62		64.38	44.28	1.0785	13.69	2.29	15.98
S. C. Early Orange	Oct. 16	10	8.29	1.23	10.9	6.5	9.47	20.89	69.64	41.27	1.0815	14.63	4.34	18.97
S. C. Early Orange	Oct. 17	1	8.50	1.53	13.0	.....	26.60		73.40	43.30	1.0831	15.34	1.64	16.98

VARIETIES OF SORGHUM COMPARED—CONTINUED.

VARIETIES.	Date of Analysis.	No. of stalks	Average height in feet	Average weight in pounds	Average No. of joints	Average No. of dead leaves	Per cent. of tops	Per cent. of leaves	Per cent. of clean cane	Per cent. of juice calculated on clean cane	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice	Per cent. of total sugars in juice
Liberian, from Kansas	Oct. 2	6	10.54	2.64	13.5	4.20	14.21	21.48	64.31	42.70	1.0604	9.51	2.52	12.03
Little Sumach	Sept. 21	9	7.63	2.15	10.8	2.88	17.50	23.94	58.56	50.84	1.0456	8.38	3.51	11.89
Link's Hybrid	Sept. 27	10	9.69	1.81	12.0	3.90	13.83	18.34	67.83	46.37	1.0657	11.88	1.24	13.12
Link's Hybrid	Oct. 13	12	9.74	1.60	11.3	4.30	13.48	18.66	67.86	42.67	1.0737	14.01	.83	14.84
Link's Hybrid	Oct. 13	1	9.92	2.26	12.0	6.00	32.30		67.70	46.73	1.0750	14.27	.54	14.81
New Variety, from Missouri	Sept. 22	10	10.03	2.22	12.1	3.00	12.24	23.18	64.58	48.18	1.0655	12.05	1.41	13.46
New Variety, from Missouri	Oct. 27	8	....	......	......	......	....	....	....	42.34	1.0585	9.04	3.61	12.65
New Variety, from Missouri	Oct. 1	1	11.17	2.50	14.0	3.00	34.00		66.00	46.67	1.0727	13.62	1.30	14.92
Early Orange	Sept. 27	10	9.76	1.73	11.1	3.00	12.59	21.67	65.74	45.52	1.0684	12.68	1.03	13.71
Early Orange	Oct. 11	12	9.22	1.38	11.2	4.50	31.86		68.14	40.28	1.0696	12.64	.96	13.60
Early Orange	Oct. 11	1	10.08	1.52	13.0	3.00	36.12		63.88	34.02	1.0771	14.92	......	....
Russell's	Sept. 27	6	9.86	1.84	9.5	4.00	14.38	22.06	63.56	46.23	1.0660	11.94	1.05	12.99
Russell's	Oct. 22	10	....	......	......	......	....	....	....	42.63	1.0621	10.74	2.00	12.74
New sugar cane from Central America	Sept. 17	10	10.8	1.92	10.5	0.70	8.60	20.40	71.00	48.96	1.0606	9.49	2.90	12.39

VARIETIES OF SORGHUM COMPARED—CONTINUED.

VARIETIES.	Date of Analysis.	No. of stalks	Average height in feet	Average weight in pounds	Average No. of joints	Average No. of dead leaves	Per cent. of tops	Per cent. of leaves	Per cent. of clean cane	Per cent. of juice calculated on clean cane	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice	Per cent. of total sugars in juice
New sugar cane from Central America	Oct. 6	7	11.10	1.96	10.6	1.0	7.71	18.62	73.67	49.16	1.0701	11.98	1.96	13.94
Price's	Aug. 28	8	7.91	1.30	6.9	0.8	34.30		65.70	51.61	1.0392	4.47	3.73	8.20
Price's	Sept. 15	10	8.22	1.35	7.2	1.8	31.40		68.60	51.13	1.0467	4.98	3.70	8.68
Price's	Oct. 5	15	8.44	1.31	8.0	1.7	34.74		65.26	50.82	1.0623	9.25	2.73	11.98
Silver Top*	Oct. 19	*6	10.46	2.50	12.0	.....	38.95		61.05	48.36	1.0550	8.02	5.71	13.73
Swain's Early Golden	Aug. 28	8	7.93	1.13	6.3	0.9	31.35		68.65	50.48	1.0654	12.67	1.55	14.22
Swain's Early Golden	Oct. 6	10	7.49	.91	6.5	5.3	7.43	22.53	70.04	44.31	1.0515	8.14	1.26	9.40
Swain's Early Golden	Sept. 8	1	7.67	1.21	6.0	1.0	31.40		68.60	43.37	1.0640	12.60	1.18	13.78
Swain's Early Golden	Sept. 8	1	8.00	1.28	7.0	3.0	32.80		67.20	45.35	1.0680	13.42	1.13	14.55
Swain's Early Golden	Sept. 10	1	7.83	1.20	7.0	2.0	24.20		75.80	43.95	1.0739	14.65	1.02	15.67
Wabaunsee	Aug. 29	6	8.25	1.92	8.8	2.2	35.04		64.96	53.41	1.0486	6.97	2.08	9.05
White African†	Sept. 7	7	9.13	1.69	10.0	1.3	30.78		69.22	48.78	1.0590	9.28	2.46	11.74
White African†	Sept. 26	8	....	......	9.5	2.7	....	....	....	42.56	1.0653	10.67	1.31	11.98

*Inferior canes. †Seed largely taken by birds.

VARIETIES OF SORGHUM COMPARED — CONTINUED.

VARIETIES.	Date of Analysis.	No. of stalks	Average height in feet	Average weight in pounds	Average No. of joints	Average No. of dead leaves	Per cent. of tops	Per cent. of leaves	Per cent. of clean cane	Per cent. of juice calculated on clean cane	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice	Per cent. of total sugars in juice
White African †	Sept. 8	1	8.25	1.34	9.0	1.0	....	....	82.10	54.50	1.0542	2.65	....	....
White African †	Sept. 7	1	8.67	1.31	10.0	1.0		23.70	76.30	45.00	1.0665	10.37	2.80	13.17
White African †	Sept. 7	1	8.92	1.28	9.0	.0		23.40	76.60	42.80	1.0748	9.77	6.46	16.23
White Amber	Aug. 28	8	8.12	1.20	6.6	1.8		29.87	70.13	50.37	1.0533	9.53	2.63	12.16
White Amber	Sept. 15	10	7.70	.96	6.4	1.5		30.53	69.47	48.58	1.0594	10.43	1.65	12.08
White Amber	Oct. 3	10	7.47	.88	6.5	3.7		30.98	69.02	41.58	1.0581	9.58	1.67	11.25
White Amber	Sept. 11	1	8.58	1.05	7.0	2.0		30.50	69.50	46.57	1.0621	11.68	1.85	13.53
White Amber	Sept. 11	1	7.83	1.22	7.0	3.0		27.05	72.95	48.30	1.0483	7.45	3.06	10.51
White Amber	Sept. 11	1	7.33	1.10	6.0	3.0		27.30	72.70	46.25	1.0663	12.51	1.22	13.73
White India	Sept. 21	10	9.08	1.95	11.8	2.6	8.21	21.18	70.61	48.59	1.0642	11.59	2.04	13.63
White India	Oct. 12	10	9.28	1.60	12.1	5.3	6.05	15.16	78.79	45.33	1.0721	12.73	1.49	14.22
White Mammoth	Sept. 21	10	7.80	1.67	11.2	3.5	17.97	19.30	62.73	45.46	1.0691	11.87	2.71	14.58
White Mammoth	Sept. 24	1	6.67	1.96	10.0	5.0	20.92	16.84	62.24	45.90	1.0633	10.07	....	....
Whiting's	Aug. 21	9	*5.33	*.34	5.2	1.6	....	*22.00	*78.00	41.28	1.0237	1.74	2.27	4.01

* Without seed top. † Seed largely taken by birds.

VARIETIES OF SORGHUM COMPARED—CONCLUDED.

VARIETIES.	*Date of Analysis.*	*No. of stalks.*	*Average height in feet.*	*Average weight in pounds.*	*Average No. of joints.*	*Average No. of dead leaves.*	*Per cent. of tops.*	*Per cent. of leaves.*	*Per cent. of clean cane.*	*Per cent. of juice calculated on clean cane.*	*Specific gravity of juice.*	*Per cent. of cane sugar in juice.*	*Per cent. of reducing sugar in juice.*	*Per cent. of total sugars in juice.*
Whiting's	Sept. 24	10	5.79	.40	4.9	2.5	18.13	21.92	59.95	36.22	1.0449	6.37	1.79	8.16
Whiting's Earliest Cane	Aug. 21	1	5.67	* .46	5.0	2.0	*19.57		*80.43	40.50	1.0181	.96	1.37	2.33
Variety, with Early Amber	Sept. 21	9	7.69	1.65	11.4	3.4	14.74	20.84	64.42	48.54	1.0664	12.26	1.36	13.62
Unnamed new variety	Oct. 4	6	11.67	3.64	15.5	3.7	8.89	20.87	70.24	49.93	1.0646	9.69	3.36	13.05

* Without seed top.

It is fully realized that one season is too short a time to determine relative value with precision; for the conditions of growth may have favored some varieties. Nor is exact sampling possible by selecting stalks from plats. But in these analyses care was taken to get an average lot in size. All sizes — small, medium, and large — were taken.

There are five principal points to be looked after in selecting varieties of sorghum. These are, quality, size, feeding value of the by-products — blades and tops, whether the canes retain their good qualities well after they have ripened, and how to secure a long working season. The last two mentioned are intimately related. An early maturing variety, if a good keeper, might give a long campaign. But the early kinds are usually small, giving a light yield to the acre. The large varieties, conversely, are late. It will, therefore, generally be found advisable to obtain length of season by growing several kinds. Quality has primarily to do with the total quantity of sugar; but the solids not sugars, extracted in the juice, are worthy of attention. Where the quality of the cane is judged by the composition of the juice expressed, the per cent. of juice obtained is an essential factor. For sugar making, crystallizable sugar, or sucrose, as the chemists call it, is the one important substance; and for this purpose alone, all solids not sucrose, including uncrystallized sugars, so called, are not only useless, but positively objectionable. A kind of sorghum that is rich in sucrose and poor in uncrystallizable sugar should be selected for making sugar. If syrup is to be the product, it makes much less difference what kind of sugar is present. A large content of total sugars will give a large yield of syrup. And although the same quantity of sucrose would be somewhat sweeter than the mixture of the two, other good qualities may greatly overbalance this consideration, so that we would be justified in selecting for syrup a variety that contains a large amount of uncrystallizable sugar.

The ratio between the weight of the whole cane and the same when stripped and topped is an important consideration in choosing a variety of sorghum. If the cane is used for syrup or sugar the seed is a valuable by-product, and a large yield, if not accompanied by a corresponding lack of sugar, would be a good characteristic in a variety. If the cane is to be used solely for forage, a small, leafy stalk with a large seed top should be chosen. In the manufacture of sugar from sorghum by the diffusion process, the tops and almost all of the leafy portion are separated from the cane, and are available as fodder. It seems desirable, therefore, that we should possess fuller data in regard to the ratio existing between these portions of the plant, and all our examinations of sorghum include a determination of the weight of the clean cane as well as the whole stalk. In most cases, the seed tops were weighed separately, also, and the weight of the leaves found by difference. In all analyses made by us this season, the leaf sheaths, as well as the blades, were removed in ascertaining the weight of the clean cane. The table includes our data respecting the physical characteristics of the varieties grown.

The following notes are designed to draw attention to the principal characteristics of some of the varieties, and to bring out some facts that cannot well be tabulated.

The varieties African and Liberian are apparently identical, and the same as that grown throughout the State for syrup. It is often called Imphee. It has a very compact head, with small, round dark-red seed, extending considerably beyond the glumes. Its large sugar content makes it very valuable for syrup, but the large proportion of uncrystallizable sugar detracts from its value for sugar making. The stalks stand up well.

The Chinese sugar cane seed planted was said to produce a large number of varieties from the same seed. Six or eight more or less distinct varieties were noticed in the plat, and were analyzed. Some of these kinds were of only medium height, while some were fully seventeen feet high. Some had black seed and some had red seed. The seed of these varieties will be planted separately. None of the varieties seems to have a special value. The very large sort has juice of good composition, but in small quantity only. It ripens so late that unless planted very early it will not mature. The frost caught ours before maturity. Another year will show more in regard to these interesting plants.

Early Gooseneck is not early and is not goosenecked. It seems to be identical with Late Orange.

Dutcher's Hybrid is one of the earliest sorts. It is of only medium size, and so far as one season can show seems to have no peculiar advantages to counterbalance its rather inferior sugar content.

Enyama is a cane above the medium size, having nearly white seed inclosed in black glumes.

The Golden Rod, so called, was a mixture of even more varieties than the Chinese, and these varied, in time of ripening, from moderately early to very late. There was considerable difference in their habits of growth also, but they shaded into each other, so that it was difficult to decide where to draw lines of distinction. It is scarcely an exaggeration to say, that no two hills were alike. Quite a number of the more pronounced types were analyzed. They were about like the Chinese, but had in general a less amount of reducing sugar. The per cent. of juice was usually low.

Honey Dew has white seed, which was badly attacked by sparrows. The cane is of medium size and the juice of fair quality.

Honey Drip has a peculiar top. The upper portion of the panicle droops over on all sides, giving it a mushroom-like shape. It seems to be among our best varieties, having a heavy stalk and juice of large sugar content. It ripens in good season.

Liberian from Kansas does not at all resemble the other Liberian canes, and is probably not truly named. The type varied greatly and it is too late to be of much value here.

Link's Hybrid is a good sort. The stalks are of fair size and of more than medium height. They are a little inclined to be slender above, and generally have the appearance of being top-heavy. The head is lengthy and loose, the seed pendulous, and, with the head as a whole, hangs to one side. The glumes are black, and the exposed part of the seed is light reddish yellow with black specks.

This cane is doubtless the true Link's. In our work in 1883, upon the quality of sorghum at different stages of ripeness, we found that the sort sold us a Link's was worthless. It was a different cane from that of the same name this year. The canes were short and stocky, and the seed tops close and bunchy. But it is no great rarity to find confusion in the names of varieties of sorghum. Four sorts on the present list are really Link's. These are the ones marked Link's, Early Orange, Russell's, and New Variety from Missouri. There is no apparent difference between them except in name.

New sugar cane from Central America is above the medium height, and although a little late seems to be a promising variety. It very much resembles the old Chinese sorghum.

Another unnamed new variety, said to have been originated in Missouri, is a tall, large cane, but quite late. The percentage of total sugars is large, but reducing sugar forms a considerable portion.

The Orange cane is well known in a considerable portion of our State. There are several varieties, more or less distinctly marked, either by appearance or time of ripening. Seed from different sources, purporting to be the same variety, we have found to produce canes having notable differences. Kansas Orange (I), as given in the table, was from seed purchased the present season from a well-known dealer. The seed from which Kansas Orange (II) was grown was obtained in this State. It was derived from seed originally obtained by us several years ago from another well-known dealer in sorghum seed. The seed top from (II) differs from (I) in being longer and having no tendency to spread. Both were planted in considerable quantity and in adjoining plats. (II) was almost totally destroyed, except at one end of the plat, by the disease described by Professor Kellerman in this volume, while (I) was but little affected.

Late Orange, New Orange, and South Carolina Early Orange furnish noticeably large percentages of sugars. Late Orange is no later in ripening than Kansas Orange. There are some indications that it preserves its good qualities later in the season, but further observations are needed on this point.

Medium Orange is not an Orange cane. It resembles Early Amber closely, and may be the same cane. Of the seed marked Early Amber, only a few germinated; hence this kind is given less prominence in our work than would otherwise have been the case.

Amber and Orange Crossed has shown itself in the past season to be an excellent cane. It is early, and the juice is of good quality. It is not intended in anything presented in this article to in any way express an opinion on the disputed point of crossing of sorghum.

Price's has shown no advantageous qualities the past season.

Swain's Early Golden appears to be one of the best early varieties we have examined. No other variety this season has made as good a showing at an early stage of ripeness. For early working, this variety merits a trial.

White African is chiefly noticeable for its large white seed. The head is not large, however. The sparrows took the seed very badly, also.

White Amber differs little, if any, from the Early Amber.

White India is a beautiful cane, tall, and stands up remarkably well. The seed is similiar to that of Enyama, and was taken somewhat by sparrows.

Whiting's has been recommended as useful for early working. The figures obtained on the small amount at our disposal are not favorable to this view. The stalks are extremely small, and the juice poor.

From lack of sufficient cane upon which to work, we are unable to form any serviceable judgment respecting the following sorts: White Mammoth, Silver Top, Little Sumach, India, Red Top, Wabaunsee, Honduras, and Honey Cane. Several of these ripen so late, that the analyses given do not show the cane at its best stage.

THE KEEPING QUALITIES OF SORGHUM.

It has long been known that the uncrystallizable sugar decreases, and the crystallizable sugar increases, as the cane developes. Our work did not begin on the sorghum until it had reached a workable condition. The figures in the table show, that the juices of those varieties which became fully ripe before frost continued to improve until the cane was dead ripe, and then continued sensibly constant until the cane was injured by freezing; then rapid deterioration set in. The diagram below shows the eye these facts. It is made up from the table. Enough of the varieties have been included in the diagram to show that this kind of development is a general rule. The principal point to which attention is called, is the fact that these varieties at least retain their good qualities after ripening as long as the canes are left standing in the field without being injured by some external agent. Some writers voice a generally received notion, that the sugar in the sorghum is so far an accident to the plant that it is extremely liable to transformation; so much so, in fact, that unless worked promptly on ripening the sap rapidly deteriorates. It has been thought that, because of this habit of the plant, little should be expected from it. Our results the past year have not sustained this view. Other kinds of sorghum or a different season may give different results and lead to opposite conclusions.

In calling attention to the diagram, it is necessary to mention that a frost on the morning of October 3 killed some sorts and injured others, so that they gradually gave outward evidence of the freeze, although at first it was not prominently noticeable. On October 20, the whole of the sorghum was killed by the frost, and rapid deterioration set in. The chemical characters of the juice, even before the frost of October 20, had become so modified by the frost of October 3 that much reliance cannot be placed on any analyses made later than October 15, and some of earlier date seemed anomolous.

DIAGRAM showing percentage of sugars contained in certain varieties of sorghum at the dates named. The length of the open portion shows the per cent. of cane sugar; that of the shaded portion, the reducing sugar.

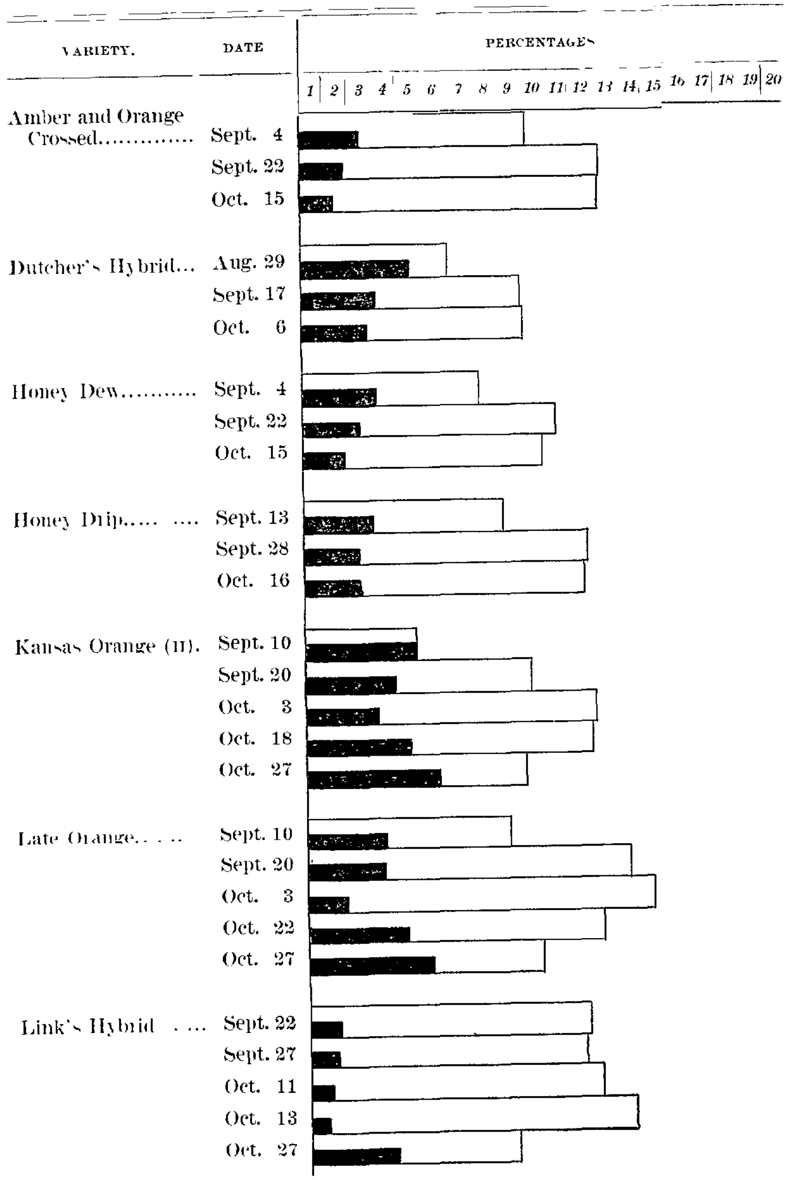
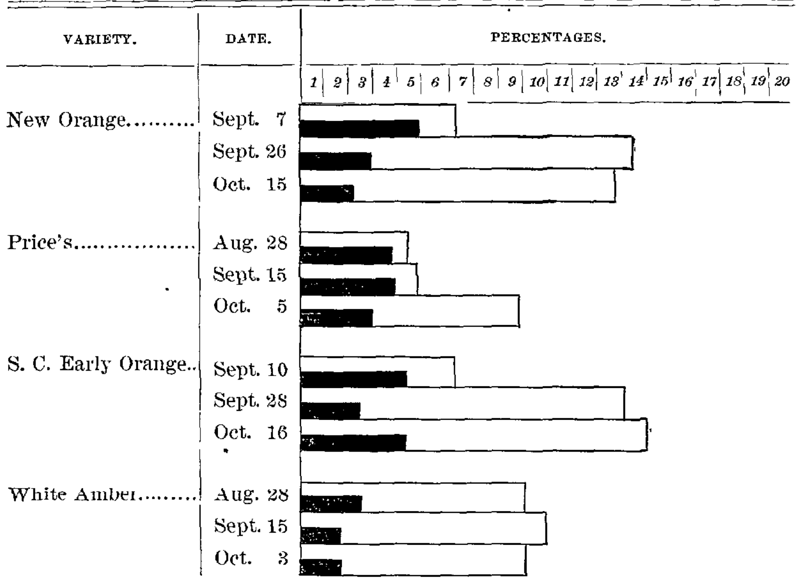


DIAGRAM SHOWING PERCENTAGES OF SUGARS, ETC.— CONCLUDED.



ATTEMPTS TO IMPROVE SORGHUM BY SEED SELECTION.

The great success attending the efforts to improve the quality of beets for sugar making — an improvement which consisted in greatly increasing the content of the true crystallizable sugar, and at the same time decreasing the substances that would interfere with the separation of the sugar — led to hopes that an analogous change might be effected in the sorghum plant. It is fully recognized by those who have worked with both, that the juice of the sorghum plant is not so well suited for sugar making by old methods as that of the southern cane. But sorghum is much better suited for working by the present methods than were beets by the methods in vogue when their improvement was undertaken. While all have felt the importance of improving sorghum, and many have believed in its possibility, but little has been done towards accomplishing it. All have realized the magnitude of the work. A long series of years will without doubt be required to change and fix a quality. Then how shall the end be reached? Shall it be by seed selection? Shall it be by crossing? or is the improvement to be sought in better tillage and by the use of fertilizers? or is it to be attained in some other way? No one pretends to be able to answer these questions, and any attempts at improvement must be attended with uncertainty as to results. In the years 1885 and 1886, some work was done in our laboratory in an attempt to improve the quality of sorghum by seed selection.* But the work was temporarily discontinued. It was taken up again the past season. It has been accepted by common consent that the seed from stalks rich in sugar and poor in objectionable substances would produce canes of similar character, but with these features intensified, while seed from a poor stalk would bring poor canes. Were this true, simple seed selection would effect an improvement in the average quality of the cane, if there is any considerable difference in the quality of individual stalks of the same variety grown under the same conditions. For, where seed is taken promiscuously, the mixture will be an average of the better and the poorer. To determine to what extent individual stalks vary when grown under the same circumstances, as well as to form a basis for present selection of seed and for future comparison, analyses were made of the juice pressed separately from a number of stalks. The varieties from which individual stalk selections were made were those which the general comparison of varieties showed to be promising sorts. This judgment was based upon the sugar content. Only perfect stalks of fair size were used. A number of stalks of each variety were taken for comparison with each other. The analyses were completed on those stalks only which the initial work showed to be extremes. In this way many more stalks could be subjected to the comparison. About one hundred and sixty-five stalks were separately thus either partially

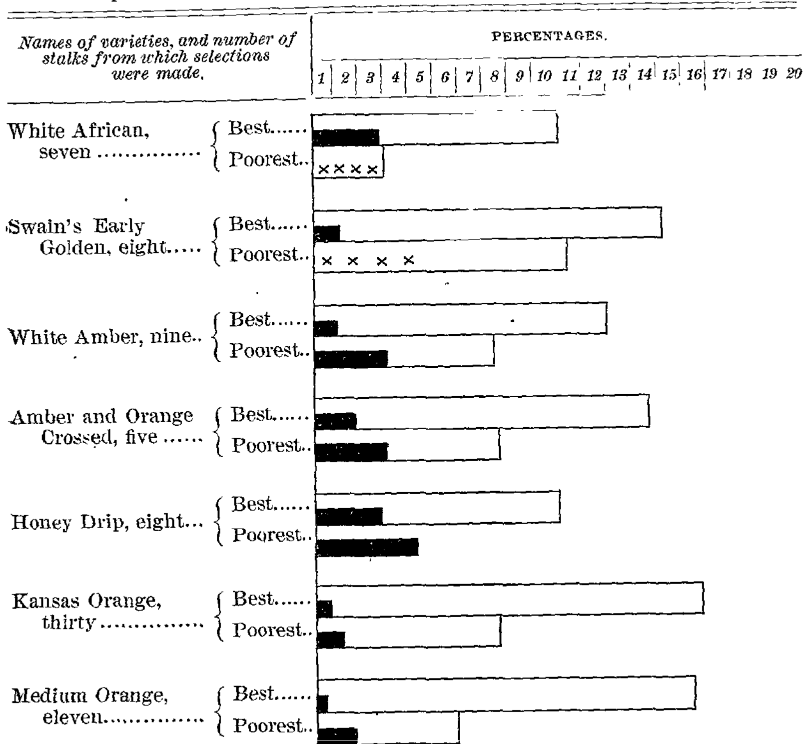
*See Transactions Kansas Academy of Science for 1885-86, p 70.

or wholly analyzed. It is obvious that the figures obtained in these analyses are of use in our work here, but are not of great interest to others. The partial analyses are entirely omitted, but the complete ones are inserted in the table on pages 124 to 133. In most cases, only the best stalks were completely analyzed. These single stalk analyses may be selected from the table by observing in the column headed "No. of Stalks" the figure 1. It is not known with any degree of certainty whether each stalk of sorghum closely resembles in sugar content the stalk from which the seed producing it was obtained. Knowing the history of the seed, we shall probably be able in a few seasons, possibly the next, to speak authoritatively on this matter. We have preserved seed from some very poor stalks as well as from the richest, believing that by this means an answer will best be obtained to the question whether richness in sugar is hereditary. It was deemed that a selection of seed from poor stalks of some half dozen varieties was sufficient, in connection with the seed of good stalks, to settle the matter in question. But the seed of stalks of all varieties on our list, which by their content of sugar or by their time of ripening give promise of good results from efforts to improve them, have been carefully labeled and preserved, and next year will be grown under similar conditions as to soil and tillage; and the crop as a whole and in individual stalks will be compared with that producing the seed. In order to show to what extent the juice of similar stalks of the same variety grown in the same plat will vary, some of the single stalk analyses given in the preceding table are brought together below. In selecting these figures, all cases have been included where both a "poorest" and a "best" stalk of the same variety were analyzed. These were consecutive analyses, and hence represent what would probably be found in almost every variety of sorghum. The intermediate stalks not given ranged promiscuously between these extremes. The figures of the table may perhaps be better appreciated by an observation of the diagram following the table.

TABLE showing extreme variations of sugar content observed in certain varieties of sorghum.

Names of varieties, and number of stalks from which selections were made.		Weight in pounds.	Per cent. of juice.	Per cent. of cane sugar.	Per cent. of reducing sugar.
White African, seven,	Best	1.31	45.0	10.37	2.80
	Poorest	1.34	54.5	2.98	....
Swain's Early Golden, eight,	Best	1.20	43.9	14.65	1.02
	Poorest	1.29	47.8	10.75	....
White Amber, nine,	Best	1.22	46.3	12.51	1.22
	Poorest	1.10	48.3	7.45	3.06
Amber and Orange Crossed, five,	Best	1.99	53.6	14.18	1.70
	Poorest	1.64	50.0	7.92	2.95
Honey Drip, eight,	Best	2.33	50.7	10.41	2.70
	Poorest	2.19	50.7	2.92	4.41
Kansas Orange, thirty,	Best	1.73	41.4	16.44	.95
	Poorest	1.30	46.3	8.13	1.32
Medium Orange, eleven,	Best	1.24	37.5	16.25	.45
	Poorest	1.06	43.8	6.00	1.72

DIAGRAM showing the extreme variations of sugar content observed in single stalks of the varieties named. The per cent. of cane sugar is shown by the length of the open portions, the reducing sugar in the same stalk is shown by the shaded portion.



From this table and diagram, it will be seen that there are extreme variations in the quality of the juice expressed from stalks. The following considerations, while presenting the matter correctly, will probably show it in stronger colors than the mere figures of the table do:

First, let it be remembered that for sugar making all soluble substances not true cane sugar, in the juice, will interfere with the separation of the cane sugar as crystals. Refiners usually expect a quantity of cane sugar equal in weight to the foreign substances to be held in solution by them, so that for every pound of solids not cane sugar in the juice a pound of the cane sugar will be unavailable for making sugar. Applying this principle to the case of Honey Drip in the previous table: if one hundred pounds of the juice of the best cane be taken, there would be 10.41 pounds of cane sugar; this, diminished by 2.70 pounds, representing the uncrystallizable sugar would leave 7.71 pounds for sugar making neglecting other solids. One hundred pounds of juice from the poorest of Honey Drip would contain 2.92 of cane sugar, which in the presence of 4.41 pounds of glucose would not be able to crystallize at all. Only syrup could be made from such a juice. Even in Medium Orange the comparison is striking. One hundred pounds of the best juice would contain 16.25 pounds of cane sugar. This diminished by .45 gives 15.8 pounds of available sugar. One hundred pounds of the poorest would contain 6 pounds of cane sugar. This diminished by 1.72 pounds leaves 4.28 pounds of available sugar. The one is worth nearly four times as much as the other for sugar. Is anything more required to make the variations of individual canes apparent? And these canes are sensibly alike in size, weight, and in general appearance.

The foregoing only shows what we are trying to do, and how, with perhaps why, we are trying to do it. But obviously we have only made a beginning. It is hoped that another season will settle some of the points, and that progress will be made in others. But from the nature of the case we cannot expect great returns for some time yet. And they may not be secured at all. It may be that ultimate success is to be had by some other line of work entirely. We can learn only by experience.

It is suggested that cane growers, next season, select seed from stalks of a good quantity, and assist in the test as to heredity of qualities, as well as in efforts to improve the sorghum. It was observed that the quality of cane sugar, in fully ripe canes, followed very nearly the specific gravity of the juice. But since all other soluble substances, as well as the cane sugar, increase the specific gravity, it is obvious that this test is only approximate. But as cane growers may not be able to select by means of a chemical analysis, the gravity test might be made to serve a useful purpose. A delicate hydrometer should be used, so that small differences will be apparent.

FERTILIZERS ON SORGHUM.

The effect of fertilizers on sorghum was tried on plats of three rows in width and some ten rods long. The fertilizers used were superphosphate, sodium nitrate, lime and plaster. Each of these was applied to one plat, but no record seems to have been kept of the amount used. “Nothing” plats alternated with these. These experimental plats were adjacent to the sorghum so badly injured by the blight described by Professor Kellerman in his report, plat 1 being on the side next the diseased sorghum. The disease attacked the plants when they were quite young, and killed many in the first and second plats. It was less severe further from the source of contagion.

All of this sorghum, except 33 feet off the south end of the plats, was used for feed, and these short plats were placed at our disposal. As the plats were separated by no more than the usual space between rows, it was thought best to take the middle row of the plat for analysis. This would avoid any effect. from such of the fertilizers as might have been washed from one plat to another. The entire row, 33 feet in length, was taken for the sample. The average height was determined by measuring all of the stalks in one row of the plat.

From the following table it appears that there was very little effect from the fertilizers. The lime seems to have been an injury, and the plaster may have been of benefit.

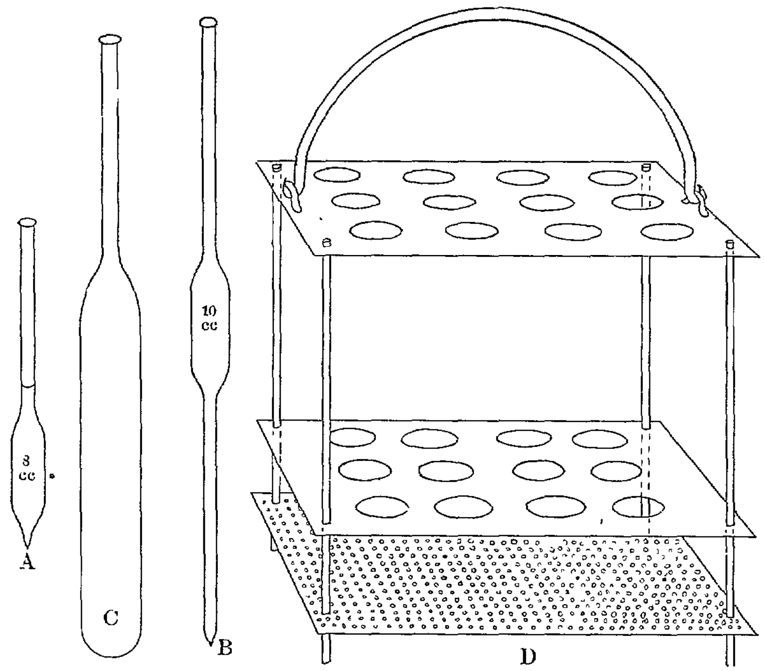
TABLE SHOWING RESULTS OBTAINED IN PLATS OF SORGHUM TO WHICH CERTAIN FERTILIZERS WERE APPLIED.

ITEMS.	*Plat I—Superphosphate.*	*Plat II—Nothing*	*Plat III—Sodium nitrate*	*Plat IV—Nothing*	*Plat V—Lime*	*Plat VI—Nothing*	*Plat VII—Plaster*
Number of stalks	37	43	60	57	59	51	66
Average height	8.34	8.43	8.51	8.71	8.59	8.90	8.89
Average weight	1.51	1.76	1.48	1.63	1.51	1.54	1.47
Per cent. of clean cane	62.23	61.42	58 76	60.22	62.36	59.87	61 85
Per cent. of tops	11.93	10.03	11.51	10.28	11.55	10.83	11.14
Per cent of leaves	25.84	28.55	29.73	29.50	26.09	29.30	27.01
Per cent. of juice calculated on whole cane	30.10	29.20	29.28	30.08	29.67	28.21	29.79
Per cent. of juice calculated on clean cane	45.49	47.54	49.83	49.94	47.59	47.13	48.16
Specific gravity of juice	1.0684	1.0726	1.0710	1.0704	1.0680	1.0699	1.0750
Per cent. of cane sugar	11.99	13.02	12.24	12.25	11.30	12.04	13.01
Per cent. of reducing sugar	2.24	2.35	2.26	2.45	2.69	2.55	2.65
Per cent. of total sugars	14.23	15.37	14.50	14.70	13.99	14.59	15.66
Per cent. of solids not sugars	1.52	1.30	1.58	1.32	1.31	1.32	1.55
Per cent. of total solids	15.75	16.67	16.08	16.02	15.30	15.91	17.21

A NEW METHOD OF MILK ANALYSIS FOR THE USE OF DAIRYMEN, AND A COMPARISON OF ITS RESULTS WITH THOSE OBTAINED BY THE CHURN.

For the use of dairymen, creameries, etc., it has seemed very desirable to have some simple way of testing the relative quality of milk. Such a method, to be practicable, would necessarily include these characters: It must be so simple so far as manipulations are concerned, as to be easily performed by one who has not had training in a chemical laboratory. The appliances must be comparatively inexpensive. This would involve dispensing with a delicate balance, and hence would be a volumetric method, unless, by operating on a considerable quantity of milk, the heavier weights involved could be taken on a coarse balance. There have been various methods suggested for making this test. These have been of two classes: the one depending upon the principle of the churn, the other involving the determination of the total fat by some chemical or physical method. Of the latter class, perhaps the most successful is that known as Short's method. It is described in the Sixteenth Bulletin of the Wisconsin Experiment Station. In all chemical methods, the total fat in the milk is determined. Comparisons of milk made by the fat actually present will give the real food value, in this respect, of the milk as such. This has been the basis almost universally used in the past for judging the value of milk. Even the old method of' testing by the lactometer or by obtaining the specific gravity had the fat in the milk in view. No account was taken of any difference in the proportion of this fat that could be obtained by churning. All methods which completely extract the fat from the milk are alike in this respect. So that none of these have advantages over the others except in respect to accuracy, and to ease and rapidity of performance. The Short method, to which reference has been made, is rather simple, so far as the manipulations are concerned, but the chemical reactions involved are somewhat complicated. The accuracy of the work, however, does not depend upon a knowledge of the principles involved in these reactions, if the very full directions given in the bulletin are carefully followed. But one drawback which will greatly operate against the general use of the method, is the fact that, including measuring, cooling, and the four hours' boiling, fully five hours will be required to complete the analysis. Of course the operator can be doing other work during much of this time, but some personal supervision would seem to be necessary. Where many analyses are being performed at the same time, this element of time will not be of such consequence; but if only a few analyses are to be made, it seemed to be very desirable to have a shorter method than this. An attempt was made to work out such a method. It was decided at the outset that the butter should be determined as such. The problem seemed to be simply to dissolve the curd and collect the butter fat. After trying several solvents and combinations of these, a modification of a process described by Dr. W. Schmid in the *Zeitschrift fur Analytische Chemie,* Vol. 27, p. 464, was finally settled upon as being the best, all things considered. The method, as originally proposed, consists in boiling ten cubic centimeters of milk with an equal quantity of strong hydrochloric acid in a graduated tube until the liquid turns brown. It is then cooled, and shaken up with thirty cubic centimeters of ether. After allowing it to settle, the volume of supernatant ether is observed, and ten cubic centimeters of this ether are taken off and evaporated in a tarred dish. The dish and contained fat are accurately weighed, and from this and the known volume of ether from which the ten cubic centimeters were taken the total fat in the milk is calculated. This method requires an accurate balance, and some skill in using it. Where the necessary appliances are at hand, this may be entirely satisfactory. We have given it no trial in this respect, our aim being to avoid weighing. It was found that the solution of the curd could be readily effected in the hydrochloric acid, but that the fat did not readily collect as a whole. The use of the solvent for this purpose seemed essential. To make the readings volumetric, and at the same time delicate, a tube was used having a contracted part, similar to those described by Short, except that the bottom is thin and rounded and well annealed, so that the contents can be boiled over a naked flame, and the narrow tube, in which the reading is effected, is of less diameter, so that smaller differences will be made apparent.

The details of the process as finally settled upon, will be made clear below.



The following materials are necessary for this method of analysis:

(a) Tubes in which the analysis is made. Ours were made from eight-inch test tubes, by drawing off the top and sealing on a piece of tubing of 4 — 5 m. m. internal diameter, and expanded into a small funnel at the top. The whole tube is 10

inches long, the narrow portion being 3½ inches. The narrow tube is graduated. (See Fig. C.)

(b) A water bath of some sort, about 10 inches deep, and having a rack inside in which the tubes can be supported. A rectangualar box of copper is the best, but a cheaper one may be used. A tin pail would do, in which case the rack would better be round. Fig. D illustrates a very serviceable form of rack for holding the tubes. It is 5x6½ inches, and 6½ inches high. The lower shelf is made of perforated metal, and the upper two have holes to accommodate twelve tubes.

(e) Some means of boiling the water in the bath. A gasoline stove would be best, where gas is not available.

(d) Two pipettes, as illustrated by A and B in the cut. It is better to have the 8-c. c. pipette of the form shown, as it can then be put down in the bottle of acid and filled without suction, the acid fumes making the latter method very disagreeable. In using pipettes, the liquid to be measured is drawn up above the mark on the stem, and is then allowed to fall until the lowest portion of the surface of the liquid in the tube just reaches line. That remaining will be the required volume. In measuring the milk, at least one-half minute must be allowed for the milk to drain down, the last drop being blown out. The pipette for milk must be kept clean. This is easily done by rinsing it repeatedly with cold water, immediately after using. Finish the cleaning by rinsing with hot water.

(e) A glass tube of about 4 m. m. external diameter, 18 inches long, and bent at right angles about 5 inches from one end. A small rubber cork on the other end assists one in blowing, or in connecting with a bellows.

(f) Where a Bunsen gas burner cannot be used, an alcohol lamp giving a large flame.

(g) Something for introducing boiling water into the analytical tube. A wash bottle is best; a pipette may be used. A tin cup with a spout soldered in near the top would answer

every purpose, and be unbreakable. The spout should be a tube, like that of an oiler, the opening being very small.

(h) A bellows, which can be attached by a rubber tube to the glass tube described in (*e*), is very desirable, but not essential, as the blowing can be done by the lungs. A small rubber bulb pump might be used.

(i) Concentrated commercial hydrochloric acid.

(j) A gasoline of low boiling point, such as used in gas machines. This must leave no residue when evaporated by the method used in the analysis.

In making the analysis, 10 c.c. of the milk are first carefully measured into the tube used in analysis. The inside of the narrow, graduated portion should be wet with water first. There will then be no difficulty in introducing the milk if the tube is held in an inclined position. The milk is then heated just to boiling by* a naked flame (gas is best, but a large alcohol lamp will answer) and 8 c. c. of conc. hydrochloric acid added from a pipette, taking care to wash down any milk in the narrow part of the tube. The mixture is then heated cautiously in the flame, passing the tube rapidly backwards and forwards across the flame, holding it in an inclined position, and so that the heat is applied to the *upper* portion of the liquid. There is considerable tendency to foam at first. As soon as the foam is seen to be rising, the tube must be removed from the flame momentarily and heated again as soon as the foam subsides. In about a minute all foaming ceases. If now the contents of the tube be examined, it will be seen that a flocculent layer rises rapidly to the surface. This contains the butter fat, entangled, however, with some portion of the other milk solids which is not readily soluble in acids.

The next object is to get rid of this substance entangling the fat. This portion of the operation is the only one requiring special care, and upon its proper execution depends the success

* If the acid and milk are mixed cold, a coagulated mass is produced, similar to ordinary thick milk. This mixture is much less readily shaken and boiled and solution less readily effected than if treated in the manner described.

of the analysis. The contents of the tube must be kept very hot; they must be kept constantly shaken together; the heating must be continued long enough and yet not too long. The tube is best shaken by holding it in a considerably inclined position and moving it rapidly backwards and forwards, in a way which given it both a lateral and a longitudinal motion, thus setting the contents of the tube into rapid rotation. This method of giving the best motion while hard to describe, is easy of execution. It is not necessary to shake in this particular way, but the contents must be kept thoroughly mixed. Care must be taken not to shake the contents against the opening of the narrow tube, or they will be thrown out by the rapidly escaping steam and acid. During heating, the flame must never be applied to the bottom of the tube, but to a point on the side which would be above the liquid if it were at rest, but is kept constantly covered by the vigorous shaking. By heating and shaking in this way, there is absolutely no danger from bumping. The heating is continued until, on stopping for a moment, the globules of fat are seen to be clear as they slide down the side of the tube and in the layer which they form on the liquid. The acid liquid in the tube will have become black, and the flocculent matter which at first rose with the fat will have disappeared. If the heating is not continued long enough, this matter is not all dissolved, and will rise with the fat when the measurement is made, and prevent accurate reading. If on the other hand the heating be too long continued, the acid effects further decompositions, and a black humus-like solid is produced. which interferes equally as much with the measurement of the fat. The heating requires about five minutes. When it is judged to be complete, the tube is set aside to cool somewhat, or is dipped in cold water a few minutes. When it is cooled below the boiling point of the gasoline, but while the butter fat is still melted, fifteen or twenty c. c. of gasoline are added. The contents of the tube are gently agitated, until the fat is mostly taken up; it is then shaken vigorously, the opening being kept tightly closed by the finger. If any of the frothy mixture produced lodges in the narrow part of the tube. it must be allowed to flow back before removing the finger, or the inside pressure will drive it out. The tube is rinsed down with a little gasoline and set aside. In a few minutes the gasoline containing the fat will have risen to the surface in a clear stratum.

The tube is now placed in the bath of boiling water, laid in a very much inclined position, so that the gasoline is spread over a large surface, and a current of air is blown in by means of the narrow glass tube, either by the mouth or by a bellows. The current of air is continued until the gasoline is all driven off. The tube is then filled with boiling water up to where it begins to contract, being careful not to stir the contents much. The tube is twirled a few times to detach any small globules of fat which may have lodged on the side, and is then allowed to stand in the bath of boiling water for a few minutes to allow the fat to collect in one globule, and to be sure to expel all traces of gasoline. This is not only necessary to accurate measurement of the fat, but if any gasoline remains it is liable to volatilize suddenly and drive out the fat if it has been brought up into the narrow tube. Finally, enough more boiling water is added to bring the column of fat within the graduated tube, and its amount is measured. The measurement is best made by having the hot water bath nearly full, so that readings can be made while the body of the tube is immersed. In this way the column of fat remains stationary, while, if the tube is taken out, the cooling and consequent contraction of the water causes it to move rapidly downward, and makes accurate measurement very difficult. If a light-brown flaky substance rises in the water, lodging against the fat, or rising between it and the glass, it indicates that the milk was not boiled with the acid long enough. If, however, a black substance rises in the same way, the boiling was too long continued. Sometimes a twirl of the tube will send the interfering substance down long enough to enable the reading to be made. Sometimes a thin platinum wire is useful in displacing it. If the heating has been properly conducted, however, there will be no trouble from this source.

The analysis of a single sample of milk occupies about twenty-five minutes. Four can be analyzed in an hour and a quarter if the water has been put to heating, so as to be boiling when wanted.

It will occur to the chemist that ether might serve a better purpose in collecting the fat. It was however, found entirely unavailable on account of its solubility in water. While ether can be readily removed from fat alone, it cannot be removed from a layer of fat floating on water containing ether in solution. The ether continually passes from the water to the fat until entirely removed from the water. This was found to require a long time. Sometimes, too, a sudden ebullition takes place, which is very likely to cause the loss of some of the fat. Gasoline by its insolubility in water, presents no such difficulties.

The calculations necessary depend in part on the kind of graduation adopted for the tubes in which the analysis are made. This may be simply a millimeter scale on the narrow tube. In this case, it is necessary to know the capacity of the tube for a given length. It is better to have the tube graduated in cubic centimeters and fractions. It can easily be graduated in fiftieths of a cubic centimeter. If ten cubic centimeters of milk be taken for analysis the number of tenths of a cubic centimeter of fat measured will give the per cent. by volume. If the specific gravity of the hot butterfat be taken as 8/100, the per cent. by volume multiplied by this fraction, will give the per cent. by weight, if we assume that the milk delivered by a 10 c. c. pipette weighs ten grams. Perhaps a still better kind of graduation would consist in providing the tube with a decimal scale such that 87 divisions shall be equal to one cubic centimeter. One-tenth the number of divisions occupied by the column of fat will show the per cent by weight in the milk.

If it be assumed that a 10 c. c. pipette will deliver ten grams of milk, no calculations other than those indicated above will be necessary. For ordinary analyses for purpose of comparison, this assumption will give results which are sufficiently near the truth. If greater accuracy is desired, a correction must be introduced. Milk being heavier than water, ten cubic centimeters will weigh more than ten grams. On the other hand, a 10 c. c. pipette, allowed to drain one-half minute or even a minute, will not deliver ten cubic centimeters of milk; so that an accurate correction cannot be applied by taking into account the specific gravity of the milk.

The following trials were made, bearing on this point. An accurate 10 c. c. pipette was used. The contents of the pipette were measured out a number of times in succession, and all weighed at once. The milk was allowed to drain out one-half minute, except in the first instance, when it was allowed to drain one minute. The last drop was blown out. The specific gravity of the milk was taken by an accurate flask.

KIND OF MILK.	*Average amount obtained from 10 c. c. pipette*	*Weight of 10 c. c., as calculated from the specific gravity*	*Per cent. delivered*	*Number of times pipette was filled*	
Night's milk stirred up in the morning	10.2082	10.3250	98.9	5	Pipette drained one minute.
New milk	10.1755	10.3167	98.6	8	Pipette drained one-half minute.
New milk from another source	10.1755	10.3231	98.5	9	Pipette drained one-half minute.
Skim-milk	10.1934	10.3560	98.4	9	Pipette drained one-half minute.

It will be seen that the weight obtained in the last three trials is 1.5 per cent less than that calculated from the specific gravity. On the other hand, it is in excess of ten grams by about 1.8 per cent.

From this we see, that if the per cent. of fat obtained by the method of calculation before described be diminished by 1/60 of itself, the result will be very close to the truth. There will probably be a slight variation with the specific gravity and other properties of the milk.

To test the accuracy of the method, the analyses given in the table were made. Proper tests of a method require that there should be parallel determination in each of several distinct analyses and that the results of these should be compared with the real amount of the substance known to be present. Where a definite and pure compound is operated upon, the proportion of any ingredient present is easily calculated. But in case of such a substance as milk, comparison of the results of a new method of analysis must be made with the results of an already tried and accepted one. In this case, comparisons were made with the method used by Dr. Babcock in his work at the New York Experiment Station. Duplicate analyses were made by this method except in one case. All analyses made are printed; in some cases there were three, in some four, by the new method.

TABLE giving results of analyses of milk by the new method, and by Babcock's gravimetric method.

DATE.	NEW METHOD.						GRAVIMETRIC METHOD.			
	Parallel Analyses.				*Average.......*	*Greatest difference.......*	*Duplicate Analyses.*		*Average.......*	*Greatest difference.......*
Dec. 20.....	4.52	4.54	4.42	....	4.49	.12	4.61	4.52	4.57	.09
Dec. 21.....	5.20	5.33	5.34	5.37	5.31	.17	5.27	5.25	5.26	.02
Dec. 22.....	4.91	4.81	4.76	4.88	4.84	.15	4.86	....	4.86	......
Dec. 24.....	4.95	4.90	5.02	....	4.96	.12	4.89	4.92	4.91	.03
Dec. 25.....	4.56	4.50	4.53	....	4.53	.06	4.62	4.61	4.62	.01
Dec. 26*...	4.53	4.35	4.57	....	4.48	.22	4.70	4.78	4.74	.08
Dec. 27*...	4.84	5.03	5.27	....	5.05	.43	5.03	5.04	5.04	.01
Dec. 29.....	3.63	3.51	3.56	....	3.57	.12	3.49	3.53	3.51	.04
Dec. 31*...	5.02	4.91	5.31	....	5.08	.40	5.03	5.08	5.06	.05
Jan. 2......	5.16	5.20	5.10	....	5.15	.10	5.25	5.32	5.29	.07

* Method modified, as stated in the text.

In the analyses of the milk of December 26 and December 27, the acid was left in contact with the milk much longer than usual. In those of the milk of December 31, the boiling was less prolonged than usual. The bad effect of excessive and of insufficient action of the acid are exemplified by the much more widely divergent results obtained on those days. Leaving out these results, a comparison of the figures will show that the greatest difference between the results of parallel analyses by the new method is .17 per cent., and the greatest departure of any single determination by the new method from the mean result obtained by the gravimetic analyses of the same milk is .19 per cent. Usually the difference is only .1 to .12 per cent. If averages are to be compared, the differences are much less. The results are certainly satisfactory for technical purposes.

It is not claimed for this method any greater accuracy than by Short's method; from the manner of executing the work in the two cases, it seems that equal care should give almost equal accuracy. Both assume certain constants which are averages, and which will depart from the truth in individual cases, but for practical purposes will answer fairly well, especially if the milk is the mixed milk of a herd, for then it will come nearer being of average character. The short time necessary to complete the analysis, the simple reagents required and the fact that all the butter is collected are the principal advantages of the new method of analysis.

It was also part of the scheme of comparison to churn the milk in order to see how the results of analysis agree with those by the churn. A Cherry churn was used to make the butter test. Two-quart glass fruit jars were used on the churn. In these were placed one kilogram (about 2.2 pounds) of the fresh milk. This filled the jars about three-fifths full. In each trial, three exactly similar portions were weighed out. For these successive churnings the milk was let stand twenty-four hours and then churned. It was perfectly sweet and the whole milk was churned, as it seemed a fairer test than to introduce the error of unequal skimming. In the last three trials, six portions of milk were weighed out as before. All were left 48 hours; three were kept cool and remained sweet; the other three were kept warm enough to become sour. The churning of all was effected at a temperature of 21 or 22 degrees C. (70 to 72 degrees F.), except the milk of December 26 — this was churned at a higher temperature; as a result, the butter was whiter than usual, and collected in balls so that it was worked to remove water collected in cavities in the balls, and then weighed "moist." Otherwise this butter was treated as were the others described below. Except as noted above, the butter procured was eminently granular and had a fine color. Visitors to the laboratory, who saw the butter as it was drying or after being bottled, spoke of its excellent appearance. There can be no question as to the satisfactory character of the method of churning. Any unsatisfactory results by the churn must be explained otherwise than by the manner of churning. The butter was placed on brass gauze and thoroughly washed with cold water. It was then allowed to drain, after which it was weighed. This is the "moist" weight of the table. The butter was then allowed to dry in the air for twenty-four hours, being still in the granular condition and piled up much like shot. After twenty-four hours drying the butter was weighed, giving the "dry" weight of the table and immediately bottled. The butter was afterwards analyzed for water and butter fat. The difference between these two per cents and one hundred per cent. was considered "curd." The following tables give our results upon the six samples of milk. They show the per cent. of fat in the milk; the per cent. of butter obtained weighed both moist and dry; the composition of the dry butter, and the per cent of fat extracted as butter from the milk.

TABLE showing per cent. of fat in the milk, per cent. of butter obtained, the composition of the butter, and the per cent. of fat extracted as butter from the milk. Milk set 24 hours, and churned sweet.

DATE.	Per cent. of fat in milk	PER CENT. OF BUTTER.		COMPOSITION OF BUTTER.			Per cent. of fat extracted as butter from the milk
		Weighed moist	Weighed dry	Per cent. of fat	Per cent. of water	Per cent. of curd by difference	
Dec. 25		4.65	4.24	78.99	18.51	2.50	3.35
Dec. 25		5.10	4.58	74.40	23.21	2.39	3.41
Dec. 25		4.94	3.80	78.45	18.91	2.64	2.89
Mean	4.62	4.90	4.21	77.28	20.21	2.51	3.25
Greatest difference		.45	.78	4.59	4.70	.25	.43
Dec. 26		4.50	4.23	72.18	24.77	3.05	3.05
Dec. 26		5.03	4.77	71.36	25.34	3.30	3.40
Dec. 26		4.97	4.64	66.82	29.28	3.90	3.10
Mean	4.74	4.83	4.55	70.12	26.46	3.41	3.18
Greatest difference		.53	.54	5.36	4.51	.85	.35
Dec. 27		5.76	5.37	75.77	22.57	1.66	4.07
Dec. 27		5.89	5.59	78.33	20.45	1.22	4.38
Dec. 27		6.31	5.89	73.11	26.40	.49	4.30
Mean	5.04	5.99	5.62	75.74	23.14	1.12	4.25
Greatest difference		.55	.52	5.22	5.95	1.17	.31

TABLE showing per cent. of fat in the milk, the per cent. of butter obtained, the composition of the butter, and the per cent. of fat extracted from the milk as butter. Milk set forty-eight hours: one set of samples churned sweet, the other set churned sour.

DATE.	Per cent. of fat in milk	CHURNED SWEET. Per cent. of butter obtained. Weighed moist	Weighed dry	Composition of butter. Per cent. of fat	Per cent. of water	Per cent. of curd	Per cent. of fat extracted as butter from the milk	CHURNED SOUR. Per cent. of butter obtained. Weighed moist	Weighed dry	Composition of butter. Per cent. of fat	Per cent. of water	Per cent. of curd	Per cent. of fat extracted as butter from the milk
December 29		4.01	3.51	74.56	23.94	1.50	2.62	3.12	2.76	80.69	15.83	3.48	2.23
December 29		4.23	3.78	72.39	25.26	2.35	2.43	3.09	2.90	72.95	25.98	1.07	2.11
December 29		4.19	3.70	73.53	24.46	2.01	2.72	3.00	2.61	79.05	19.08	1.87	2.06
Mean	3.51	4.14	3.66	73.49	24.55	1.95	2.59	3.07	2.76	77.23	20.30	2.14	2.13
Greatest difference		.22	.27	2.17	1.32	.85	.29	.12	.29	7.74	10.15	2.41	.17
December 31		5.16	4.71	78.64	19.88	1.48	3.70	5.81	5.48	83.11	15.03	1.86	4.55
December 31		4.92	4.55	76.79	20.98	2.23	3.49	6.02	5.64	81.21	17.04	1.75	4.58
December 31		5.04	4.66	80.28	17.84	1.88	3.74	....	....	....	....	....	....
Mean	5.06	5.04	4.64	78.57	19.57	1.86	3.64	5.92	5.56	82.16	16.04	1.81	4.56
Greatest difference		.24	.16	3.49	3.14	.75	.25	.21	.16	1.90	2.01	.11	.03
January 2		5.18	4.81	77.34	20.05	2.61	3.72	6.65	6.21	76.50	20.92	2.58	4.75
January 2		5.51	5.06	76.90	21.18	1.92	3.89	7.29	6.82	70.19	26.83	2.98	4.79
January 2		4.69	4.32	79.57	18.02	2.41	3.44	7.60	7.05	67.54	29.36	3.10	4.76
Mean	5.29	5.13	4.73	77.94	19.75	2.31	3.68	7.18	6.69	71.41	25.70	2.89	4.77
Greatest difference		.51	.74	2.67	3.16	.69	.45	.95	.84	8.96	8.44	.52	.04

An examination of the tables will show that the yield of butter varied with circumstances with the greatest irregularity. Even with duplicates that are treated exactly alike, the difference is sometimes about twenty per cent. of the least quantity. On December 25, the least is .78 of one per cent. less than the greatest. On January 2, the difference is .74 per cent.; the difference on the last date in the case of the sour milk is .84 per cent. These figures are based on the weight of the milk. When calculated on the butter itself, they become respectively 20.5 per cent., 17.1 per cent. and 13.5 per cent.

If the milk be not treated alike, then the yield seems to vary still more. Thus, on December 29, the mean of one set, the sweet milk, was 3.66; of the sour milk, 2.76; a difference of .9 of one per cent, of the milk. Calculated on the least of the above means, it is practically one-third. On December 31, the means are 4.64 and 5.56; difference .92 — equal to one-fifth of the less. On January 2, the mean of the yields of sweet milk is 4.73; of the sour, 6.69 — a difference of 1.96 per cent. This is 41.4 of the smaller quantity. These from comparing means. If we look for the greatest differences from the same milk regardless of treatment, we get for December 29, 1.17 per cent. in favor of sweet milk; on December 31. 1.09 per cent. in favor of sour milk; on January 2, 2.73 per cent. in favor of the sour milk. In the last case, the difference between the least butter obtained and the most is 63.2 per cent. of the least. When these differences are compared with the per cents. themselves, it is seen that they are very great. There are certainly grave sources of error in the use of the churn for testing milk. Unless very great care be taken to have all conditions alike, the method would seem to be untrustworthy. In these trials there were a sufficient number of duplicates to make nothing further in this line desired. But had more than six different kinds of milk been used, it would have added to the value of the test. But where the results show a great variation with a small number, it is probable that the variations would have been increased by a greater number. One would reject a method on fewer unsatisfactory trials than would induce him to accept it if the results are satisfactory.

When the percentage of fat in the milk is compared with the "dry" butter, that is, drained butter, obtained by the churn, it is seen that only a very general agreement in quantity exists. Sometimes analysis gives the greater per cent. and sometimes the churn does. The milk of December 27th, with 5.04 per cent. of fat, churned sweet, gave 5.62 per cent. of butter; but the milk of the 31st, with 5.06 of fat, churned sweet, gave only 4.64 of butter; and of January 2, with 5.29 per cent., gave 4.73 of butter. In these cases, although there was more fat, there was less butter. We might be inclined to see in this the proof of certain views as to the relation of composition to churnability of milk. But if we look further, we will see that December 31 and January 2, churned sour, gave butter in excess of the fat, being respectively 5.56 and 6.69. It will be seen that the quantity of butter obtained is less or greater than the fat in the milk according to the conditions of churning. Even the fat extracted in the butter varies similarly.

If we inquire why the amount of butter should so vary, the answer in general terms will be, that not all the fat is ever extracted from milk by the churn; that what we get and weigh as butter is made up of true butter fat, curd and water. These are in not at all constant proportions. This fact is brought out well in the part of the table showing the composition of the butter.

If we look at the composition of the butter, we see some reasons for these variations in the amount of butter obtained. With the same amount of real butter, it is evident that the greater the proportion of water and curd the greater will be the apparent yield of butter. By referring to the portion of the above table which gives the fat extracted as butter from the milk, it will be seen that, although these figures come within narrower limits, they are far from concordant. When the treatment has been the same, the results are close, but between the sour and the sweet there are marked differences. Thus, between the 4.58 per cent, and the 3.49 per cent., of December 31, there is a difference of nearly one-third of the latter. The difference between the 4.70 and the 3.44, of January 2, is two-fifths of the latter. These results, all taken together, prove, so far as proof can be drawn from the number of trials, that it is exceedingly difficult to get the same yield of butter from duplicates. Except as stated, the conditions attending these trials were more nearly alike than will usually be the case in dairy trials; indeed, it was the aim to treat the duplicates alike, and in no respect is it possible to specify wherein this was not true; but the results differ, and there must have been some unexplained cause for it. It is possible that the yield of butter may be made to serve as a test of the quality of milk, but it is evident that the treatment given both milk and butter is by no means an indifferent matter. It was not, however, the purpose of these trials to work up the conditions by which accuracy can be secured with the churn, but incidentally these results have been obtained, and these conclusions drawn.

REPORT OF THE DEPARTMENT OF HORTICULTURE AND ENTOMOLOGY.

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In the following pages are given the results of experiments in spraying the apple orchard to prevent the ravages of the larva of the codlin moth; of observations on life-history and habits of certain injurious insects, with the means of their suppression; and of garden trials of vegetables, inducting potatoes, peas and tomatoes.

EXPERIMENTS WITH SPRAYING APPLE TREES TO PROTECT THE FRUIT FROM THE APPLE WORM.

The codlin moth is beyond question the most formidable insect foe in Kansas orchards; not more insidious or more difficult of control than others, perhaps, but more widespread and more numerous than any other one insect, and more immediately active in the diminution of product. For this reason, and because it seemed to us that more extended definite trial is needed to settle the value of popular modes of warfare against the insect, it was decided to place under experiment one of the apple orchards upon the College grounds, an orchard numbering two hundred and sixty-eight trees, including forty-seven different varieties; the chief points which it was desired to include in the observation being — (1) the comparative value of certain different compounds of arsenic as preventive of the ravages of the larva of the codlin moth; (2) the result of a repetition of application in comparison with a single application of the same mixture; (3) the relative injury to the foliage of the apple under the different treatments; and (4) the utility of banding the trees for the capture of the full-grown larvae.

The orchard under experiment was originally planted as a commercial orchard by a private individual, and then included but a few standard varieties, each occupying one or more rows, the trees standing twenty feet apart in squares. Several years ago needed room was given by the removal of alternate trees in each row, those remaining now standing opposite the intervals in the adjoining rows, the original numbering still subsisting. To replace missing trees, some small trees were lately set; and to increase the number of sorts, top grafting was done, so that the former regularity of the rows, in age and variety of tree, was much impaired. It was thought, however, that the representation and distribution of the original varieties was still sufficient to render possible the comparison of treatments.

In order to test as many different treatments as consistent with the desire to secure for each treatment results from as great a number of individual cases as possible, the entire orchard was divided into transverse blocks, each including parts of each original row, excepting row XI, and so including trees of each original sort. For the sake of comparison, row XI, containing thirteen Winesap trees, extending through all the blocks, and flanked on either side by other rows of the same variety, was left unsprayed. This exception should be remembered in the following discussion. To all the trees in each block, the treatment was the same as regards the quality of the mixture used and the manner of application. In four of the blocks, half the trees received a second application.

The following explanation will show the treatment given to each tree:

Block "A," trees (original numbers) 1, 2, 3 and 4 in each row. Sprayed with London purple in water, in the proportion of one (1) ounce of the powder to eight (8) gallons of water. The application was made to all the trees in this block upon the same date, May 12th.

Block "B," trees (original numbers) 5, 6, 7 and 8 in each row. Sprayed with London purple in water, in the proportion of one (1) ounce of the powder to four (4) gallons of water. The application was made upon trees 5 and 6, May 10th; upon trees 7 and 8, May 12th, a heavy rain intervening. For convenience, trees 5 and 6 may be called "B1," trees 7 and 8 "B2."

Block "C," trees (original numbers) 9, 10, 11 and 12 in each row. Sprayed with Paris green in water, in the proportion of one (1) ounce of the powder to twenty (20) gallons of water. The application was made to all the trees in this block upon May 10th. Trees 9 and 10, indicated below as "C1," received but the single application, while trees 11 and 12, indicated below as "C2," were sprayed a second time with the same mixture, upon May 19th.

Block "D," trees (original numbers) 13, 14, 15 and 16 in each row. Sprayed with Paris green and water, in the proportion of one (1) ounce of the powder to ten (10) gallons of water; all the trees sprayed alike, upon May 10th. Trees 15 and 16 ("D2") were sprayed again with the same mixture, May 19th, trees 14 and 15 ("D1") having received but the single application of May 10th.

Block "E," trees (original numbers) 17, 18, 19 and 20 in each row. Sprayed with the "Climax Insect Poison," sold in packages, by the Nixon Manufacturing Company, in the proportion recommended by them of one package (1½ lbs.) to fifty (50) gallons of water. All the trees in this block were sprayed alike on May 9th, this being the only application for trees 17 and 18 ("E1"), while trees 19 and 20 ("E2") received a second application of the same upon May 19th.

Block "F," trees (original numbers) 21, 22, 23 and 24 in each row. Sprayed with Paris green and water, in the proportion of one (1) ounce of the powder to five (5) gallons of water. All the trees were sprayed alike upon May 9th, this being the only application for trees 21 and 22 ("F1"), while trees 23 and 24 ("F2") received a second application of the same, upon May 19th.

Block *"G,"* trees (original numbers) 25 and 26 in each row. Sprayed, May 9th, with Paris green in water, in the proportion of one (1) ounce of the powder to three and one-third (3 1/3) gallons of water.*

Upon the evening of May 10th a heavy rain fell, and a shower followed upon the 11th. To all appearances the powder was largely washed off the trees by these rains.

The work of spraying was done with a Nixon Barrel Machine, using the "Climax" nozzle No. 3. This combination distributed the mixture satisfactorily, though its work was slow, and the labor of operating the pump unnecessarily heavy.

THE SCALDING OF THE FOLIAGE BY APPLICATIONS OF ARSENIC.

The first result noted for the spraying was the scalding of the foliage of the trees sprayed. With some varieties, the amount of foliage destroyed in this way was considerable, while other varieties suffered little or not at all. The amount of scalded foliage was found to vary also under different treatments, and in a few cases, for which no explanation was found, an important variation under apparently similar conditions was noted.

In taking account of the injury from scalding, the amount of foliage destroyed was carefully estimated for each tree, the estimate being made throughout the orchard by the same observer and at the same time; consequently the comparative error should be slight.

The following table shows the average amount of scalding suffered by trees of the varieties most numerously represented. Owing to the irregular distribution of the varieties through the blocks, the figures are to be taken rather as showing the relative susceptibility of the foliage of the different sorts, than as indicating perfectly the comparative danger in the use of the several preparations.

*As employed by Prof. S. A. Forbes, (Transactions Illinois State Horticultural Society, 1886, p. 110) A convenient approximation to "one pound to fifty gallons," as used by W. B. Alwood, (Report U. S. Department Agriculture, 1887, p. 109)

TABLE showing, for the varieties named, the average per cent. of foliage injured by the spraying.

VARIETIES.	"A."		"B."				"C."				"D."				"E."				"F."				"G."	
			"B_1."		"B_2."		"C_1."		"C_2."		"D_1."		"D_2."		"E_1."		"E_2."		"F_1."		"F_2."			
	No. trees....	Average per cent. injury...	No. trees....	Average per cent. injury...	No. trees....	Av. per ct. injury...	No. trees....	Av. per ct. injury..	No. trees....	Av. per ct. injury...	No. trees....	Average per cent. injury...	No. trees..	Average per cent. injury...	No. trees....	Average per cent. injury...	No. trees....	Average per cent. injury...	No. trees....	Average per cent. injury...	No. trees....	Average per cent. injury...	No. trees....	Average per cent. injury...
Winesap	5	10.0	2	37.5	1	45	1	5	2	10	2	27.5	2	22.5	2	22.50	2	45.0	2	25	2	47.5	1	35.0
Genet	1	1.0	5	12.8	2	10	1	2	....	....	4	2.0	3	3.7	6	11.66	4	15.0	2	10	4	12.5	10	6.5
Wagener	3	1.3	1	5.0	1	10	1	1	....	....	....	......	1	5.0	2	5.00	2	20.0	....	......	2	12.5	1	20.0
Huntsman	5	2.4	....	......	1	10	1	20	....	....	2	4.0	4	2.5	....	....	1	20.0	1	20	1	10.0	2	3.5
Gilpin	3	5.0	2	22.5	1	25	....	....	....	....	1	5.0	....	......	2	17.50	1	50.0	....	......	2	25.0	2	25.0
Jonathan	1	2.0	2	22.5	2	20	1	2	....	....	1	5.0	....	......	1	20.00	....	......	....	......	....	......	....	......
Yellow Bellflower	....	......	....	......	1	20	....	....	1	2	2	3.0	....	......	3	20.70	....	......	....	......	1	10.0	....	......
Talman	....	......	1	10.0	1	15	....	....	....	....	....	......	....	......	....	....	3	23 3	1	15	2	12.5	....	......
Perry Russet	....	......	1	18.0	1	20	....	....	....	....	....	......	....	......	1	20.00	....	......	....	......	....	......	....	......
Ben Davis	....	......	....	......	....	....	....	....	....	....	....	......	....	......	....	....	1	30.0	1	50	....	......	....	......
Rambo	....	......	2	20.0	....	....	....	....	....	....	....	......	....	......	1	20.00	....	......	....	......	....	......	....	......
Tetofsky	....	......	....	......	....	....	1	10	....	....	1	10.0	....	......	....	....	....	......	....	......	....	......	....	......
Bailey Sweet	....	......	....	......	....	....	....	....	....	....	....	......	....	......	....	....	1	20 0	1	10	....	......	....	......
Willow Twig	1	10.0	...	......	....	....	....	....	....	....	....	......	....	......	1	20.00	....	......	....	......	....	......	....	......

EFFECT OF SPRAYING UPON THE QUALITY OF THE FRUIT.

To learn the effect of treatment upon the condition and quality of the fruit, a careful count was made of the fallen apples, the first record being made as soon as the young apples began to fall, others following throughout the season, at intervals of two to five days, the last observation being made upon the fruit gathered from the tree for market or storage. Where the picked product of a single tree much exceeded a bushel, the separate examination of each apple being impracticable, a method of approximation was employed to find the proportion of sound to wormy fruit. In this method, the product of the tree was carefully measured and poured into a single conical heap, the apples from different parts of the tree being thus thoroughly mingled. A sample bushel was then taken from the middle of the heap, the apples counted and examined, and the result taken as the average for each bushel in the heap. The total for the entire heap was thus approximated. The trustworthiness of these approximations was tested in several cases by comparing the results found by sample bushels with those of an actual count and examination of the product of the same tree. For the complete record of the orchard, the reader is referred to the tables at the end of this article.

As going to show the effect of treatment, as well as the relative value of the different applications, considered solely from the standpoint of the amount of imperfect fruit found, the following summaries of the records of the Winesap trees in rows X, XII and XIII, sprayed, and row XI, unsprayed, will have importance. In the unsprayed row, XI, are thirteen trees, extending through blocks A—F, inclusive, and evenly distributed. The total product of these trees was 88,727 fruits, of which 45.7 per cent. were infested. In the sprayed rows, X, XII and XIII, the totals give averages as follows:

Block A, 6 trees	gave	*47	per cent.	infested	of the	total product.
Block A, 5 "	"	†40	"	"	"	"
Block B, 4 "	"	24.7	"	"	"	"

* Including the extraordinary record of tree A, XIII, 1.
† Excluding tree A, XIII, 1.

Block C, 5 trees gave 29.7 per cent. infested of the total product.
Block D, 4 " " 33.8 " " " "
Block E, 4 " " 32.6 " " " "
Block F, 4 " " 24.7 " " " "

As the trees of the Winesap were throughout loaded with fruit, the above averages may be taken as fairly conclusive under the conditions of the present trial.

It will be seen by an examination of the full tables at the end of this article, that the distribution through the blocks of varieties other than the Winesap is too irregular to admit of conclusions for these sorts upon the relative value of the mixtures equally fair with those just given. For the present, it is not thought necessary to give further analysis of the tables in this direction, as the indications noted will be made the starting points for special investigation during the coming season.

As to the effect of a repetition of treatment upon the proportion of sound fruit, a fair conclusion seems possible from the following data. The figures, as will be seen, are, for the most part, from more than a single tree, and prominently represent popular varieties, under four distinct treatments. An average of the percentages shows a gain of 3.2 per cent, under a repetition of the treatment, even after the interval, perhaps too great under the circumstances, of nine or ten days.

TABLE SHOWING THE EFFECT OF A REPETITION OF TREATMENT.

VARIETIES.	*Total number of apples.*	*No. of trees.*	*Treatment.*	*Per cent. infested under a single application.*	*Per cent. infested under a double application.*
enet........	18,512	3	C_1	25.1	....
"	23,825	4	C_2	....	23.3
"	15,029	6	D_1	28.1	....
"	22,133	5	D_2	....	26.6
"	4,198	5	E_1	33.8	....
"	2,400	4	E_2	....	35.5
"	10,868	4	F_1	27.2	....
"	3,743	4	F_2	....	32.9

TABLE SHOWING THE EFFECT OF A REPETITION OF TREATMENT — CONCLUDED.

VARIETIES.	*Total number of apples.*	*No. of trees.*	*Treatment.*	*Per cent. infested under a single application.*	*Per cent. infested under a double application.*
Winesap	20,240	2	C_1	34.9	
"	20,767	3	C_2		24.7
"	8,947	2	D_1	38.8	
"	12,080	2	D_2		30.1
"	8,056	2	E_1	38.3	
"	8,997	2	E_2		27.6
"	11,888	2	F_1	34.1	
"	12,272	2	F_2		15.8
Wagener	6,844	2	C_1	43.0	
"	1,724	1	C_2		43.5
"	4.565	3	D_1	35.9	
"	3,845	2	D_2		38.1
"	1,003	2	E_1	43.1	
"	2,023	2	E_2		49.9
"	1,326	1	F_1	33.5	
"	1,380	2	F_2		38.4
Gilpin	7,916	2	C_1	41.9	
"	16,256	2	C_2		38.4
"	2,293	1	D_1	43.8	
"	7,245	1	D_2		34.4
"	2,360	1	E_1	49.1	
"	3,326	1	E_2		53.6
Huntsman	1,951	3	C_1	63.7	
"	500	1	C_2		63.2
"	1,161	2	D_1	52.8	
"	2,563	4	D_2		58.9
"	697	2	F_1	66.7	
"	215	1	F_2		57.6
Jonathan	7,457	2	C_1	44.8	
"	4,368	2	C_2		40.7
Yellow Bellflower	1,754	1	C_1	58.7	
"	3,562	2	C_2		41.6
Averages				41.9	38.7

A comparison of early gathered fruit, of some fall and winter sorts, with the regular picking at maturity of the remaining fruit upon the same tree, makes an interesting showing. In several cases it became necessary to gather a part of the fruit upon certain trees some time before the date when the fruit of that sort was in general ready for market or storage. In these few cases, it appears that the percentage of infested fruit is very much smaller up to the middle of August, while, for the same tree, the percentage is later materially increased. This is shown for five trees as follows:

	EARLY PICKING.			LATE PICKING.		
	Sound	Infested	Per cent. infested	Sound	Infested	Per cent. infested
Genet, II, 6, B	*764	112	13	‡10,850	2,206	17
Jonathan, V, 5, B	*777	87	10	‖590	320	35
Yellow Bellflower, VI, 18, E	*174	72	29	‖52	63	54
Yellow Bellflower, VIII, 11, C_2	*328	49	13	‖236	268	53
Wagener, IX, 3, A	†304	63	17	‖397	359	47

*Picked August 8 and 9. †Picked July 28. ‡Picked October 13. ‖Picked September 15.

That this difference in favor of the early picked fruit is not entirely due to the fact, as some claim, that the apples attacked by the first brood of larvae mostly fall from the tree, while those later attacked largely hang until gathered, is shown by the percentages of infested fruit in the sum of the fallen and gathered fruit, in each case, up to the earlier date given. Thus, while for the Genet tree cited this per cent. is 17, the same as for the fruit gathered upon October 13th, for the Jonathan it is 15 per cent., for the Yellow Bellflower (row VI) it is 27 per cent., for the Yellow Bellflower (row VIII) it is 17 per cent., and for the Wagener it is 19 per cent., in each case still much below the final per cent., and in one case actually less than for the fruit gathered on the earlier date.

Of similar import are the records of the Early Harvest (A, I, 4), Red Astrachan (C2, I, 11), Tetofsky (D, I, 13 and 14), and Chenango Strawberry (B2, I, 8).

The above showing makes prominent one weak point in this practice of spraying. While it is a most important and valuable method in the protection of early maturing fruit, its value for late fruit is lessened by the appearance of a second brood of the larvae, which have now, the freedom of the orchard; and it is after all to these that we are indebted for the greater part of the damage to our winter fruit. The argument follows, that even with the most careful and thorough work with the spraying engine, the long recommended practices of daily gathering and destroying the fallen fruit, and of trapping and destroying the larvae and moths by all possible means, must still be made use of; and these not only by the interested orchardist himself, but also by his neighbors, else is his own work but partly repaid.

It is a question of importance why some varieties of apples regularly show in our tables so much greater percentage of infested fruit than do others under the same treatment and surroundings. It may be suggested that application of the poison to all at the same absolute time, instead of at the same relative time, or age of the fruit, will largely account for this. Again, the character, conformation and surface of the apple itself may be in close relation to this difference; but upon this point further observation will be made before conclusions are offered. As it is quite possible that the date of blooming may be made an index of the proper time of spraying, the following imperfect calendar, the record of the year 1888, so far as could be made under the pressure of more important work, is here given as the first of a series of observations bearing upon this point.

TABLE showing the day of the month (April) on which bloom was noted, as given, for different varieties of apple trees.

VARIETIES.	*First bloom.*	*Full bloom.*	*Last bloom.*
American Golden Russet	....	20	23
American Summer Pearmain	21	....	....
Austin Sweet	20	....	23
Bailey's Sweet	20	....	23
Baldwin	21	....	23
Bellflower Pippin	23	....	....
Benoni	....	21	23
Bentley's Sweet	....	23	....
Ben Davis	22	23	....
Black Twig	23	....	....
Black Warrior	20	....	....
Blinkbonny	20	....	....
Broad River	20	....	....
Carolina Red June	....	20	....
Cheese	....	23	....
Chenango Strawberry	20	....	23
Cherry Crab	....	20	....
Cole's Quince	21	....	....
Cooper's Early White	23	....	....
Danver's Winter Sweet	21	....	....
De Wolf	20	....	....
Disharoon	20	....	....
Domine	18	....	....
Duchess of Oldenburg	....	21	....
Early Harvest	....	20	23
Early Ripe	....	20	....
Early Sweet	20	....	....
English Sweet	21	....	....
Fall Pippin	21	....	....

TABLE SHOWING DATE OF BLOOMING—CONTINUED.

VARIETIES.	*First bloom.*	*Full bloom.*	*Last bloom.*
Fall Spitzenburg	23	....	....
Fall Stripe	23	....	....
Fameuse	....	21	....
Fay's Russet	....	21	....
Franklin's Golden Pippin	21	....	23
Fulton	21	....	....
Garden Beauty	20	....	....
Garretson's Early	....	20	....
Gilpin	21	....	....
Golden Sweet	....	21	....
Gramar's Pearmain	21	23	....
Grimes' Golden	....	23	....
Hawthornden	23	....	....
Hopkins	21	....	....
Homestead	21	....	....
Huntsman's Favorite	....	23	....
Jonathan	20	....	....
Jefferis	21	23	....
Kansas Bellflower	20	....	....
Keswick Codlin	....	21	....
Kirkbridge White	21	....	....
Lady Crab	21	....	....
Lady's Sweet	21	....	....
Lawver	23	....	....
Large Bough	21	....	....
Ledge Sweet	21	....	....
Lowell	....	23	....
Mackintosh Red	....	20	....
Maiden's Blush	....	21	....

TABLE SHOWING DATE OF BLOOMING - CONTINUED

VARIETIES.	*First bloom.*	*Full bloom.*	*Last bloom.*
Maiden's Blush Crab	....	21	....
Malus Maxima Crab	21	....	....
Mangum	....	21	....
Master	....	21	....
Minkler	21	....	....
McAfee's Nonsuch	23	....	....
McLellan	21	....	....
Muscat Livlandisher	21	....	....
Missouri Pippin	20	....	....
Nelson Rock	....	21	....
Nickajack	....	21	....
Oblong Crab	21	....	....
Ortley	21	....	....
Pawpaw	21	....	....
Pennock	21	....	....
Rawle's Genet	26	....	....
Rambo	....	23	....
Red Astrachan	21	....	....
Red Cedar	21	....	....
Red Crab	....	20	....
Roman Stem	21	21	....
Russet Pearmain	....	21	....
Scallop Gilliflower	21	....	....
Seeknofurther	21	....	....
Showy Crab	....	21	....
Sops of Wine	21	....	....
Sweet June	....	21	....
Tetofsky	21	....	23
Titovka	21	....	....

TABLE SHOWING DATE OF BLOOMING—CONCLUDED.

VARIETIES.	*First bloom.*	*Full bloom.*	*Last bloom.*
Victuals and Drink	21	....	....
Wagener	21	....	....
Warfield	21	....	....
White Pippin	....	21	....
White Winter Pearmain	21	....	....
Whitney's No. 20	....	21	....
Wine	....	21	....
Winesap	21	....	....
Yellow Bellflower	21	....	....
Yellow Newton Pippin	21	....	....
Yellow Siberian Crab	....	....	21
Yopp's Favorite	21	....	....

THE UTILITIES OF BANDS IN THE CAPTURE OF THE APPLE WORM.

Following the spraying, the trees were banded for the purpose of trapping the larvae after they had left the apple. The bands, of the ordinary felt paper sold for carpet lining, were cut about ten inches wide, and long enough to go around the trunk of the tree below the branches, overlapping a few inches. Divided trunks received bands about each division, the united records of the several bands being counted as one. The bands, being held in place by a round-headed carpet tack, pushed by the thumb through the overlapping ends, were easily removed for examination, and quickly replaced. Beginning upon June 25, the bands were examined at intervals of six to ten days throughout the season, and a record was kept for each tree, of the number of insects captured, whether larvae or pupae, the last examination being made after the fruit was gathered.

The degree of value of this feature of the warfare against the codlin moth will be shown, so far as the present record goes, by the comparison of the total number of insects captured under the bands with the number of infested apples. As our records show, there were gathered, by a very close approximation, over 238,000 infested apples, from the total of over 642,000. From under the bands there were taken during the season, by actual count, 17,245 larvae and 3,153 pupae of the codlin moth, or a total of 20,398 insects. Making no account of cases where the same larva had injured two apples, or where one apple had contained two larvae, it may be stated that the captures represented about 8.5 per cent. of the insects that had done the injury. Viewing in its full bearing the fact of the destruction of this number of insects that had escaped the poison, and the slight expense of this part of the work, the question of the profit of banding the trees seems to be satisfactorily answered in the affirmative.

FULL RECORD.

Block "A."—Sprayed May 12th. Mixture: London purple, 1 ounce; water, 8 gallons.

Row.	Tree.	Varieties.	Record of fallen apples.		Date of gathering.	Picked apples.		Per cent. infested.	Total product.		Insects taken under bands.	Per cent. of injury to foliage.
			Sound.	Infested.		Sound.	Infested.		Sound.	Infested.		
I	1	Genet	108	456	Oct. 13	2,031	1,462	41.9	2,139	1,918	182	......
I	2	Gramar's Pearmain	703	752	Sept. 4	132	22	14.3	835	774	30	......
I	4	Early Harvest	191	86	July 9	351	6	1.7	542	92	10	......
II	2	Genet	468	548	Oct. 13	7,457	1,958	20.8	7,925	2,506	112	......
II	4	Genet	482	523	Oct. 13	7,667	2,152	21.9	8,149	2,675	110	......
III	1	Genet	250	601	Oct. 13	2,761	957	25.7	3,011	1,558	209	......
III	3	Genet	657	682	Oct. 13	10,528	1,645	13.5	11,185	2,327	157	......
IV	1	Jonathan	1,132	1,903	Sept. 15	1,180	770	39.5	2,312	2,673	209	......
IV	2	Jonathan	477	1,389	Sept. 15	1,105	772	41.1	1,582	2,161	149	......
IV	4	Jonathan	966	1,631	Sept. 15	1,658	702	29.7	2,624	2,333	183	......
V	1	Jonathan	729	1,686	Sept. 15	2,112	944	30.9	2,841	2,630	166	2
V	3	Jonathan	1,167	1,921	Sept. 15	2,510	1,370	35.3	3,677	3,291	156	......
VI	1	Rome Beauty	326	634	Sept. 29	208	152	42.2	534	786	92	......
VI	2	Genet	42	60	Oct. 13	357	343	49.0	399	403	14	......
VI	4	Genet	98	98	Oct. 13	508	217	29.9	606	315	77	......

BLOCK "A" — CONTINUED.

Row.	Tree.	VARIETY.	Record of fallen apples. Sound.	Record of fallen apples. Infested.	Date of gathering.	Picked apples. Sound.	Picked apples. Infested.	Picked apples. Per ct. infest'd	Total product. Sound.	Total product. Infested.	Insects taken under bands.	Per cent. of injury to foliage.
VII ...	1	Yellow Bellflower	822	1,437	Sept. 15	688	846	55.1	1,510	2,283	102	......
VII ...	3	Yellow Bellflower	261	1,699	Sept. 15	1,170	1,086	48.1	1,431	2,785	139	......
VIII...	1	Wagener	11	11	....	....	....	....	11	11	15	......
VIII...	2	Wagener	143	234	Sept. 15	28	34	54.8	171	268	9	1
VIII...	4	Wagener	15	28	....	....	....	....	15	28	10	......
IX	1	Wagener	60	80	....	....	....	....	60	80	30	2
IX	3	Wagener	884	726	....	397	359	47.5	1,281	1,085	75	1
X	2	Huntsman	117	367	Sept. 29	98	183	65.1	215	550	74	5
X	4	Winesap	548	1,136	Oct. 11	2,830	1,190	29.6	3,378	2,326	91	5
XII ...	2	Winesap	625	1,611	Oct. 11	2,052	756	26.9	2,677	2,367	344	10
XII ...	4	Winesap	511	1,451	Oct. 11	1,856	781	29.6	2,367	2,232	152	10
XIII ..	1	Winesap	393	1,751	Oct. 11	792	452	36.3	1,185	2,203	241	10
XIII ..	3	Winesap	580	1,102	Oct. 11	1,656	900	35.2	2,236	2,002	80	15
XIII ..	4	Winesap	462	1,455	Oct. 11	2,544	584	18.4	3,006	2,039	130	......
XIV...	1	Gilpin	169	490	Oct. 19	226	160	41.5	395	650	88	5
XIV...	2	Huntsman	2	5	....	....	....	....	2	5	20	2

BLOCK "A"—CONCLUDED.

Row.	Tree.	VARIETY.	RECORD OF FALLEN APPLES.		Date of gathering.	PICKED APPLES.			TOTAL PRODUCT.		Insects taken under bands.	Per cent. of injury to foliage.
			Sound.	Infested.		Sound.	Infested.	Per ct. infest'd	Sound.	Infested.		
XV	1	Gilpin	73	137	Oct. 19	31	32	50.8	104	169	24	5
XV	2	Huntsman	58	199	Sept. 29	32	30	48.4	90	229	62	1
XV	3	Gilpin	121	244	Oct. 19	35	51	59.3	156	295	64	5
XVI	1	Huntsman	29	138	Sept. 29	12	17	58.6	41	155	37	......
XVI	2	Huntsman	55	162	Sept. 29	60	69	53.5	115	231	80	3
XVI	3	Huntsman	40	230	Sept. 29	37	59	61.5	77	289	41	......
XVI	4	Genet	53	104	Oct. 19	101	67	39.9	154	171	24	......
XVII	1	Talman Sweet	9	25	....	....	....	....	9	25	12	......
XVII	2	Willow Twig	11	15	....	....	....	....	11	15	8	10
XVII	3	Yellow Transparent	487	479	Aug. 23	686	84	10.9	1,173	563	62	5
XVIII	2	Huntsman	91	116	Sept. 29	30	42	58.3	121	158	63	1
XVIII	3	Genet	5	2	Oct. 19	3	4	57.1	8	6	1	......
XVIII	4	Genet	18	47	Sept. 15	45	75	62.5	63	122	32	1

Block "B_1."—Sprayed May 10th. Mixture: London purple, 1 ounce; water, 4 gallons.

Row	Tree	Variety	Record of fallen apples: Sound	Record of fallen apples: Infested	Date of gathering	Picked apples: Sound	Picked apples: Infested	Picked apples: Per cent. infested	Total product: Sound	Total product: Infested	Insects taken under bands	Per cent. injury to foliage
I	5	Genet*	234	484	Oct. 13	2,368	660	21.8	2,602	1,144	100	4
I	6	Franklin's Golden Pippin	665	380	......	......	......	......	665	380	42	......
II	6	Genet	502	425	Oct. 13	11,614	2,318	16.6	12,116	2,743	89	5
III	5	Genet	424	366	Oct. 13	6,568	1,290	16.4	6,992	1,656	79	20
IV	6	Jonathan	1,024	1,488	Sept. 15	1,450	574	28.4	2,474	2,062	177	20
V	5	Jonathan	835	489	Sept. 15	1,367	407	22.8	2,202	896	34	25
VI	6	Genet†	127	186	Oct. 13	621	176	22.1	748	352	65	20
VII	5	Genet	146	214	Oct. 13	446	229	33.9	592	443	35	......
VIII	6	Genet	96	172	Sept. 15	580	225	28.0	676	397	84	15
IX	5	Wagener	82	76	......	......	......	......	82	76	0	5
X	6	Winesap	555	947	Oct. 11	4,974	804	13.9	5,529	1,751	79	45
XII	6	Winesap	1,055	757	Oct. 11	4,165	755	15.3	5,220	1,512	73	30
XIV	6	Perry Russet	201	714	Sept. 15	159	420	72.5	360	1,134	108	18
XVI	5	Gilpin	177	445	Oct. 19	741	273	26.9	918	718	84	25
XVI	6	Gilpin	218	446	Oct. 19	361	240	39.9	579	686	122	20
XVII	5	Talman Sweet	191	306	Sept. 18	96	148	60.7	287	454	41	10
XVIII	5	Rambo	33	30	Sept. 15	32	19	37.3	65	49	12	20
XVIII	6	Rambo	179	401	Sept. 15	384	202	34.5	563	603	44	20

* With bearing grafts of Grimes' Golden. † Grafted in top with another variety.

BLOCK "B_2."—Sprayed May 12th. Mixture: London purple, 1 ounce; water, 4 gallons.

Row.	Tree.	VARIETY.	RECORD OF FALLEN APPLES.		Date of gathering.	PICKED APPLES.			TOTAL PRODUCT.		Insects taken under bands.	Per cent. of injury to foliage.
			Sound.	Infested.		Sound.	Infested.	Per ct. infest'd	Sound.	Infested.		
I	7	Northern Spy	....	....	....	....	....	....	....	....	......	5
I	8	Chenango	87	45	July 31	63	8	11.3	150	53	9	......
II	8	Genet	17	149	Oct. 13	1,175	420	26.3	1,292	569	53	5
III	7	Genet	296	369	Oct. 13	5,453	1,140	17.3	5,749	1,509	163	15
IV	8	Jonathan	147	79	Aug. 7	2,652	218	7.6	2,799	297	11	20
V	7	Jonathan	1,047	907	Sept. 15	2,496	762	23.4	3,543	1,669	54	20
VI	8	Yellow Bellflower	358	645	Sept. 15	322	414	56.3	680	1,059	63	20
VII	8	Huntsman*	129	203	Sept. 29	112	188	62.7	241	391	53	......
IX	7	Wagener	15	16	....	....	....	....	15	16	0	10
X	8	Winesap	462	790	Oct. 11	4,427	701	13.7	4,889	1,491	148	45
XII	7	Winesap	689	938	Oct. 11	2,726	560	17.0	3,415	1,498	87	†
XII	8	Rambour Gruener	....	....	....	....	....	....	....	....	......	40
XIV	8	Perry Russet	482	1,367	Sept. 15	411	337	45.0	893	1,704	126	20
XV	7	Gilpin	314	731	Oct. 19	952	301	24.0	1,266	1,032	157	25
XVI	8	Huntsman	59	165	Sept. 29	134	178	57.1	193	343	71	10
XVII	7	Talman Sweet	140	185	Sept. 18	32	111	77.6	172	296	37	15

*With top grafts of other varieties. †Scalding not recorded.

BLOCK "C_1."—Sprayed May 10th. Mixture: Paris green, 1 ounce; water, 20 gallons.

Row.	Tree	Variety.	Record of fallen apples.		Date of gathering.	Picked apples.			Total product.		Insects taken under bands	Per cent. of injury to foliage
			Sound.	Infested.		Sound.	Infested.	Per ct. infest'd	Sound.	Infested.		
I	9	Tetofsky	12	8	......	......	......	......	12	8	1	10
I	10	Genet*	433	112	Oct. 13	69	69	50.0	502	181	13	......
III	9	Genet	852	899	Oct. 13	11,045	2,538	18.7	11,897	3,437	223	......
IV	10	Jonathan	721	1,019	Sept. 15	1,181	539	31.3	1,902	1,558	168	......
V	9	Jonathan	801	1,196	Sept. 15	1,408	592	29.6	2,209	1,788	168	2
VI	9	Genet	162	234	Oct. 13	1,048	352	25.1	1,210	586	57	2
VI	10	Yellow Bellflower	378	597	Sept. 15	345	434	55.7	723	1,031	28	2
VII	9	Huntsman	63	117	Sept. 29	26	50	65.8	89	167	15	20
VIII	9	Huntsman	152	194	Sept. 29	121	113	48.3	273	307	21	†
VIII	10	Dominie	989	1,232	Sept. 29	1,164	498	30.0	2,153	1,730	63	......
IX	9	Wagener	917	1,067	Sept. 15	709	561	44.2	1,626	1,628	90	1
IX	10	Wagener	883	711	Sept. 15	1,389	607	30.4	2,272	1,318	36	......
XII	10	Winesap	1,070	2,069	Oct. 11	6,399	1,381	17.8	7,469	3,450	231	5
XIII	9	Winesap	914	2,229	Oct. 11	4,791	1,387	22.5	5,705	3,616	217	......
XIV	10	Neumeister	......	......	......	......	......	......	......	......	......	2
XV	9	Gilpin	492	1,251	Oct. 19	2,990	662	18.1	3,482	1,913	249	......
XVI	9	Genet	135	317	Oct. 19	618	312	33.5	753	629	90	......
XVI	10	Gilpin	275	902	Oct. 19	840	504	37.5	1,115	1,406	127	......
XVII	10	Huntsman	153	371	Sept. 18	192	399	67.5	345	770	115	......

* Top grafted with Hawthornden. † No record of scalds.

BLOCK "C_2."—Sprayed May 10th, and again May 19th. Mixture: Paris green, 1 ounce; water, 20 gallons.

Row.	Tree.	Variety.	Record of fallen apples.		Date of gathering.	Picked apples.			Total product.		Insects taken under bands.	Per cent. of injury to foliage.
			Sound.	Infested.		Sound.	Infested.	Per cent. infested.	Sound.	Infested.		
I	11	Red Astrachan	28	25	July 16	174	8	4.4	302	33	10	......
I	12	Nickajack	400	399	Sept. 4	226	67	22.9	626	466	58	......
II	12	Genet	326	427	Oct. 13	6,540	2,540	28.0	6,866	2,967	88	......
III	11	Genet	302	431	Oct. 13	9,720	1,728	15.1	10,022	2,159	120	......
IV	12	Jonathan	484	650	Sept. 15	949	551	36.7	1,433	1,201	129	......
V	11	Jonathan	502	492	Sept. 15	651	89	12.0	1,153	581	46	......
VI	11	Genet*	135	150	Oct. 13	1,140	220	16.2	1,275	370	26	......
VI	12	Genet*	59	34	Oct. 13	52	21	28.8	111	55	7	......
VII	11	Yellow Bellflower	706	529	Sept. 15	276	235	46.0	982	764	30	......
VIII	11	Yellow Bellflower	532	408	Sept. 15	564	312	35.6	1,096	720	20	......
IX	11	Wagener	520	385	Sept. 15	454	365	44.6	974	750	28	......
IX	12	Ben Davis	725	304	Sept. 15	416	295	41.5	1,141	599	119	......
X	12	Winesap	865	1,178	Oct. 11	3,566	461	11.4	4,431	1,639	105	......
XII	12	Winesap	714	1,179	Oct. 11	4,446	715	13.9	5,160	1,894	147	10
XIII	11	Winesap	679	724	Oct. 11	5,358	882	14.1	6,037	1,606	74	10
XIV	12	Perry Russet	727	1,787	Sept. 15	530	803	60.2	1,257	2,590	144	......
XV	11	Gilpin	672	1,690	Oct. 19	4,960	1,600	24.4	5,632	3,290	298	......
XVI	12	Gilpin	533	1,621	Oct. 19	3,843	1,337	25.8	4,376	2,958	262	......
XVII	11	Talman Sweet	280	495	Sept. 18	298	552	64.9	578	1,047	30	......
XVIII	12	Rambo	352	908	Sept. 15	1,368	613	30.9	1,720	1,521	102	......

BLOCK "D_1."—Sprayed May 10th. Mixture: Paris green, 1 ounce; water, 10 gallons.

Row.	Tree	VARIETY.	RECORD OF FALLEN APPLES.		Date of gathering.	PICKED APPLES.			TOTAL PRODUCT.		Insects taken under bands.	Per cent. of injury to foliage.
			Sound.	Infested.		Sound.	Infested.	Per cent. infested.	Sound.	Infested.		
I	13	Tetofsky	25	3	July 13	76	2	2.6	101	5	2	......
I	14	Tetofsky	38	2	July 13	83	1	1.2	121	3	0	......
II	14	Genet	66	60	Oct. 13	75	25	25.0	141	85	58	2
III	13	Genet	375	464	Oct. 13	3,990	570	12.5	4,365	1,034	100	......
IV	14	Jonathan	387	600	Sept. 15	643	337	34.4	1,030	937	50	5
V	13	Genet	209	236	Oct. 13	2,124	276	11.5	2,333	512	34	2
VI	13	Genet	267	139	Oct. 13	927	200	17.7	1,194	339	29	1
VI	14	Genet	152	128	Oct. 13	1,056	198	15.8	1,208	326	62	3
VII	13	Yellow Bellflower	167	152	Sept. 15	156	193	55.3	323	345	9	3
VII	14	Huntsman	264	148	Sept. 20	195	305	61.0	459	453	54	3
VIII	13	Yellow Bellflower	269	254	Sept. 15	207	234	53.1	476	488	52	3
VIII	14	Huntsman	51	71	Sept. 20	37	90	70.9	88	161	14	5
IX	13	Wagener	1,126	657	Sept. 15	984	310	24.0	2,110	967	52	......
IX	14	Wagener	298	352	Sept. 15	420	250	37.3	718	602	58	......
X	14	Wagener	94	74	....	....	....	....	94	74	3	......
XII	14	Winesap	611	1,291	Oct. 11	2,719	777	22.2	3,330	2,068	100	30
XIII	13	Winesap	623	958	Oct. 11	2,520	448	15.1	3,143	1,406	78	25
XV	13	Gilpin	252	585	Oct. 19	1,036	420	28.8	1,288	1,005	138	5
XVII	13	Talman Sweet	356	527	Sept. 18	383	632	62.3	739	1,159	51	......
XVII	14	Bentley's Sweet	273	570	Oct. 19	618	418	40.3	891	988	73	......
XVIII	14	Genet	95	165	Oct. 19	1,455	1,777	55.0	1,550	1,942	27	......

BLOCK "D_2."—Sprayed May 10th, and again May 19th. Mixture: Paris green, 1 ounce; water, 10 gallons.

Row.	Tree.	Variety.	Record of fallen apples. Sound.	Record of fallen apples. Infested.	Date of gathering.	Picked apples. Sound.	Picked apples. Infested.	Picked apples. Per cent. infested.	Total product. Sound.	Total product. Infested.	Insects taken under bands.	Per cent. of injury to foliage.
I	15	Cotter's Red	2	....	....	....	....	....	2	....	....	4
I	16	Lowell	40	28	....	....	....	....	40	28	4	3
II	16	Genet	254	312	Oct. 13	2,669	850	24.1	2,923	1,162	95	1
III	15	Genet	759	473	Oct. 13	9,435	1,810	16.1	10,194	2,283	93	......
IV	16	Genet	515	482	Oct. 13	7,220	1,140	13.6	7,735	1,622	127	5
V	15	Huntsman	90	116	Sept. 20	97	172	63.9	187	288	23	1
V	16	Huntsman	181	290	Sept. 20	359	474	56.9	540	764	82	2
VI	16	Genet	104	164	Oct. 13	645	143	18.1	749	307	40	5
VII	15	Huntsman	131	67	Sept. 20	93	166	64.1	224	233	39	5
IX	15	Wagener	1,015	724	Sept. 15	1,179	635	35.0	2,194	1,359	39	......
X	16	Wagener	185	109	....	....	....	....	185	109	8	5
XII	16	Winesap	338	982	Oct. 11	2,178	379	14.8	2,516	1,361	140	25
XIII	15	Winesap*	868	1,306	Oct. 11	5,057	972	16.1	5,925	2,278	158	20
XV	15	Gramar's Pearmain	319	151	Sept. 4	214	20	8.5	533	171	12	2
XV	16	Huntsman	69	106	Sept. 29	31	121	79.6	100	227	65	2
XVI	16	Gilpin	1,050	1,739	Oct. 19	3,700	756	17.0	4,750	2,495	379	......
XVII	15	Genet	167	315	Oct. 19	467	209	30.9	634	524	74	......
XVIII	15	Rambo	300	337	Sept. 15	827	327	28.3	1,127	664	45	......

*Center of tree Shockley, furnishing one-sixth of the entire product of tree. Not differing from Winesap for the purposes of this record.

BLOCK "E_1."—Sprayed May 9th. Mixture: Nixon "Climax" Poison, 1½ pounds; water, 50 gallons, (1 ounce to 2⅗ gallons.)

Row.	Tree.	VARIETY.	RECORD OF FALLEN APPLES.		Date of gathering.	PICKED APPLES.			TOTAL PRODUCT.		Insects taken under bands.	Per cent. of injury to foliage.
			Sound.	Infested.		Sound.	Infested.	Per cent. infested.	Sound.	Infested.		
I	17	Genet*	108	115	Oct. 13	288	112	28.0	396	227	11	5
I	18	Genet*	92	75	Oct. 13	300	135	31.0	392	210	10	......
II	18	Genet	84	102	Oct. 13	577	297	34.0	661	399	48	5
III	17	Genet	51	75	Oct. 13	342	138	28.8	393	213	27	10
IV	18	Genet	201	238	Oct. 13	680	152	18.3	881	390	24	10
V	17	Jonathan	786	687	Sept. 12	32	28	46.7	818	715	60	20
V	18	Genet	127	136	Oct. 13	428	106	19.9	555	242	22	15
VI	17	Genet†	74	99	Oct. 13	293	78	21.0	367	177	17	25
VI	18	Yellow Bellflower	157	140	Aug. 8 & Sept. 15	226	135	‡37.4	383	275	12	17
VII	17	Yellow Bellflower	318	464	Sept. 15	156	193	55.3	474	657	67	20
VIII	18	Yellow Bellflower	230	283	Sept. 15	143	167	53.9	373	450	28	25
IX	17	Wagener	134	114	Sept. 5	15	10	40.0	149	124	8	5
X	18	Wagener	364	272	Sept. 15	57	37	39.4	421	309	14	5
XII	18	Winesap	296	728	Oct. 11	1,480	285	16.1	1,776	1,013	163	10
XIII	17	Winesap	542	1,476	Oct. 11	2,646	603	18.6	3,188	2,079	140	35
XIV	18	Perry Russet	243	891	Sept. 15	82	425	83.8	325	1,316	145	20
XV	17	Gilpin	319	781	Oct. 19	882	378	30.0	1,201	1,159	185	25
XVI	18	Gilpin	72	141	Oct. 19	42	90	68.2	114	231	42	10
XVII	17	Willow Twig	116	213	Oct. 19	34	47	58.0	150	260	19	20
XVIII	17	Rambo	112	174	Sept. 15	256	81	24.0	368	255	20	20

* With bearing grafts of Jefferis. † With small non-fruiting top grafts of other sorts.
‡ Greater part of the fruit picked at first date given; hence the—for this variety—low per cent. infested.

BLOCK "E_2."—Sprayed May 9th, and again May 19th. Mixture: Nixon "Climax" Poison, 1½ pounds; water, 50 gallons.

Row.	Tree	VARIETY.	Record of fallen apples.		Date of gathering.	Picked apples.			Total product.		Insects taken under bands	Per cent. of injury to foliage
			Sound.	Infested.		Sound.	Infested.	Per cent. infested.	Sound.	Infested.		
I	19	McClellan	103	38	Oct. 13	35	26	42.6	138	64	1	10
I	20	Genet*	259	359	Oct. 13	1,920	547	22.2	2,179	906	33	10
II	20	Genet	215	306	Oct. 13	1,195	432	26.5	1,410	738	96	10
III	19	Genet	82	52	....	....	....	....	....	....	5	10
IV	20	Roman Stem	9	13	....	....	....	....	9	13	6	5
V	20	Bailey's Sweet	1,103	466	....	....	....	....	1,103	466	59	20
VI	20	Genet	35	31	Oct. 13	11	19	63.3	46	50	6	30
VII	19	Ben Davis	450	351	Sept. 29	161	174	51.9	611	525	37	30
VIII	20	Huntsman	288	414	Sept. 29	180	218	54.8	468	632	162	20
IX	19	Wagener	287	263	Sept. 15	71	54	43.2	358	317	6	20
X	20	Wagener	399	435	Sept. 15	255	259	50.4	654	694	6	20
XII	20	Winesap	288	580	Oct. 11	924	259	21.9	1,212	839	54	40
XIII	19	Winesap	1,155	890	Aug. 5 / Oct. 11	4,146	755	†15.4	5,301	1,645	71	50
XV	19	Gilpin	458	888	Oct. 19	1,084	896	45.3	1,542	1,784	217	50
XVI	19	(Unnamed)	554	221	Aug. 23	291	15	4.9	845	236	14	30
XVI	20	Talman Sweet	313	204	....	....	....	....	313	204	11	30
XVII	19	Talman Sweet	110	199	Sept. 18	57	119	67.6	167	318	18	10
XVIII	20	Talman Sweet	202	195	Sept. 18	76	142	65.1	278	337	19	30

* Grafts of Hubbardston. † Of portion gathered August 5, but 10 per cent. were infested.

BLOCK "F_1."—Sprayed May 9th. Mixture: Paris green, 1 ounce; water, 5 gallons.

Row.	Tree.	Variety.	Record of fallen apples.		Date of gathering.	Picked apples.			Total product.		Insects taken under bands.	Per cent. of injury to foliage.
			Sound.	Infested.		Sound.	Infested.	Per cent. infested.	Sound.	Infested.		
II	22	Genet	337	407	Oct. 13	2,443	594	19.5	2,780	1,001	107	......
III	21	Genet	200	254	Oct. 13	1,640	496	23.2	1,840	750	72	10
IV	22	Genet	359	406	Oct. 13	2,646	540	16.9	3,005	946	93	......
V	21	Genet	104	192	Oct. 13	180	70	28.0	284	262	58	10
VIII	22	Ben Davis	137	64	Sept. 29	31	56	64.4	168	120	6	50
IX	21	Bailey's Sweet	635	384	Aug. 23	246	61	19.9	881	445	30	15
X	22	Seedling apple	......	......	......	......	......	......	......	......	......	20
XII	22	Winesap	595	872	Oct. 11	2,611	602	18.7	3,206	1,474	214	25
XIII	21	Winesap	802	1,659	Oct. 11	3,825	922	19.4	4,627	2,581	218	25
XIII	22	Huntsman	120	222	Sept. 29	80	208	72.2	200	430	47	......
XV	21	Bailey's Sweet	123	83	Sept. 4	18	4	18.2	141	87	8	10
XV	22	Huntsman	32	35	......	......	......	......	32	35	4	20
XVI	21	Fink	15	21	......	......	......	......	15	21	1	20
XVI	22	Talman Sweet	80	114	Sept. 18	70	76	52.7	150	190	18	15

BLOCK "F_2." Sprayed May 9th, and again May 19th. Mixture: Paris green, 1 ounce; water, 5 gallons.

Row.	Tree.	VARIETY.	RECORD OF FALLEN APPLES. Sound.	RECORD OF FALLEN APPLES. Infested.	Date of gathering.	PICKED APPLES. Sound.	PICKED APPLES. Infested.	PICKED APPLES. Per cent. infested.	TOTAL PRODUCT. Sound.	TOTAL PRODUCT. Infested.	Insects taken under bands	Per cent. of injury to foliage
I	23	Genet*	164	143	....	....	....	....	164	143	7	10
II	24	Genet	49	63	Oct. 13	34	35	50.7	83	98	12	15
III	23	Genet	133	158	Oct. 13	825	235	22.3	958	393	34	10
IV	24	(Unknown)	411	85	....	....	....	....	411	85	2	25
V	23	Genet	234	276	Oct. 13	913	337	27.0	1,147	613	83	5
VI	24	Genet	71	80	Oct. 13	252	48	16.0	323	128	25	20
VII	23	Yellow Bellflower	190	187	Sept. 15	69	117	62.9	259	304	43	10
VIII	24	Huntsman	78	49	Sept. 29	13	75	85.2	91	124	21	10
IX	23	Wagener	233	194	Sept. 15	43	35	44.9	276	229	7	5
X	24	Wagener	516	191	Sept. 15	57	111	66.1	573	302	15	20
XII	24	Winesap	250	368	Oct. 11	7,565	265	3.4	7,815	633	25	60
XIII	23	Winesap	477	750	Oct. 11	2,037	550	21.3	2,514	1,300	106	35
XIV	24	Gilpin	166	68	Oct. 19	41	43	51.2	207	111	14	25
XV	23	Gilpin	203	395	Oct. 19	1,006	253	20.1	1,209	648	129	25
XV	24	(Unknown)	86	59	Sept. 29	32	46	59.0	118	105	9	20
XVII	23	Talman Sweet	318	247	Sept. 18	102	124	54.9	420	371	29	15
XVIII	24	Talman Sweet	253	154	....	....	....	....	253	154	14	10

*Top grafts of English Sweet.

BLOCK "G."—Sprayed May 9th. Mixture: Paris green, 1 ounce; water, 3⅛ gallons.

Row.	Tree.	Variety.	Record of fallen apples. Sound.	Record of fallen apples. Infested.	Date of gathering.	Picked apples. Sound.	Picked apples. Infested.	Picked apples. Per cent. infested.	Total product. Sound.	Total product. Infested.	Insects taken under bands.	Per cent. of injury to foliage.
I	25	Genet*	49	53	Oct. 13	47	22	31.9	96	75	3	5
I	26	Genet	83	146	Oct. 13	680	320	32.0	763	466	23	5
II	25	Genet	331	378	Oct. 13	1,836	622	25.0	2,167	990	110	5
II	26	Genet	....	....	Oct. 13	....	....	....	....	....	....	5
III	25	Genet	105	169	Oct. 13	524	280	34.8	629	449	43	5
III	26	Genet	165	297	Oct. 13	840	378	31.0	1,005	675	122	5
IV	26	Genet	327	411	Oct. 13	1,968	708	26.5	2,295	1,119	96	5
V	25	Genet	111	122	Oct. 13	214	92	30.1	325	214	64	5
VI	26	Huntsman	18	30	Sept. 29	0	7	100.0	18	37	8	......
VII	25	Huntsman	58	122	Sept. 29	16	102	86.0	74	224	40	2
IX	25	Wagener	617	394	Sept. 15	85	135	61.4	702	529	11	20
X	26	Huntsman	19	10	Sept. 29	1	5	83.3	20	15	....	5
XII	26	Genet	71	118	Oct. 19	14	23	62.2	85	141	11	10
XIII	25	Winesap	419	741	Oct. 11	560	540	49.1	979	1,281	94	35
XIV	26	Gilpin	216	407	Oct. 19	276	245	47.0	492	652	99	25
XV	25	Gilpin	192	264	Oct. 19	264	266	50.2	456	530	22	25
XVI	26	Talman Sweet	290	188	Sept. 18	106	108	50.5	395	296	34	10
XVII	25	Genet	365	401	Oct. 19	2,158	377	14.9	2,523	778	125	15

*Top grafts of Swaar, not fruiting.

OBSERVATIONS UPON INJURIOUS INSECTS.

THE ASH SAW-FLY.

Monophadnus bardus (SAY.)*

Feeding very abundantly, in May, upon the leaves of the ash tree, a yellowish green 22-footed slug about one inch in length, with a darker green translucent line along the back and along each side; transforming in the following spring into a four-winged fly about one-third inch in length, in color black, with the thorax above and in front dull orange or honey red.

During several seasons the ash plantations upon the College grounds, especially the white ash grove upon the upper farm, have suffered more or less injury through the attacks of the larvae of saw-flies of several species, the *Monophadnus bardus* (Say) being much the most numerously represented. In 1886 and 1887, the abundance of the larvae was such that the leaves were in many cases entirely stripped from the trees, numbers of the larvae dying from starvation. In 1888, though the parent flies appeared in great abundance, the larvae were less than usually numerous, owing doubtless to the prevalence of cold, rainy weather, which prevented the activity of the flies in the season of egg laying.

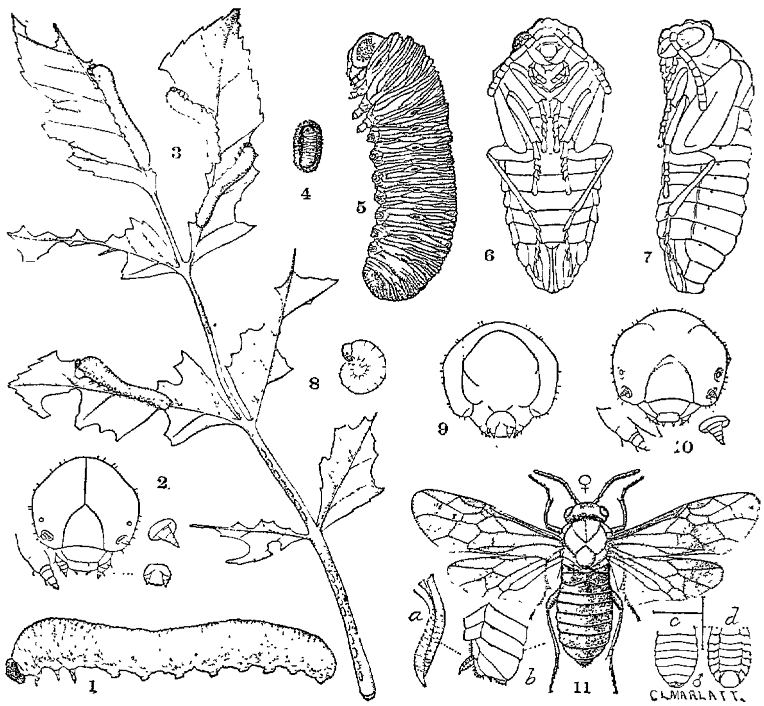
The adult insect appears from the last of April to the middle of May, the male preceding the female two or three days. The insect is very short lived, the adult period not exceeding ten or fifteen days. The date of appearance of the adult is somewhat irregular; single individuals were noted as early as April 1, and others after the middle of May, the period of greatest abundance being about May 1, at which time a sweep of a collecting net secures them by the hundred.

Ordinarily the flies do not leave the locality where they were bred, and after their season may be found dead, thickly scat-

* *Allantus bardus* SAY: Collected writings, ed. LeConte, Vol. II, p. 678. (1859.)
Selandria barda NORTON: Trans. Am. Ent. Soc., I, P. 247. (1867.)
Selandria barda (SAY): Herbert Osborn, in Bulletin Iowa Agricultural College, 1884, No. 2, p. 80.
Monophadnus bardus (SAY): Cresson, Synopsis Hymenoptera of North America. (1887.)

tered on the ground about the infested trees. Hence their migration to neighboring ash groves has been slow, and they have not been noted in such great profusion in newly planted groves away from those first mentioned.

Aside from the injury of oviposition, the flies themselves are incapable of injuring the tree. They apparently feed, to some extent, upon the grains of a whitish, waxy substance that occurs upon the surface of the freshly expanded leaves, as individuals of both sexes have been seen clearing the leaf surface of this substance.



The ASH SAW-FLY *(Monophadnus bardus* SAY), Fig. 1. Full grown larva enlarged two and one-half times natural size. Fig. 2 Head of same with details. Fig. 3. Leaf showing larvae at work, and, in the petiole and midrib, the eggs. Fig 4. Cocoon and larva of male, natural size; the female cocoon averages one-third larger. Fig. 5. Larva taken from cocoon, showing contracted form assumed previous to pupation. Fig. G. Pupa. front view, and fig. 7, side view. Fig. 8. Larvae taken from egg nearly ready to hatch. Fig. 11. Adult female enlarged, natural size indicated by lines below right lower wing: a, ovipositor: b, tip of female abdomen, showing ovipositor in position for piercing the leaf: c and d, outline figures of male abdomen, seen from above and below.

Figures 9 and 10 show the back and the front of the head of a saw-fly larva found with the above, but in very limited numbers, This larva develops into an unnamed species of *Monophadnus.*

In the act of oviposition, the female thrusts her sawtoothed ovipositor (Fig. 11*a*,) under the epidermis at the edge of the upper face of the petiole or midrib of the leaf. Then, by a forward and outward thrust, a cavity is formed in which the egg is at once laid. The ovipositor being withdrawn, a step forward is taken, and the operation is repeated, until from three to a dozen eggs are laid, when change of position may be made. When the space is not filled, the eggs are commonly laid under the epidermis of the petiole at the edge of the upper or concave side only, but when this part is occupied; other parts are brought into requisition; so that not unfrequently eggs will be found in double or quadruple rows over every available section of the petiole and midrib, or even on the bud scales. In two instances, indeed, the flies were seen placing eggs in the edge of a leaflet. While employed in egg laying, the insect is not easily disturbed, so that the observer may use a hand glass and watch the operation at his convenience.

The egg is oblong oval, colorless, and about one millimeter in length: and toward the time of hatching the outline of the larva, and more distinctly the dark colored head, becomes visible through the shell. It is interesting to note that these unhatched larvae are arranged with great regularity, backs outward, and heads turned toward the leaf tip.

The period of oviposition extends through about twenty days; beginning in 1888 upon April 25th, it continued until May 15th. In a few instances, freshly placed eggs were observed as late as June 5th. In nine or ten days after the egg laying season has begun, the first larvae are seen, the greatest number appearing from the 10th to the 20th of May. They at once begin to feed, and as they group themselves, often as many as fifty or more together, upon a single leaf, their work soon becomes noticeable. Scattering colonies of these gregarious young have been observed as late as June 15th. In their usual abundance, the sound made by the myriad jaws cutting into the leaf tissues is distinctly audible in the midst of the grove, and may be compared to the sound of fine rain drops upon the foliage. Excepting a few of the coarser veins, the leaf is eaten entire, and soon the larvae must travel in search of food. They are then often so numerous as fairly to whiten the trunk and branches over which they must crawl.

The larval development may be illustrated by the following record of the brood of 1888:

MAY 4th.—The *first larvae* observed. Newly hatched, they may be described as follows: Length, 2.75 millimeters; head, .45 millimeters in diameter, shining black; body yellowish white, smooth, with transverse wrinkles; thoracic segments of somewhat greater diameter than those of the remainder of the body; thoracic feet marked with dark, abdominal feet whitish.

MAY 6th.— *First moult:* Length of larva 4 mm.; head .65 mm. in diameter.

MAY 8th.— *Second moult:* Length of larva 7 mm.; head .91 mm. in diameter.

MAY 10th.— *Third moult:* Length of larva 11 mm.; head 1.35 mm. in diameter.

MAY 14th.— *Fourth moult:* Length of larva 15 mm.; head 1.75 mm. in diameter.

MAY 17th.— Larvae *full fed:* Length 20–25 mm.; head 1.75 mm. in diameter. The larva at this age has the head shining dark brown; mouth parts lighter; thoracic feet dark spotted; abdominal feet light; skin in numerous transverse folds and wrinkles; color yellowish green, with a dorsal and lateral line darker, translucent.

After reaching full size, the larva passes its *fifth moult*, but with little change in size. The colors are somewhat altered, the head becoming gray brown above, and of a light flesh color in front and below the small black eye spots. The body is of a smoky color, darkest on the back, yellowish on the sides and beneath, somewhat shining; thoracic feet light.

After the fifth moult the larva does not feed, but, rapidly contracting to one-third or one-half its former length, enters the soil to a depth of from one-half inch to three inches, commonly about one inch constructs an oval earthen cocoon about one-half inch long, lined interiorly with a brownish silk. In this cocoon the larva remains unchanged until March or April of the next year. In the breeding cage, where a series had been reared, all had pupated by April 16th, and flies were already appearing; but in the ash grove few pupae were found at that date, the unchanged larvae being in great preponderance. On April 19th, the first flies were noted in the grove; on the 21st they were common, and on the 25th in greatest abundance, —many in coitu and others depositing eggs. The observations of three successive seasons indicate that this saw fly is single brooded.

ENEMIES.

Larvae were frequently noticed with the eggs of a dipterous parasite attached to the skin of the back, and from some of these were bred a number of specimens of a small tachina fly, appearing in April and May. *Metapodius femoratus* and a common species of *Podisus*, both large bugs allied to the squash bug, and commonly supposed to be exclusively plant feeders, were observed preying upon the larvae of the saw fly. A species of paper wasp (*Polistes*, undermined) was repeatedly seen stinging and carrying off nearly full-grown individuals, and ichneumon flies were so numerous in the grove as to intimate the saw fly larvae to be the object of their attention, though no ichneumonized specimens were secured. In addition to insect enemies, birds were observed to destroy the larvae in numbers and at all hours of the day. As showing one natural check upon the increase of this insect, it should be stated that upon May 27, 1888, while the larvae were abundant, there occurred a heavy hail storm, and a visit to the grove the day following showed the larvae lying dead upon the ground in great numbers.

TRIALS OF INSECTICIDES.

No extended trials with poison or other insecticides were made, but enough was done to show that the larvae could be destroyed with little difficulty. The trees upon one-fourth acre of the infested grove were sprayed with London purple in water, in the proportion of eight ounces to forty gallons, with the result of the destruction of all the larvae within reach of the spray. A single limited trial of kerosene, applied in "emulsion," (two parts of kerosene to one of milk, diluted with nine parts water,) resulted less favorably, but five per cent. of the larvae being killed by it.

THE SYCAMORE FORK-TAIL.

Heterocampa unicolor PACK.

The sycamore *(Platanus occidentalis)* is one of our popular shade trees for street and lawn planting, and many planters have doubtless noted with regret the injury to the smooth, clean foliage of this tree which results mainly, perhaps, from the attacks of the two insects now described.

Probably the more important of these two species is the handsome larva of the moth known to entomologists as *Heterocampa,* or *Lochmæus, unicolor.** Under the latter name, the moth was first described by Dr. A. S. Packard, in the Proceedings of the Entomological Society of Philadelphia, volume III, page 373.

The larva is one of those peculiar forms commonly known as "fork-tails," from the presence of a pair of slender projecting appendages at the footless tip of the abdomen. We may therefore properly call this larva the sycamore fork-tail. The following description of its stages and development is drawn up from the field notes of several years:

The larvae occur in two broods each year; the first brood appearing in early June, the second in the first week in August. The larvae of the first brood reach their full size in the early part of July; and within the shelter of the cocoons which they spin when full grown, the transformation to the pupal state is effected. The summer moths soon appear, and after the pair-

* *Lochmæus unicolor* PACKARD: Proceedings of the Entomological Society of Philadelphia, Vol. III, p. 373 (in part).
Lochmæus marina PACKARD l. c.
Heterocampa unicolor PACKARD: No. 1052 of the Check List of N. A. Macrolepidoptera, in Bulletin of the Brooklyn Entomological Society, Vol. IV.
Heterocampa marina PACKARD: No. 1053 same list.

ing, the females lay the eggs which produce the second brood of larvae. The larvae of this brood mature toward the end of August, and having spun cocoons about themselves, pass the winter unchanged, the pupal state, in this brood, not being reached until the following spring, a short time before the appearance of the spring moths.

This series of changes will be better understood, perhaps, after a glance at the following record of a year's history of this insect:

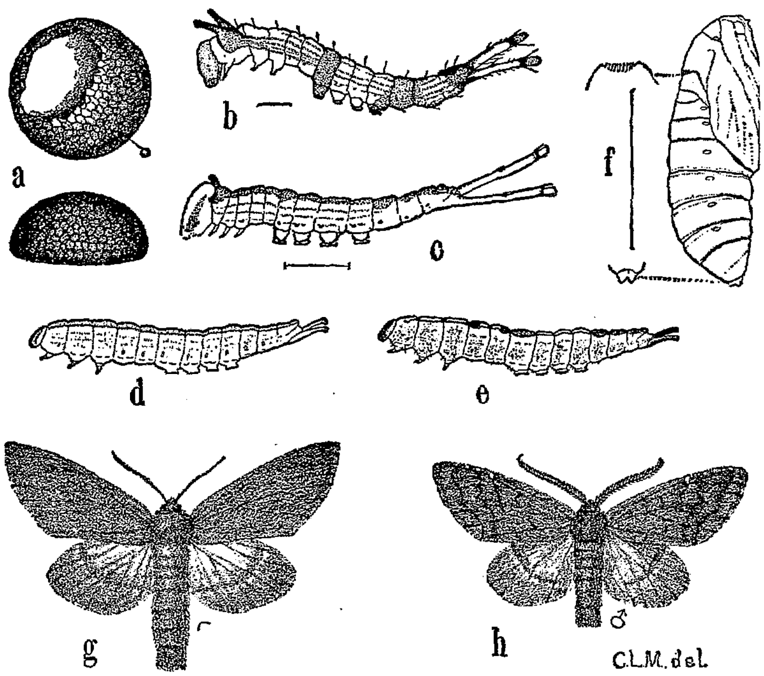
FIRST BROOD.

June 11, 1887.— Eggs deposited.
June 15, 1887.— Eggs hatched.
June 19, 1887.— First moult of larvae.
June 22, 1887.— Second " "
June 24, 1887.— Third " "
June 28, 1887.— Fourth " "
July 4, 1887.— Larvae enclosed in cocoons
July 14, 1887.— Pupae first seen.

SECOND BROOD.

July 27, 1887.— First moths appear.
July 29, 1887.— Eggs deposited.
August 2, 1887.— Eggs hatched.
August 5, 1887.— First moult of larvae.
August 8, 1887.—Second " "
August 10, 1887.—Third " "
August 15, 1887.—Fourth " "
August 19, 1887.— Larvae enclosed in cocoons.
February 25, 1888.—Larvae still unchanged.
May 20 to June 11, 1888.— Moths appear.

The several stages of the insect are well shown in the accompanying engraving, made after original drawings from specimens studied in the Entomological Laboratory of this Department.



The Sycamore Fork-Tail (Heterocampa unicolor Pack.) in its several stages.

The egg, which is shown both highly magnified and natural size at *a*, is greenish white, hemispherical and reticulated, and is broken by the hatching larva in an irregular opening upon the convex side (see *a*, upper figure). These eggs are laid in close groups of from fifteen to seventy-five, upon the under side of the leaf. The newly hatched larvae for a time feed in company upon the leaf pulp, leaving untouched the framework of the leaf. They are at this time of the form shown in figure *b*, and of the length indicated by the hair line below. At this stage the tail-like appendages are proportionately larger than in the adult, and a pair of projecting “horns” may be seen upon the second segment. If the leaf upon which these larvae are feeding be disturbed, they fall or spring from the surface, and hang suspended at the end of the thread of silk which draws out as they fall, from the silk gland on the lower lip.

By means of this thread they readily regain their feeding grounds after the disturbance has passed, if indeed they do not reach another leaf or branch, and so become generally scattered throughout the tree. As the larvae grow, slight changes in form, through the intermediate stage, shown in *c*, result finally in the full grown larva, as shown, natural size, in two forms at *d* and *e*. They now no longer feed upon the leaf pulp only, but devour the woody parts or veins as well; and it is now that their work is more noticeable. At this stage, the majority of the larvae are yellowish-green marked with red, as shown in *e*. In the same brood there will occur other larvae *(d)* lighter in coloration, but transforming into moths indistinguishable from those produced by the darker form. The full fed larva leaves the tree and forms a loosely woven silken cocoon under or among the leaves and other rubbish upon the ground. After a longer or shorter time, as indicated in the foregoing tabulated record, the pupal form is attained. In this stage the insect appears as in *f*, details at the left of pupa showing characteristic structure of the thorax and tip of the abdomen.

The moths are shown at natural size, the female at *g*, the male at *h*, in the engraving, and vary in color from pale gray-green without dark markings, to a dark purplish gray, sometimes with greenish tinge, and with transverse darker markings. The male is readily distinguished by the feathered antennae and smaller size.

The foregoing variations in color occur among the moths reared from a single batch of eggs, and although the extremes are apparently sufficiently distinct to constitute good species, as indeed they were first considered by Dr. Packard, they can, of course, in the light of present facts, be considered only individual variations.*

It may be further stated, that the differences in coloration in the adult larvae have no relation to the correspondingly great variation in the moths, so far as was observed.

* Specimens of the extremes of variation from a single lot of larvae were submitted to Dr. Packard, who wrote concerning them as follows: "It is my *Lochmaeus unicolor*; of which my *L. marina* is with little doubt a synonym. The faded one (in appearance) is like my type of *unicolor*, while the two others are my *L. marina*."

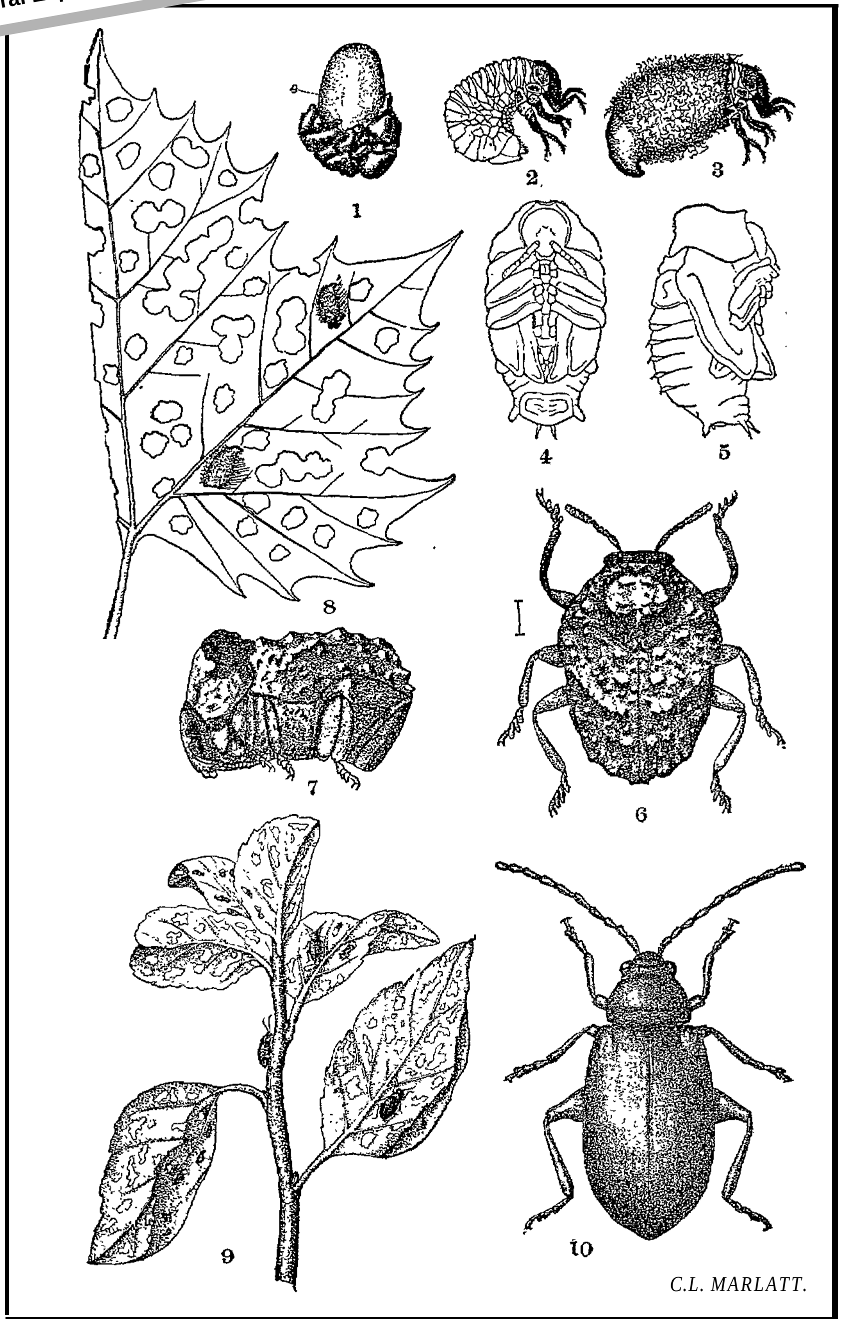


PLATE I.
The Sycamore Leaf Beetle *(Chlamys plicata)* Figs. 1-8.
The Apple Tree Flea Beetle *(Graptodera foliacea)* Figs. 9, 10.

THE SYCAMORE LEAF BEETLE.

Chlamys plicata (FAB.)

The second insect to be noticed is a beautiful little beetle which we may call the sycamore leaf beetle, *(Chlamys plicata,)** a member of the great family of leaf beetles to which the Colorado potato beetle, the striped squash beetle, and so many other garden and field pests belong.

In length, specimens of this insect average somewhat above the eighth of an inch, and in color, variations occur from the bright coppery or bronzed red of the newly transformed living insect, through duller bronze, with blue, purple or green glints, to a dull purplish brown. The form and proportions of the beetle, and the striking and characteristic sculpture of the thorax and elytra, are shown in figure 6 (from above) and 7 (from the side), on Plate I.

While commonly found on the sycamore, this species will be not infrequently beaten by the collector from other plants, both from shrubs and low weeds, though we have no evidence that it feeds on these. Its ample wings attest its power to wander to some distance from its food plant.

When alarmed, these beetle, like others of the family, will often release its hold upon the leaf, and, folding its legs and antennae closely to the sides of the body, will fall to the ground. In this position (Fig. 7) it resembles at first sight nothing else so closely as it does a fragment of the castings of a large caterpillar.

In its perfect state, however, the insect has a greater interest for the collector of beetles than for the economic entomologist, as it then does little harm, though associated with the injurious larva upon the leaves of the plants attacked.

The species is probably found in our own State wherever its food plant grows, as it has been very generally received from collectors in the eastern part of Kansas. It occurs elsewhere throughout the Atlantic region of the United States.

* Shown in Plate I, figures 1-8.

The eggs, one twenty-fourth of an inch in length, red in color, are found singly upon the midrib of the leaf upon its under side, set, like an acorn in its cup, in a brownish excrementitious mass, as shown in Fig. 1, Plate I. The natural size is indicated approximately in the outline figure connected by a dotted line at the left.

The larvae, when full grown, measure about one-fourth of an inch in length, are short, curved, six-footed grubs, of a general pale yellowish color, with the head, legs, shield on first segment and space above the bases of second and third pairs of legs dark brown or blackish, polished; the body is sparsely hairy, more especially upon the anterior portion. The larva is a case bearer, and carries about with it from the time of hatching a thick, blunt, white-downy protecting case constructed of its own castings, and covered apparently with the tomentum from the under surface of the sycamore leaf. The case is from time to time enlarged to suit the needs of the growing larva, and when the latter is mature, its case, now about one-quarter of an inch in length, serves further, when glued mouth downward upon some smooth surface, as a protection for the insect during its helpless pupal existence.

On small trees, the riddled leaves showing the work of these larvae are often more numerous than those uninjured, and it is under these circumstances that the insect demands our special attention.

In trials with insecticides, it was found easy to destroy either of these sycamore leaf-feeding species by the application of a light spray of Paris green, using for this purpose a mixture of about one ounce of the powder to ten gallons of water.

THE APPLE TREE FLEA BEETLE.

Graptodera foliacea LEC.

In his “First Annual Report on the Injurious and other Insects of the State of New York,” Prof. J. A. Lintner has given (page 327) a list of insect depredators upon the apple tree, the number of species reported reaching one hundred and seventy-six. This number included not only those seriously injurious to the apple tree or its fruit, but also all then known to subsist in part upon it, and but occasionally troublesome. About one-fifth of the entire number given may be named as species actually and noticeably injurious; and while we are solicitous to diminish rather than to increase this number, it is yet necessary that we pay due attention to all notable additions to the catalogue. One of these we have found in Kansas, in the green leaf-eating flea beetle, known to entomologists as *Graptodera foliacea,* which we may call the apple flea beetle. This beetle is generally distributed throughout the State, and from personal observation we know it to extend at least to the foot hills in Colorado.

Throughout its range, so far as noted, it usually occurs upon plants of the evening primrose family *(Onagraceae),* being especially partial to the silky gauras *(Gaura parviflora* and others), the leaves of which are often riddled by it. We have not learned the place and character of the preparatory stages of this insect, it being the adult or beetle stage in which it has proven injurious in our orchards and nurseries.*

For several years past, the beetle in question has attracted attention on the College grounds by its attacks during May and June upon the apple trees, the leaves being the portions injured. In orchard trees, the lower branches only, near the ground, have suffered, and these but slightly. The greatest injury has been done in the nursery, where the beetle has often completely defoliated the spring set root grafts and the yearling trees, and has seriously injured even two-year-old trees. The insects are most active in bright, warm weather, and are then attracted to the trees in great abundance, where they feed upon the parenchyma of the leaf (Plate I, fig. 9), avoiding the veins and

* A number of these beetles, received from Dighton, Lane county, were kept for a fortnight in a small jar, and fed with apple leaves. They fed voraciously upon the leaves, and some of the females deposited eggs upon the leaves, and also on the sides and bottom of the jar, under the fragments of the food and excreta. The eggs are orange in color, rather less than a millimeter in length, long oval in form, and, under a high magnifying power, the shells are seen to be minutely granulated.

midrib, these being sometimes all that remains after a few days' presence of the beetle. It is on the young shoots of the root grafts that their work is most injurious. In these, they keep the new growth cut so close that the graft sometimes fails to recover. While the injury to yearlings is considerable, yet the trees, though denuded, usually recover, and throw out new leaves after the season of the attack is past.

Like its near ally, the steel-blue grape beetle, this species is easily alarmed, and on being approached springs off the leaf, afterward seeking safety in flight, but only to return and again occupy its feeding ground, after the danger is past.

Upon the College grounds, we have checked the advances of this beetle without much trouble, by the timely application by spraying of the mixture of arsenical poison (Paris green or London purple) in water, as used against the codlin moth. As the beetles fly well, and as they may come in from time to time, through three weeks or more, from other localities, it may be necessary to repeat the application, the more if heavy rains have fallen. Our use of the poisons so far has been with the purpose of saving the trees, and we have not made trial to find the minimum effective strength of the mixture. In the strength employed, about six ounces of London purple to the barrel of water, we found that some injury to the tender leaf growth followed, the plants suffering less from this, however, than they would have suffered from the unchecked attacks of the flea beetle.

To assist in the identification of the insect, the following brief description is given: The apple flea beetle (Plate I, fig. 10) measures from 4 mm. to 5 mm. (.15 to .19 inch) in length, is ovate in general outline, and, except as noted below, is in all parts highly polished, and brassy green in color. The antenna are usually dull brownish black, the color obscured by a short gray pubescence, except that the first three joints are of the same color as the body, and are but sparsely pubescent. The feet are dull brownish, or reddish brown, and, with the legs and under parts generally, are thinly clothed with short gray pubescence. In other details, the species is well represented in the figure.

Since the foregoing account was published, our knowledge of the early stages of this insect has been extended by a notice of the larva and its habits, from the pen of Miss Mary E. Murtfeldt, in *Insect Life,* for September, 1888.

From that paper, the following statements are taken, as of great interest to many Kansas nurserymen, who may not have access to the original.

Eggs were found July 9 upon the apple leaves, placed in a breeding jar as food for the beetles. These eggs measured about 1 mm. in length, and were usually in clusters of two and three, side by side, attached to the stems and bases of the midrib of the leaves. From the eggs, the larvae appeared on July 17. The following account of their appearance and habits is quoted from the paper above cited:

"They are nearly cylindrical, of a dull black color, and rather more elongated in proportion to their diameter than the larvae of *G. chalybea.*

"When grown, they feed on the parenchyma of the leaf, indifferently on either surface but later, they gnaw holes in it similar to those made by the perfect insects.

"The first moult took place in eight days, and two or three of the small larvae perished in the process, being unable to entirely withdraw themselves from the outgrown skins. The second moult occurred one week later, and in this, also, one larva perished. During these periods, there are no changes of color or maculation. August 2, one larva had completed its growth, and as it was making its way to the earth, I put a stop to its further development by transferring it to the alcohol bottle. The following characters were noticed: Length of mature larva, from 6 to 7 millimeters; diameter, 1½ mm.; form, cylindrical, tapering somewhat posteriorly; general color, varying from dull black to dark fuscous: piliferous plates inconspicuous, of the same shape, number and arrangement as those of *G. chalybea*, black in color and slightly polished; each giving rise to from one to three minute hairs; head rounded, cordate, deep black, but not brilliantly polished; prolegs well developed, faintly annulate at the points with dingy white.

"The larvae move about considerably, but in a slow and rather clumsy fashion, with the tip of the abdomen appressed to the surface of the leaf or stem, to assist in keeping them in position.

"The pupa is inclosed in a frail earthen cocoon, or cell, just beneath the surface of the ground.

"None of the beetles from this brood have emerged, and it is possible that they may hibernate. Several of the parent beetles were, August 14, still alive and as voracious as ever, while eggs and young larvae were still to be found on the leaves.

"August 14, two larva entered the ground, and the beetles emerged on the 28th of the same month — the duration of the pupal stage of life being less than two weeks.

"September 1. The last beetles of the spring brood have just died, possibly from a lack of fresh food more than from old age, as I was absent from home and could not give them personal attention. The probabilities are that the second brood of these beetles hibernates, and lays its eggs early in the season for the production of the beetles that are so destructive throughout the summer.

"It will be seen from this account that *G. foliacea* is an all-summer pest, and capable of inflicting a vast amount of injury in the nursery and young orchard."

THE APPLE-TWIG BORER.

Amphicerus bicaudatus SAY.

Boring in twigs of the apple, pear, peach, sumac and grape. A cylindric, dark-brown beetle, about three-eighths inch long, the head concealed from above by the projecting prothorax, which is more or less roughened in front; the wing covers, at tip, sloping downward, and, in the males, beset with a pair of short, blunt spines, inclined inward. The larvae and pupae, as found in dead stems of tamarix, and in dead grape vines, are figured and described below.

Among the numerous insects concerning which information has been asked during the season past, none, seemingly, has attracted more general attention than the apple-twig borer. Specimens of the insect, and its work in grape vines and apple twigs, have reached us from various points in eastern and central Kansas, Norton and Lane being the westernmost counties from which complaints are noted. The following extracts from letters indicate the nature and extent of the injury caused by this beetle in our orchards and vineyards, and give some hint as to its distribution in our State: Mr. R. Robertson, under date of May 26th, 1888, writes from Nemaha county: "I send you, for name, some grape-vine destroyers. In a lot of fifty old Concord vines, they have destroyed about ten per cent. of the young or bearing wood. The vines were trimmed last fall; I did not notice the insect or its work then. In large numbers it would be very destructive." Mr. J. R. Bell writes from Rice county, May 19th: "I mail you to-day, a box containing specimens of a fly, or borer, that is working in our apple trees, and doing some damage. I find them working in grape vines as well, and hear much complaint of vines being entirely killed. I have lost a few large ones myself . . . . The sumac bush seems to be particularly their choice, as I found them very numerous in it this spring." Mr. M. A. Carleton, Mitchell county, May 28th, sending specimens in grape canes, writes: "It is a most destructive pest in this country, having so far as I have obtained information, destroyed almost all vines nearly to the roots, and all hopes of any grapes this year. I found the specimens in the heart of the vine. They have bored their way there, feeding on the soft tissue, and have, seemingly, in all cases entered at the joint." Mr. H. C. Davis, Norton county, May 21st: "Enclosed find cuttings of apple branches infested by a borer new to this country; also others showing the deposit of the larvae on the branches. * They (the borers) kill every branch that shows a burrow. I have lost fifteen

* This "deposit of the larvae" proves to be the cases of the "rascal leaf crumpler," (*Phycis indiginella* ZELLER).

four-year-old trees this spring, and have had many more damaged."

Others of the same tenor, from intermediate points, leave no doubt that the presence of this beetle was general, and that its work was unusually evident and noteworthy the past spring.* In the vicinity of the College, for instance, vines were very commonly infested, often several insects being found to a small vine, and two or more in the same cane.

In examining accessible literature for recorded observations upon this insect, it was found that little is known of its life-history, and nothing certainly known of its preparatory stages. As a partial index to published matter in this connection, and as a basis for comparison, the following references, with abstracts and quotations, will have value:

Apate bicaudatus SAY: "Found above the mouth of the Ohio." - Jour. Acad. Nat. Sci. Phila., Vol. III, p. 320, 1824. Coll. writings, ed. Le Conte, Vol. II, p. 180, No. 2. Referred (l. c.) to Bostrichus by Le Conte.

Bostrichus bicaudatus SAY: Asa Fitch, Third Report upon the Injurious Insects of New York, (1856,) p. 12: "This insect occurs from Pennsylvania to Mississippi, and has been common of late years in the orchards of Michigan and Illinois, but has never been met with as yet in New York or New England."

Bostrichus bicaudatus SAY: P. R. Uhler, U. S. Agl. Rep. for 1860 [1861], p. 321. Following a popular description of the beetle, evidently quoted, with slight modification, from Fitch, as above cited, Mr. Uhler says: "*Remedies.*— The best plan which can probably be adopted to exterminate these insects will be to saw off every infested limb beyond the point where the larvae [sic] penetrate, and burn it in the fire. Some of the mixtures before noticed [soft soap, or other alkaline wash] may prove efficient in deterring the insect from alighting and depositing its eggs in the tree."

Bostrichus bicaudatus SAY: Cyrus Thomas, in Trans. III. State Agl. Soc., Vol. V, 1865, p. 424. Description and reference to destructive habits. He says: "I have frequently traced them out of hickory limbs, which, I think, is their favorite native tree. I am inclined, also, to think their usual habit is to attack it when deadened, cut down or damaged, before becoming perfectly dry." He describes larvae, which, he surmises, may belong to this species, and their burrows in hickory. Recommends capture of beetles in their spring flights, and the destruction of prunings of trees attacked.

Bostrichus bicaudatus SAY: B. D. Walsh, Practical Entomologist, Vol. I, 1866, p. 27. Popular description of beetle, and its habits. Regarding its dis-

* Messrs. Holsinger and Espenlaub, of Rosedale, state that this insect has attracted no attention in their vicinity, and that they have not seen a case of its work.

tribution: "This insect occurs in Pennsylvania and in the valley of the Mississippi, but not in New York or New England."

Bostrichus bicaudatus SAY: Walsh & Riley, American Entomologist, Vol. I, 1869 [1869], p. 80. Figure and brief descriptions. Specimens from Iowa (in apple), Missouri, and, doubtfully, from New York. Same work, Vol. I, p. 206, specimens from Illinois (in apple). Same work, Vol. II, 1870, p. 212, Kansas (pear): p. 245, Iowa, Kansas (grape); p. 246, Wisconsin.

° *Amphicerus bicaudatus* SAY: Dr. Henry Shimer, in Trans. Am. Ent. Soc., II. 1869, p. viii. Describes work of beetles in dead vines of Clinton and Isabella grapes. Notes presence of larvae, which, however, are not certainly referable to *Amphicerus.*

Amphicerus bicaudatus SAY: C. V. Riley, Fourth Report of State Entomologist of Missouri, 1872, p. 51. Figures beetle and its burrows; gives an account of what is known of its history, with inferences as to the preparatory stages. "The beetles seem to prefer some varieties, such as Benoni and Red June, to other varieties of the apple, and, though they likewise occur in grape, pear and peach stems, I have never found them in those of the crab apple. Both male and female beetles bore these holes, and may always be found in them, head downward, during the winter and spring months. The holes are made for food and protection, and not for breeding purposes. Indeed, common as this insect is, its preparatory stages are entirely unknown." Fifth Report, p. 54: Records the beetle from New Jersey, in pear twigs, and notes statement of Dr. Henry Shimer, who bred the beetle from grape canes.

Bostrichus (Amphicerus) bicaudatus SAY: Cyrus Thomas, Trans. III. State Hort. Soc., Vol. IX, 1876, p. 194. "It is thought they prefer certain varieties of apples, such as Benoni and Red June, and will not attack the crab, but this has not yet been satisfactorily determined. The preparatory stages are yet unknown, although they are doubtless similar to those of the following species *(Sinoxylon basilare).* There is reason to believe it sometimes, at least, passes its larval state in the grape vine. I am incline to think that the larva works in hickory; that it is a borer cannot be doubted." . . . Cyrus Thomas, Sixth Report of the State Entomologist of Illinois, pt. II (1877), page 123. Description of beetle and work; cites the beetle as depredating upon the apple, "especially the young trees," the peach and hickory, "and even upon the grape vines." Other statements, essentially the same as the preceding extract from Trans. III. State Hort. Society.

Amphicerus bicaudatus LE CONTE: In list of Coleoptera collected in Northern New Mexico and Southern Colorado, in 1875, by Wheeler's Expedition.

Amphicerus bicaudatus SAY: Prof. A. J. Cook, in Fifth Annual Report of Michigan Pomological Society, 1875, p. 138. Brief notice.

Bostrichus bicaudatus SAY: Dr. S. H. Kridelbaugh, in Trans. Iowa Hort. Soc., Vol. II, 1876. Reports this beetle as, in some cases, totally killing the grape vine for a length of five or six feet; and, as "making sad havoc" in a nursery, killing the young trees.

Amphicerus bicaudatus SAY: Townend Glover, Manuscript Notes from my

Journal, or Entomological Index, etc., 1877, p. 4. "Apple-twig borer: Insect bores into the twigs of apple, grape, hickory, pear, cherry, etc."

Amphicerus bicaudatus SAY: E. A. Popenoe, List of Kansas Coleoptera, in Transactions of Kansas Academy of Science for 1876, Vol. V, p. 32. "Abundant and troublesome in vineyards, boring in the twigs."

Amphicerus bicaudatus SAY: Dr. G. H. Horn, Revision of the Bostrichidae, Proc. Am. Phil. Soc., Vol. XVII, (1878,) p. 547. "occurs everywhere east of the Rocky Mountains."

Amphicerus bicaudatus SAY: Hubbard & Schwarz, Coleoptera of Michigan, Proc. Am. Phil. Soc., Vol. XVII, p. 638, (Marquette.)

Amphicerus bicaudatus SAY: E. A. Schwarz, Coleoptera of Florida. Proc. Am. Phil. Soc., Vol. XVII, p. 455, (1878,) (Haulover, rare.)

Amphicerus bicaudatus SAY: Zesch & Reinecke, Catalogue of Coleoptera collected in vicinity of Buffalo, N. Y.

Bostrichus bicaudatus: Herbert Osborn, in Trans. Iowa State Hort. Soc., Vol. XIV, 1879, p. 94. Brief description.

Amphicerus, bicaudatus SAY: C. V. Riley, in *American Entomologist,* Vol. III, (1880,) in answer to correspondent reporting great damage to Concord grape vineyard in Nebraska, says: "It is extremely common throughout the Western States, and more often received for identification during the winter and spring months than any other beetle." Referring again to Shimer's note on the food plant of the larva: "While Dr. Henry Shimer found certain larvae in grape canes which he conjectured to be of this species, . . . yet they were doubtless those of an allied beetle (*Sinoxylon basilare* SAY) which I subsequently reared from larvae thus inhabiting grape canes." Same work, p. 108: Reported by T. V. M., Denison, Texas, boring in February in twigs of apple trees.

Bostrichus bicaudatus: G. C. Brackett, Trans. Kas. State Hort. Soc., 14th Annual Meeting, 1880, (1881,) p. 171. Account quoted and figures borrowed from Riley's Fourth Report on Insects of Missouri.

Amphicerus bicaudatus SAY: Mary Treat, Injurious Insects of the Farm and Garden, Orange Judd Co., 1882, p. 145. Account and figures copied from Riley's Fourth Report.

Amphicerus bicaudatus SAY: Wm. Saunders, Insects Injurious to Fruits, Lippincott, 1883, p. 33, (No. 13.) General account of habits of beetle. Figures from Riley's Fourth Report.

Amphicerus bicaudatus SAY: Prof. J. A. Lintner, Second Report of the Injurious and Other Insects of the State of New York, 1885, p. 125. Gives partial bibliography, description, and figures of the beetle and its work, and an account of the habits of the insect so far as known, with inferences as to the life history and breeding habits.

Bostrichus bicaudatus: A. N. Godfrey, Insect Enemies of the Apple, in Trans. Kas. State Hort. Soc., Vol. XV, (1886,) p. 163. Short note on habits, with figure from *American Entomologist,* after Riley. Says that "it is never seriously injurious."

HABITS.*

September 8, 1887, an examination of dead stems of *tamarix*, a flowering shrub of strong growth, but in this locality killing to the ground in severe winters, revealed the work of two beetle larvae unknown to us. The burrows extended lengthwise through tile stems, for the most part through the center, following the line of the slender pith. The larger of the two larvae proved to be the young of the twig borer under consideration.

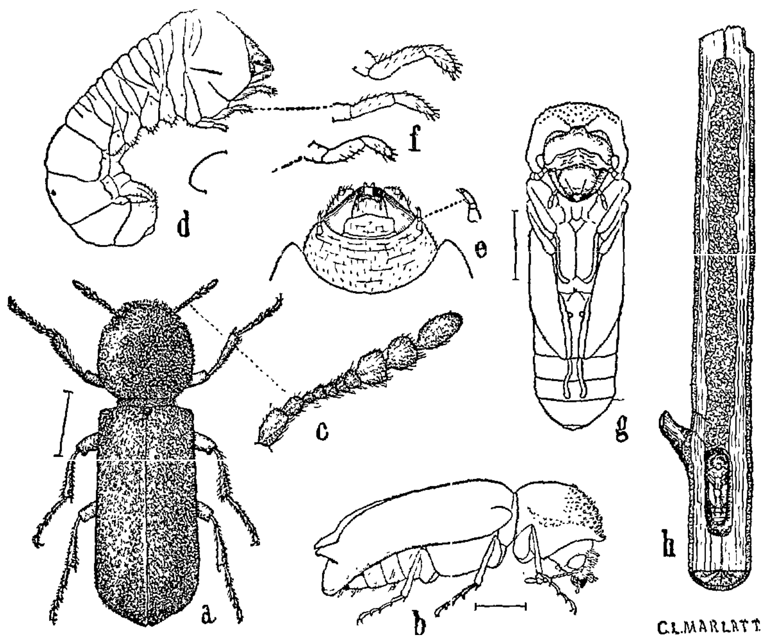


FIG. 1. TRANSFORMATIONS OF THE APPLE-TWIG BORER.
Amphicerus bicaudatus SAY.

The figures, excepting *h*, which is natural size, are enlarged, the hair lines at the side, in *a*, *b*, *d* and *g*, showing the actual size; *a*, the female beetle from above: *b*, outline side view of male beetle; *c*, antenna, showing structure; *d*, full-grown larvae; *e*, head and antenna, and *f*, the right legs of the larva; *g*, front view of pupa, in outline; *h*, twig, showing, above, the larval burrow packed with castings, and below, the pupa in its cell.

* See, also, *Entomologica Americana*, August, 1888, p. 95, where H. G. Hubbard notes the breeding of the larva of *Amphicerus* in dead underground stems of smilax.

Those burrows in which the larvae remained, or in which the pupae were found, were, as is shown in our Fig. 1, *h*, nearly of the same diameter throughout, packed closely with the sawdust-like castings of the larvae, and usually about three and one-half or four inches in extent. The pupa was found in a cell at one end of the burrow; and in one case the adult, alive, was found in the same situation, before the outward passage had been made. Many of the burrows had been already deserted by the beetles, and, in such cases, an opening had been made outward, near the upper end of the pupal cell. This must have been done by the beetle itself, and not by the larva, as the cells containing pupae had no such openings. The usual relation of this opening to the empty pupal cell is indicated by the dotted lines just above the base of the side shoot (Fig. 1, *h*). These openings may be found on any part of the infested stem, and the position in the figured burrow, at the base of the twig, is, of course, accidental.

In the twigs examined at this time, the place of the egg and the beginning of the larval burrow were not made out to a certainty. Indeed, the larval track, to all appearance, had doubled upon itself, and the whole length had been traversed anew by the nearly full-grown larva, the width of the burrow being thus left nearly uniform. This interpretation is strengthened by the finding, in one case, of a partial overlapping of earlier and later made portions of the same burrow.

Certain old vines in the College vineyard, nearly dead from the effects of the summer and winter of 1886–7, were allowed to remain through the summer of 1887, but in most cases failed to recover. On pruning the vineyard, these vines were found, January 26, 1888, to be literally riddled by beetle larvae of several kinds. An examination showed among them three specimens of the larva of *Amphicerus*. The beetles themselves were found alive in numbers in the same vines. Later, during the warm and bright days in early spring, beetles of this species were frequently taken flying. During April and

May many specimens were brought in by neighboring grape growers whose vines they were attacking. As late as the 21st of June they were found, alive, in grape canes.

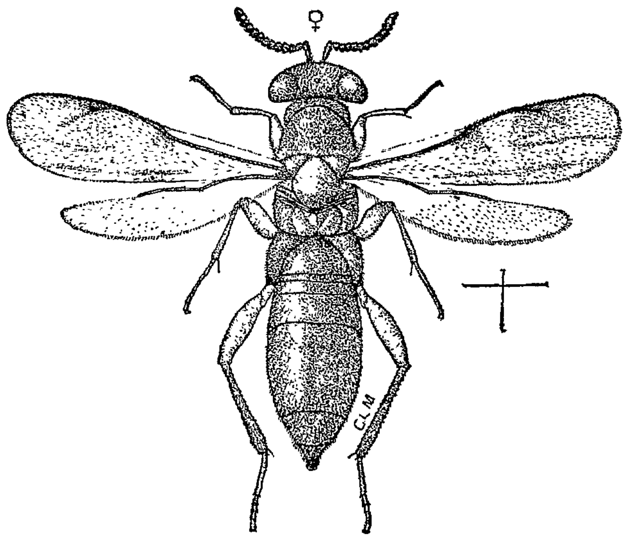


FIG. 2. *Charitopus magnificus* ASHMEAD.

On the 23d of June, examination of the dead stem of tamarix showed the larva, about one-fifth grown, in narrow burrows, some of which had reached the pith, but others being still in the outer layers of the wood. These burrows could be traced backward to their initial point in the bark, but nothing could be discovered as to the probable situation of the egg. From the size and position of these larvae, it is probable that the eggs from which they hatched were deposited early the past spring.

DESCRIPTION OF LARVA AND PUPA.

The larvae, found in connection with pupae and numerous living beetles in the dead stems of tamarix, may be described as follows: Fleshy, curved, whitish grubs (Fig. 1, *d),* measuring, in length, about ten millimeters (.4 inch); head, 1.5 mm. in width. Thoracic region much thickened. Lateral breathing pores minute, and with difficulty seen. Mandibles black, other mouth parts reddish brown; labrum, labium and maxillæ thickly set with brownish hairs; maxillary and labial palpi apparently three jointed (basal tubercle + two joints ?). Antenna reddish brown, four-jointed, basal joint (or basal tubercle ?) stout, second joint small, and when (as in Fig. 1, *e)* not fully extended, projecting about one-half the length of the third joint, which is darker colored, and furnished at tip with a long bristle; last joint short, one-half the diameter of the third.

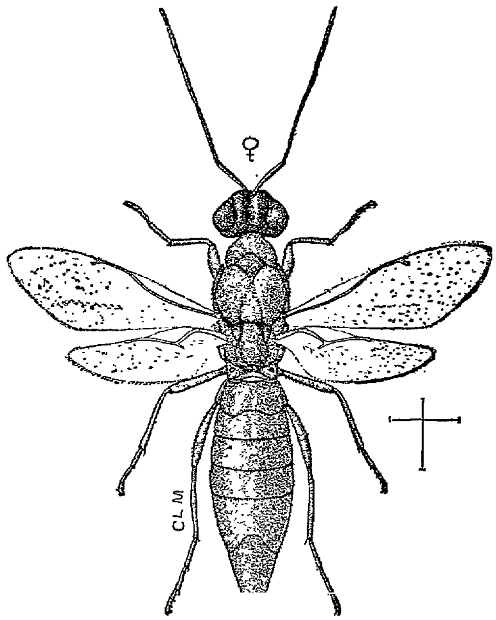


FIG. 3. *Ratzburgia amphicerovora* ASHMEAD.

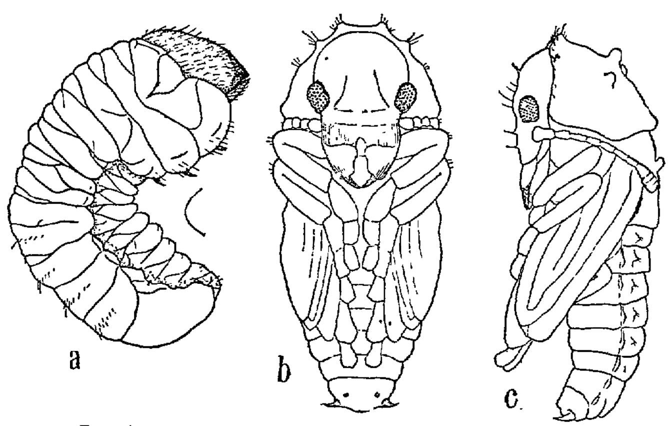


FIG. 4. Larva and pupa of *Anthribus cornutus* SAY.

The pupae (Fig. 1, *g),* of which three perfect and several parasitized specimens were found, all unmistakably referable by form and details of structure to the present species, measure in length 9 mm., in width 2.3 mm. In general color they are reddish brown, the eyes and mandibles black, the tubercles on the projecting front and sides of prothorax dark brown.

PARASITES.

From the parasitized pupae were bred specimens of two hymenopterous parasites which, being not heretofore known, are described as new by Mr. Wm. H. Ashmead, a specialist in this group. The larger of these two flies is a somewhat stout form,* (Fig. 2,) measuring about .3 inch in length, metallic green in color, changing into rich golden green and peacock blue along the sides and base of the thorax, the abdomen blackish toward the tip; the wings, except two smoky bands on each fore wing, perfectly clear and transparent; the legs, excepting their bases, yellowish red. This species merits the specific name applied to it by Mr. Ashmead, for greater magnificence in coloration in so small an insect would be difficult to find. The second form † (Fig. 3) is more slender, but slightly longer, if the short ovipositor be included in the length of the body. This insect is also brightly colored, being generally metallic green, this color shaded with purplish blue across the face, and along the sides of the thorax, the abdomen above suffused with wine purple, the legs yellow. These two species are nearly allied, and belong to the family

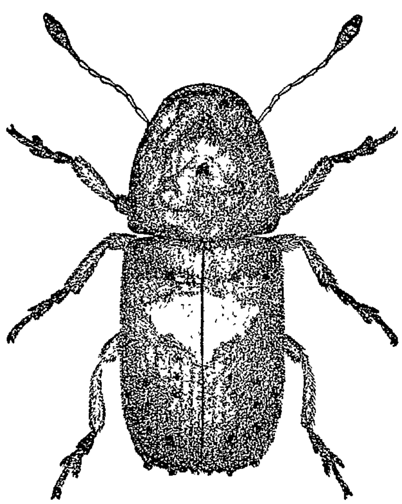


FIG. 5. Adult, *Anthribus cornutus* SAY

* *Charitopus magnificus* ASHMEAD.
† *Ratzburgia amphicerovora* ASHMEAD.

Chalcididæ, a most important group, including a great number of beneficial parasitic insects.

Associated in the tamarix stems with the larvae of the twig borer, were more numerous larvae of a smaller size, and with different characteristics features. These were reared in quantity, and proved to be the larvae of a beetle* quite different from the *Amphicerus,* belonging indeed to a family widely separated from that of the grape vine pest. These smaller larvae (Fig. 4, *a*) are less thickened in the anterior part of the body, have larger heads and shorter legs, and are otherwise readily distinguishable from their less numerous but more important associates, the larvae of the twig borer. The pupa is also quite distinct, (Fig. 4, *b,* front, and *c* side view,) though occupying a cell at the end of a burrow very much like that of the *Amphicerus* pupa. The perfect beetle (Fig 5) measures rather less than one-fourth inch in length, is grayish brown in color, with a broad blotch of cream white upon the middle of the back. This insect is not yet known to be injurious, but its association with the twig borer in this instance makes its history worth noting, as of possible economic interest.

CONCLUSIONS.

It seems to us safe to conclude from the above, that the beetle is single brooded, most of the individuals reaching maturity in the fall and winter, remaining through the latter season in the vines where they were bred, emerging in the spring, and soon after depositing eggs in unhealthy or dead wood in the vineyard and elsewhere, at least two shrubs being known as its food plants. It may also breed in the prunings of the grape which remain unburned over summer, as we have taken the adults in such material under conditions which render this explanation of their presence a most probable one.

The recommendation of Professor Uhler, as before cited, is inapplicable in the light of our observations on the habits of this insect, and seems, indeed, to have been based upon a mis-

* *Anthribus cornutus* SAY.

apprehension of the real method of injury. The usual recommendation, to collect and burn those twigs whose dying points out the insect at work, is good, but by no means sufficient; and while we may not be able to compass the complete suppression of this pest by the careful collection and destruction of all prunings, diseased or dead vines, or their stumps, yet this practice, it seems reasonable, will assist us materially in the attainment of our object.

THE BOX-ELDER BUG.

Leptocoris tririttatus (SAY).

A common hemipter, now generally known by the above name, is apparently becoming more numerous and widespread every year. Where a dozen years ago we found but a few individuals, then in demand with the entomologists of our acquaintance, as cabinet specimens, we now see them by thousands; and from the numerous queries that reach us by letter from different parts of the State, we infer that this bug is everywhere in Kansas about as abundant as it is here.

The species was first described by Thomas Say, in the Journal of the Academy of Natural Sciences, of Philadelphia, for 1825, under the name *Lygæus tririttatus,* from specimens collected by him while with Major Long's expedition to the Rocky Mountains, in 1819-20. The original specimens were from "Engineer Cantonment," a locality frequently noted by naturalists of that day, but now lost from our maps.*

Following are all the references to this insect, that we have been able to find:

Lygæus tririttatus SAY: Collected Writings, ed. Le Conte, Vol. II. p. 226, (1859.) "Engineer Cantonment," "Missouri."

† *Leptocoris tririttatus* SAY: Stal, Enumeration Hemipterorum, I, p. 226, (1870.) "Mexico; Missouri."

Leptocoris tririttatus SAY: Uhler, in Hayden's Report on the Geological Survey of Montana, (1871.) p. 404. "A common species in Colorado, Arizona and California."

*"Engineer Cantonment" was situated in what was then the "Missouri" country. Its location, in what is now the State of Nebraska, was a few miles above the present site of Omaha, on the west side of the Missouri river.

† The genus *Leptocoris* was founded by Dr. Hahn, in 1831, upon a Brazilian insect, and described in his work upon "Die Wanzenartigen Insecten," Vol. I, page 200. Our species seems to have been referred for the first time to this genus by Dr. Stal in the "Enumeratio Hemipetrorum" as above cited.

Serinetha trivittata SAY: Walker, Catalogue of the Hemiptera Heteroptera in the British Museum, Supplement, p. 40, (1873.) "Mexico."

Leptocoris trivittatus SAY: Uhler, List of the Hemiptera of the Region west of the Mississippi River, Hayden's Bulletin, No. 5, 2d series, p. 301, (1875.) "Inhabits Colorado, Arizona, San Francisco, California, Kansas, Missouri and Mexico."

Leptocoris trivittatus SAY: Uhler, in Hayden's Bulletin, Vol. III, No. 2, p. 408. (1877.) Not common in Colorado; occurred at Canon City, at the roots of cacti and yuccas. (Uhler.) American Fork Canon, Utah. (Packard.)

Leptocoris trivittatus SAY: Popenoe, in *Industrialist,* Vol. V, No. 47. (1880.) Notes on habits and suggestions as to the destruction of the bugs.

Leptocoris trivittatus SAY: Popenoe, in *Industrialist,* Vol. VI, No. 31. (1881.) Notes on habits.

Leptocoris trivittatus SAY: Distant, in Biologia Centrali-Americana: Rhynchota, p. 172. (1882.) "North America, Mexico."

Leptocoris trivittatus SAY: Uhler, Checklist of the Hemiptera Heteroptera of North America, p. 13, No. 606. (1886.)

Leptocoris trivittata: Riley, in Miscellaneous Notes on the Work of the Division of Entomology for the Season of 1885. Figured in Plate 1, Fig. 5. (Bulletin No. 12, Division of Entomology, U. S. Dept. of Agriculture, 1886.) Injurious habits noted; remedies suggested.

HABITS.

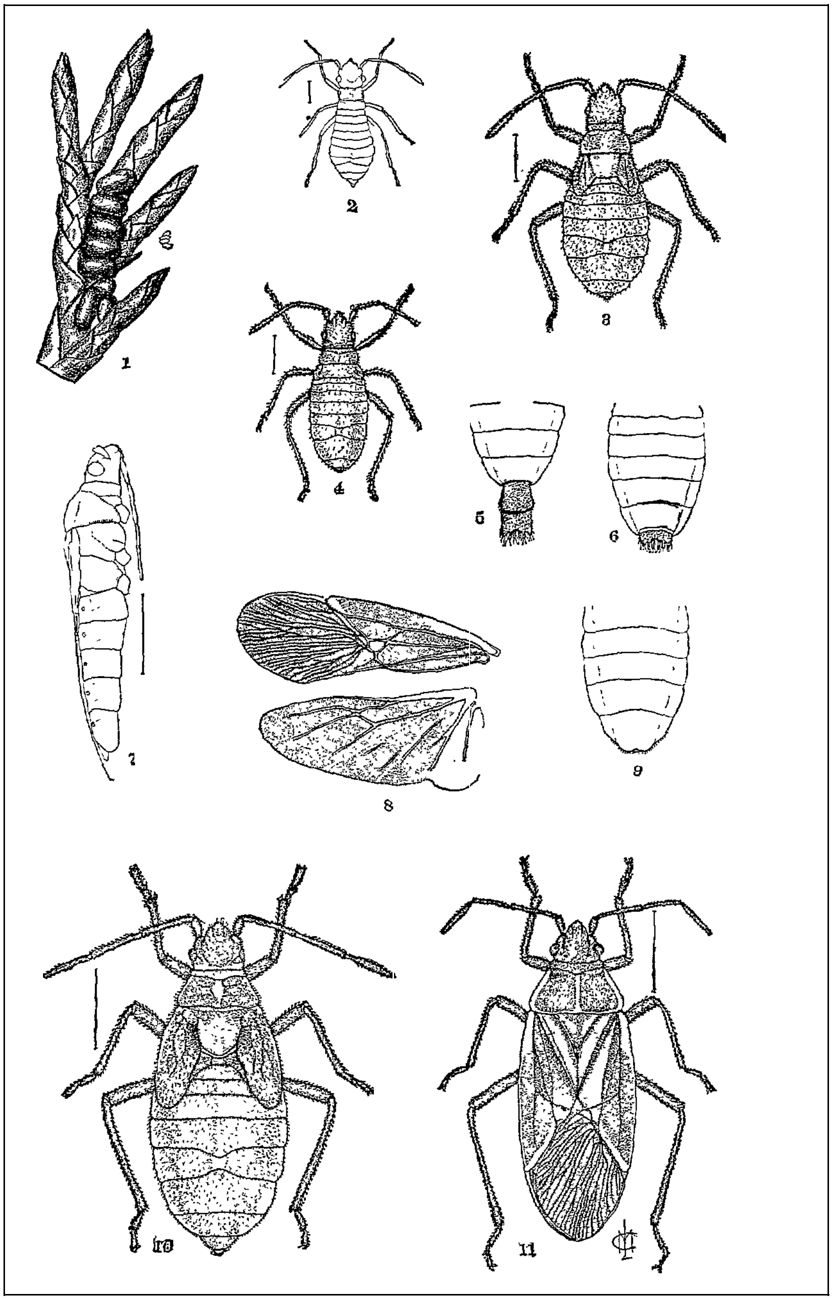
This species has been known in this locality for over ten years as a tree pest, appearing at times in great numbers upon the box elder, and occasionally attacking the ash. During the winter, the adults are hidden in sheltered nooks and corners everywhere, but are especially abundant in crevices of stone walls and the angles of stone buildings, on the south sides of which they appear, singly and in clusters, every warm day during the season. As soon as the increasing warmth of spring allows, they leave these shelters and seek the trees attacked by them. From the time of their scattering in spring until the appearance of the first adults after midsummer, they are much less conspicuous, and are not likely to be noticed except upon search directly for them. It is at this time, however, that their eggs are laid, * and the numerous young are hatching and beginning their work on the trees. After midsummer, their gregarious tendency is manifested in the flocking of bugs of all sizes and

*In creases of the bark, on the trunk, and also upon the twigs of the trees attacked, as well as occasionally on the bark, twigs and leaves of other trees.

in great numbers in lines up and down the trunks and branches of the trees. Not infrequently they may be seen crowded in a broad line extending from the ground to the secondary branches, the company including larvae of all sizes, pupae, and fully matured individuals. This habit persists more or less completely until October and November, or until the trees are bare. During the warm days of Indian summer the bugs fly everywhere, flocking to the warm sides of buildings, and entering houses, where, though otherwise harmless, they become troublesome through their abundance and through their propensity to fall clumsily into pails of water, crocks of milk and other articles of food left uncovered.

They are principally found, as stated, upon box elder trees, but observation shows them to be much more general in their selection of food plants. They feed also on the ash, and I have observed them in abundance sucking the sap from the ampelopsis clinging to the south side of a stone building. Into the greenhouse many make their way during the autumnal flight, and such are specially fortunate; for they find there not only the desired warm shelter, but abundance of food as well. They are not slow to test the qualities of the juices of the plants growing in the house, and we have seen them with beaks inserted in the stems of geraniums, cactuses, lilies, coleus, ageratums, and other plants.

Personally we have observed no great variations from the general habits above set forth, but would call attention to the very important observations of Mr. A. L. Siler, Ranch, Utah, communicated to Prof. Riley, and by him published in Bulletin No. 12 of the Entomological Division, U. S. Department of Agriculture. This communication charges these bugs with "destroying the fruit crop, eating the fruit as fast as it ripened. On one tree which Mr. Siler examined, and which bore apples of a medium size, they were present in enormous numbers, and every apple that he could see was covered with the bugs. They were stated to have bred on the box elder shade trees *(Negundo aceroides).*"



EXPLANATION OF PLATE.

Leptocoris trivittatus. Fig. 1. A twig of red cedar, with eggs, greatly enlarged, the natural size of the eggs shown by the outline at the right. Fig. 2. The larval bug in its first stage. Figs. 4 and 3. Same at later stages in order. Fig. 10. Pupa. Fig. 11. Adult bug. Fig. 7. Side view of body, showing characteristic structure. Fig. 8. The upper and lower wings. Fig. 9. The abdomen of female. Figs. 5 and 6. Abdomen of male. (From drawings by C. L. Marlatt.)

DESCRIPTION.

The following description is drawn up from the examinations of numerous specimens, and, in connection with the figures on the plate illustrating this article, will be found sufficient for the identification of the species in all its stages.

The color in the earlier stages of the insect is nearly uniform, varying slightly in different individuals and ages from orange scarlet to a deeper or blood red. Specimens of the youngest larvae are of the form shown in Fig. 2, and uniform red throughout. Succeeding stages, shown in Figs. 4 and 3 in the order of growth, have the same body color, with the tip of the beak, the tarsi and the tibiae obscured with brownish shadings. The full grown pupa (Fig. 10), of the same red color, has the inner edges of the wing pads a decided brownish black, shading outwardly into the pure red of the exterior; the feet and beak more distinctly brown than in Fig. 3: a narrow, median, yellowish white line along the back, expanding on the contracted fourth abdominal segment into an oval patch. A trace of this line is observed in the earlier stages. The adult, shown in Fig. 11, measures 10-14 millimeters (.4–.6 inch) in length, and, when fully colored, is dull black, marked with orange scarlet. The head is dull black, with the eyes and ocelli deep blood red; the prothorax black, with a median and two lateral lines, and usually the posterior margin narrowly, red; the remaining upper parts, when the wings are folded, appear dull black, except the tip of the scutel, the exterior margin of the wing, and the oblique tip of the thicker basal portion of the wing, which are red, the red exterior margin of the wings being broad at the shoulder and abruptly narrowed to a line behind this. In some specimens, two or three prominent veins and the scutellar margin of the wing are also red. Under the wings, the dorsal surface of the abdomen is red, with two rows of black spots. Beneath, the thorax is black, the coxæ red; the abdomen red, with a broad black line on each side from base to the terminal segment, which is entirely black.

The male is distinguished by the usually narrower abdomen

(Fig. 6) and by the curiously lobed extensile tip of that part (Fig. 5), the corresponding part of the female being rounded (Fig. 9).

SUGGESTED REMEDIES.

The well known habit of these bugs, of assembling in numbers together upon the tree trunks or upon the sides of buildings, renders their destruction a matter of comparative ease by any of the simple methods employed against insects of their order. If no better means of killing them is at hand, they may even be destroyed, especially while yet immature, by brushing them off the tree with a coarse, stiff broom. Where no danger of injury to the tree is apprehended, they may be killed by scalding water, or by an application of kerosene and water, as recommended for the destruction of other insects. From the fact that they feed upon plant juices by means of a beak, it will be seen that it is useless to attempt to kill them by the application of direct poisons like Paris green, as some of our correspondents have suggested.

GARDEN TRIALS OF VEGETABLES.

POTATOES

The ground selected for the trial of potatoes was bottom land, which had been a blue grass sod for several years, the soil being a rich black loam. This was broken up in the summer of 1887 and remained in that condition till April, when it was replowed three inches deeper. It was then well pulverized with harrow and roller, and the rows furrowed out with a common stirring plow. The seed of each lot being cut to single eyes, the pieces were dropped twelve inches apart and covered as nearly four inches deep as possible with the hoe. Each lot was marked by a stake bearing the list number and a zinc label with the name and source of the seed. The planting was begun Saturday, May 12, and finished the following Monday.

The following table gives a list of varieties tested, the source of each lot, the total product in pounds and ounces, and the percentage of potatoes of marketable size. Up to No. 112, but a single tuber of each variety was planted; of the remainder of the list, a pound of each. Numbers 170 to 191, inclusive, were from seed raised by the Horticultural Department of this College. As the product in some cases was from a single tuber and in others from a pound of seed, no account being kept of the number of eyes these furnished, the data given on this point are not properly open to comparison.

The observations on the time of ripening were made almost wholly from the ripening and dying of the vines.

The descriptive notes upon the several lots must be held as applying only in the present trial. In the list, " Stine" refers to E. R. Stine, Cuyahoga Falls, Ohio; "Bouk" to James W. Bouk, Greenwood, Cass Co., Nebraska; "Burpee" to W. Atlee Burpee & Co., Philadelphia; "Bassler" to Bassler Brothers, Manhattan, Kas.; "Hort. Dept." to Horticultural Department, Kansas Agricultural College: "Everitt" to J. A. Everitt & Co., Indianapolis, Ind.: "Thorburn" to James M. Thorburn & Co., New York.

No.	Source of seed.	VARIETIES.	GROSS WEIGHT.		Percentage of marketable tubers.
			Lbs.	Oz.	
1	Stine	Advance	....	14	0
2	Stine	Agnoth's Favorite	5	9	62
3	Stine	Akron	2	13	31
4	Stine	Bermuda	5	14	59
5	Stine	Bermuda Pink Blossom	1	14	93
6	Stine	Boston Cracker	....	15	0
7	Stine	Boston Market	11	2	93
8	Stine	Bonton	9	12	78
9	Stine	Breese (no product)	....	....	......
10	Stine	Brigham's Seedling	2	12	84
11	Stine	Canfield's Seedling	5	12	57
12	Stine	California Rose	10	2	88
13	Stine	Cap Sheaf	8	12	86
14	Stine	Cayuga	8	0	96
15	Stine	Champion of America	6	14	81
16	Stine	Chenango	1	5	86
17	Stine	Chicago Sun	8	8	87
18	Stine	Cook's Superb	8	10	90
19	Stine	Cow Horn (no product)	....	....	......
20	Stine	Cowle's Seedling	8	4	83
21	Burpee	Coy's Seedling	13	14	84
22	Stine	Cuyahoga	8	8	93
23	Stine	Durham	9	2	92
24	Stine	Davis' Seedling	2	2	85
25	Stine	Early Electric	6	12	86
26	Stine	Early Hancock	6	4	81
27	Stine	Early Harvest	4	12	83
28	Stine	Early Howard	6	2	84
29	Stine	Early Modena	1	3	63

No.	Source of seed.	VARIETIES.	GROSS WEIGHT.		Percentage of marketable tubers.
			Lbs.	Oz.	
30	Stine	Early Perfection	6	0	79
31	Stine	Early Sun	7	12	81
32	Stine	Early Telephone	2	12	77
33	Stine	Early Prolific	5	0	87
33½	Stine	Early Washington	7	12	58
34	Stine	El Paso	5	3	78
35	Stine	Eureka	2	4	78
36	Stine	Farina	2	12	77
37	Stine	Gilead Red	5	4	83
38	Stine	Globe	6	7	88
39	Stine	Golden Age	....	13	0
40	Stine	Great Eastern	7	10	86
41	Stine	Green Mountain (no product)	....	....	......
42	Stine	Improved Irish Cup	4	12	64
43	Stine	Irish Cup	3	1	82
44	Stine	Jordon's Prolific	9	1	93
45	Stine	Jumbo	5	7	89
46	Stine	Knapp's Snowbank	11	0	95
47	Stine	King's Excelsior	12	0	86
48	Stine	Ladies' Favorite	3	14	69
49	Stine	Lady Finger	2	4	67
50	Stine	Late Beauty of Hebron	7	4	84
51	Stine	Late Ohio	9	0	97
52	Stine	Late Snowflake	9	0	94
53	Stine	Lion	1	6	0
54	Stine	Lombard	3	4	87
55	Stine	Magic	9	0	80
56	Stine	Matchless	3	0	73
57	Stine	Mug White	5	8	90

No.	Source of seed.	VARIETIES.	GROSS WEIGHT. Lbs.	GROSS WEIGHT. Oz.	Percentage of market-able tubers.
58	Everett	Moore's Dakota Seedling	....	14	0
59	Stine	Morning Star	4	8	78
60	Stine	Murray's Goldflake	10	6	95
61	Stine	New Eximus	9	0	97
62	Stine	New Queen	7	2	75
63	Stine	Newton	4	6	81
64	Stine	New York State	2	4	72
65	Stine	New Zealand	7	12	94
66	Stine	Ohio Fancy	1	2	0
67	Stine	Peachblow	....	15	0
68	Stine	Pootatuck	6	6	86
69	Stine	Prairie Farmer	3	0	48
70	Stine	Pride of Ireland	3	10	79
71	Stine	Pride of Japan	3	14	91
72	Stine	Pride of the West	2	2	91
73	Stine	President Cleveland	6	0	85
74	Stine	Purple Blush	3	8	63
75	Stine	Queen of the Roses	2	12	84
76	Stine	Red Astrachan	1	13	66
77	Stine	Red Elephant	6	4	76
78	Stine	Rocky Mountain Rose	7	6	83
79	Stine	Rogers' No. 4	6	8	85
80	Stine	Rose's No. 76	2	4	92
81	Stine	Rose's Seedling	5	5	86
82	Thorburn	Rural New Yorker No. 2	5	8	85
83	Stine	Seek No Further	4	6	100
84	Stine	Seneca Chief	1	12	68
85	Stine	Snowflake	2	14	52
86	Stine	Stanton	1	10	38

No.	Source of seed.	VARIETIES.	GROSS WEIGHT.		Percentage of market-able tubers.
			Lbs.	Oz.	
87	Stine	State of Maine................................	7	12	89
88	Stine	Sterling	1	11	74
89	Stine	Steuben Beauty................................	6	10	81
90	Stine	Stray Beauty (no prod c:).................	....	....	......
91	Stine	Superb Beauty..................................	6	12	71
92	Stine	Sunlit Star.......................................	6	14	84
93	Stine	Tunxis...	1	10	54
94	Stine	Tremont..	3	2	70
95	Stine	Vermont Champion..........................	6	8	92
96	Stine	Victor	6	4	87
97	Stine	Wall's Orange..................................	6	3	53
98	Stine	Weld's No. 1....................................	5	4	93
99	Stine	Weld's No. 4....................................	3	8	89
100	Stine	Weld's No. 14..................................	6	14	81
101	Stine	Wells' Seedling................................	1	14	70
102	Stine	White Beauty of Hebron...................	2	15	81
103	Stine	White Mercer...................................	1	12	50
104	Stine	White Lily	1	14	93
105	Stine	White Seedling................................	2	9	21
106	Stine	White Whipple.................................	4	4	50
107	Stine	White Prolific..................................	4	1	85
108	Stine	Winston's Seedling..........................	2	12	64
109	Stine	Wood Ants......................................	3	13	77
110	Stine	Woodbury's White Sport..................	8	0	87
111	Stine	Yankee Notion.................................	2	10	60
112	Stine	Yosemite...	6	6	37
113	Stine	American Giant................................	25	10	89
114	Stine	Beauty of Beauties...........................	30	10	89
115	Bouk	Beauty of Beauties...........................	27	9	81

No.	Source of seed.	VARIETIES.	GROSS WEIGHT.		Percentage of marketable tubers.
			Lbs.	Oz.	
116	Stine	Beauty of Hebron	26	....	74
117	Stine	Beauty of Sheba	46	10	94
118	Stine	Belle	36	6	88
119	Stine	Burbank	27	....	78
120	Stine	California Red	16	1	72
121	Stine	Charles Downing	12	9	71
122	Stine	Charter Oak	15	10	57
123	Stine	Chicago Market	19	14	82
124	Stine	Clark's No. 1	13	5	84
125	Stine	Dakota Red	14	13	72
126	Stine	Dictator	23	11	87
127	Stine	Dunmore	27	4	89
128	Bouk	Earliest and Best	8	6	81
129	Stine	Early King	24	1	85
130	Stine	Early Ohio	19	13	72
131	Stine	Early Queen	10	....	77
132	Stine	Early Rose	16	3	85
133	Stine	Early Sunrise	20	4	86
134	Stine	Empire State	11	9	59
135	Stine	Fearnaught	16	4	92
136	Stine	Garfield	19	14	80
137	Stine	Hampden Beauty	31	....	79
138	Stine	Hawkeye	39	7	93
139	Stine	Junkis	24	3	83
140	Stine	La Fayette	9	12	62
141	Stine	Lee's Favorite	9	4	61
142	Stine	Magnum Bonum	21	10	89
143	Stine	Mammoth Pearl	19	5	83
144	Bouk	Mammoth White Chief	17	2	84

No.	Source of seed.	VARIETIES.	GROSS WEIGHT.		Percentage of market-able tubers.
			Lbs.	Oz.	
145	Stine	Mayflower	18	6	69
146	Bouk	McFadden's Favorite	4	13	64
147	Stine	O. K. Mammoth	25	0	86
148	Bouk	Ohio Junior	18	2	78
149	Stine	Pearl of Savoy	23	0	80
150	Stine	Perfect Peachblow	28	2	80
151	Stine	Pride of Nebraska	2	2	0
152	Stine	Queen of the Valley	13	14	72
153	Stine	Red King's	17	7	86
154	Stine	Red Star	16	1	91
155	Stine	Rochester Favorite	29	8	84
156	Stine	Rose's No. 4	13	1	81
157	Stine	Rundel Rose	18	13	86
158	Stine	Rural Blush	19	8	90
159	Stine	Scotch Gray	30	2	91
160	Stine	Snowdrop	29	8	94
161	Stine	State of Maine	24	12	91
162	Stine	Saint Patrick	23	14	76
163	Stine	Summit	18	8	78
164	Bouk	Sunrise	9	2	75
165	Stine	Vanguard	25	6	86
166	Stine	Vick's Gem	19	10	87
167	Stine	Watson's Seedling	20	4	83
168	Stine	White Elephant	23	4	88
169	Stine	White Prize	26	10	86
170	Stine	White Star	19	8	86
171	Hort. Dept.	Alexander's Prolific	17	12	86
172	Hort. Dept.	American Giant	11	12	77
173	Hort. Dept.	Beauty of Hebron	24	15	81

No.	Source of seed.	VARIETIES.	GROSS WEIGHT. Lbs.	GROSS WEIGHT. Oz.	Percentage of market-able tubers.
174	Hort. Dept..	Burbank's Seedling	23	2	81
175	Hort. Dept..	Chicago Market	14	....	69
176	Hort. Dept..	Clark's No. 2	18	6	81
177	Hort. Dept..	Dakota Red	23	1	81
178	Hort. Dept..	Early Maine	28	4	81
179	Hort. Dept..	Early Harvest	12	4	74
180	Hort. Dept..	Early Sunrise	11	4	54
181	Hort. Dept..	Early Ohio	21	2	71
182	Hort. Dept..	Empire State	37	6	82
183	Hort. Dept..	Great Eastern	26	10	86
184	Hort. Dept..	Hale's Early Peachblow	5	14	89
185	Hort. Dept..	Pearl of Savoy	13	4	65
186	Hort. Dept..	Polaris	29	12	78
187	Hort. Dept..	Queen of the Valley	5	12	78
188	Hort. Dept..	Snowflake	12	4	74
189	Hort. Dept..	The Thorburn	9	11	57
190	Hort. Dept..	Vick's Extra Early	15	1	38
191	Hort. Dept..	White Elephant	17	12	85
192	Bassler	Early Ohio (Kansas seed)	16	....	81
193	Bassler	Early Ohio (Iowa seed)	13	8	68
194	Bassler	Early Ohio (Dakota seed)	10	4	51

NOTES ON VARIETIES.

No. 1, *Advance.* Vines short, slender, upright; leaflets small, rough, dark green; tubers small, oval, pale rose; eyes very small, shallow. Ripened late in October.

No. 2, *Agnoth's Favorite.* Vines small; leaflets medium sized, light colored; tubers medium sized, oblong, flattened; skin smooth, yellow; eyes of medium size and rather shallow. A late sort, ripened in October.

No. 3, *Akron.* Vines short, vigorous; leaflets five to seven, terminal one large and broad: tubers small, nearly cylindrical, two to three inches long, one inch in diameter; skin smooth, pale rose; eyes numerous, small, shallow. Ripened in October.

No. 4, *Bermuda.* Vines of medium growth; tubers of medium size, roundish, smooth, fine; eyes small, few, shallow. Ripened the last of September.

No. 5, *Bermuda Pink Blossom.* Vines of small, slender growth; in bloom July 5th: tubers small, irregular, oblong: skin slightly rough, pale rose, a shade deeper around the eyes, which are small, usually shallow, and not numerous; flesh of a yellowish tint. Ripened in October.

No. 6, *Boston Cracker.* Vines small, slender; tubers small, roundish, flattened: skin roughened, yellow; eyes of medium size, rather deep; flesh firm. Yield very scant and poor. Ripened the first of September.

No. 7, *Boston Market.* Vines rank and vigorous; in bloom June 28: tubers medium to large, long oval, flattened, somewhat irregular; skin smooth, rose colored; eyes of medium size, shallow. Ripened the last of September.

No. 8, *Bonton.* Vines of medium habit; tubers large, roundish, irregular; skin rough, yellow; eyes few, large, shallow; flesh white, firm. A handsome variety. Ripened in October.

No. 9, *Breese.* Vine of medium strength and vigor. No product recorded.

No. 10, *Brigham's Seedling.* Vines slender, upright; leaves long, leaflets numerous and small; tubers medium in size, oblong, flattened, irregular: skin smooth, red mottled with yellow, especially around the stem; eyes rather small, shallow. Ripened in October.

No. 11, *Canfield's Seedling.* Vines small, slender; tubers of medium size, oblong, flattened; skin smooth, pale yellow; eyes small, shallow; flesh white, firm, fine grained. Ripened in October.

No. 12, *California Red*. Vines compact, vigorous, dark colored, leaflets small; in bloom July 5th; tubers large, oval or oblong, mostly flattened; skin slightly rough, rose colored; eyes large, rather deep; flesh white. Produced but few tubers of good market quality. Ripened late in September.

No. 13, *Cap Sheaf*. Vines of medium size, upright, vigorous; tubers large, irregular, ovate or oblong, slightly flattened; skin smooth, reddish yellow, deepening to red about the eyes, which are medium in size and rather deep; flesh firm, white, fine grained. Ripened the last of September.

No. 14, *Cayuga*. Vines of medium strength; bloom July 4; tubers, large, irregular, branched; skin slightly rough, yellow; eyes medium size shallow. Some tubers found to be rotten at the tips in storage, Jan. 15. Ripened the last of September.

No. 15, *Champion of America*. Vines of medium size, vigorous; tubers medium sized, oval, flattened, somewhat irregular; skin smooth, rose colored; eyes few, shallow. Ripened in October.

No. 16, *Chenango*. Vines small, slender; tubers small, irregular, oblong, often larger at the stem; skin smooth, purple splashed with rose; eyes small and of medium depth; flesh firm, decidedly yellow. Too small to be of great market value. Ripened in October.

No. 17, *Chicago Sun*. Vines of average size and vigor; bloom July 5; tubers small or medium in size, irregular, branched; flesh soft and watery; found to be rotten at the tips, when examined in storage, January 12; color yellow, skin smooth; eyes small and shallow. Ripened in October.

No. 18, *Cook's Superb*. Vines medium sized and vigorous; tubers large, roundish or angular; skin smooth, yellow; eyes large, shallow. A handsome, even sized, late potato. Ripened in October.

No. 19, *Cow Horn*. Vines medium, erect, purplish; leaves long, leaflets small; tubers small, purple, curved. No product of any value.

No. 20, *Cowle's Seeding.* Vines strong, vigorous; bloom white, June 27; tubers medium or large, irregular and uneven in size; skin smooth, yellow; eyes large and of medium depth. Ripened middle of September.

No. 21, *Coy's Seedling.* Vines strong, vigorous; bloom July 5; tubers large, long, round in cross section, somewhat irregular; color yellow; eyes small, shallow, numerous. A few tubers scurfy. Ripened in October.

No. 22, *Cuyahoga.* Vines rank; bloom white, June 27; tubers medium to large, long, irregular, branching; color purplish red; eyes large, prominent and numerous. Ripened first of September.

No. 23, *Durham.* Vines large, vigorous; bloom white June 27; tubers large, long irregular; skin smooth, pale red; eyes large prominent numerous. Ripened first of September.

No. 24, *Daris' Seedling.* Vines low, compact, dark green; tubers small, oval, somewhat irregular; color deep rose, with eyes darker; eyes small, deep. Ripened in October.

No. 25, *Early Electric.* Vines large and vigorous; bloom white, June 27; tubers of medium size, long, round or branched and irregular; skin rough, pale red; eyes of medium size, prominent and numerous; flesh yellow. Ripened last of August.

No. 26, *Early Huncock.* Vines stocky, vigorous; bloom white, June 27; tubers of medium size, oval flattened, irregular: skin smooth, or rarely scurfy; eyes small, shallow, numerous; flesh yellow. Ripened last of September.

No. 27, *Early Harvest.* Vines strong, vigorous; bloom white. June 27 tubers medium sized, oblong or ovate, flattened; skin smooth, pale rose; eyes rather large, shallow; flesh yellowish, inclined to be watery. Ripened middle of September.

No. 28, *Early Howard.* Vines rank, vigorous; bloom white, June 27; tubers of medium size, oblong or ovate, sometimes slightly flattened; skin smooth, dull yellow, with a faint rose tint; eyes medium sized, often deep; flesh inclined to be watery. Ripened first of September.

No. 29, *Early Modena*. Vines small, weak, slender; tubers small oblong or irregular; skin smooth, yellow; eyes few, small. Product small, of uneven tubers. Of little value. Ripened first of October.

No. 30, *Early Perfection*. Vines of medium size and vigor; tubers large, irregular, cracked and knotty; skin smooth, pale rose, a deeper shade around the eyes; flesh yellowish, rather coarse and watery. Ripened last of September.

No. 31, *Early Sun*. Vines large and vigorous; bloom white, June 27; tubers medium or large, oblong, irregular; skin smooth, pale rose; eyes small, rather deeply set. Ripened last of September.

No. 32, *Early Telephone*. Vines small, slender; tubers medium or large, ovate or oblong, elongated and irregular; skin slightly rough and wrinkled, pale rose color; eyes rather numerous, large, and often deeply set; flesh firm, white. Ripened the last of September.

No. 33, *Early Prolific*. Vines tall, rank; in bloom July 5; tubers of medium size, oval, flattened; skin smooth, rose color: eyes few, rather large; flesh yellowish, firm. Ripened in October.

No. 33½, *Early Washington*. Vines rank, vigorous; tubers medium in size, of irregular form; skin rough, yellow; eyes of medium size and depth. Ripened the first of September.

No. 34, *El Paso*. Vines large, rank; bloom purple, July 5; tubers of medium size, roundish or oblong, irregular; skin slightly rough, light yellow; eyes of average size and depth. Ripened middle of September.

No. 35, *Eureka*. Vines of medium strength and vigor; tubers small, oval, flattened; color russet yellow; eyes few, of medium size, shallow; flesh white, fine grained, firm. Ripened in October.

No. 36, *Farina.* Vines of low, compact, vigorous habit; tubers small, two to four inches long, one inch in diameter, slightly flattened; skin smooth yellow; eyes few, very small and close to the surface; flesh yellowish, fine grained. Ripened in October.

No. 37, *Gilead Red.* Vines of medium size, with purplish stems; in bloom July 5; tubers of medium size, roundish or oblong, slightly flattened; skin wrinkled, grayish red; eyes few, very small and shallow; flesh white, fine grained, not quite firm. Ripened last of September.

No. 38, *Globe.* Vines strong, vigorous; bloom white, June 27; tubers of medium size, oval or ovate, flattened; skin smooth, pale rose color; eyes small, of average number. Ripened the last of September.

No. 39, *Golden Age.* Vines small, weak, slender; in bloom July 5. No product recorded.

No. 40, *Great Eastern.* Vines rank and coarse; tubers large, oval or oblong, slightly flattened; skin smooth, yellow; eyes large, prominent, shallow; flesh white, firm. A superior lot. Ripened in October.

No. 41, *Green Mountain.* Vines erect, slender; in bloom July 5. No product recorded.

No. 42, *Improved Irish Cup.* Vines rank, vigorous; stems dark purple; tubers small to medium, long oval, flattened; skin smooth purple; eyes of medium size, not deep. Ripened first of October.

No. 43, *Irish Cup.* Vines short, slender, with purple stems; tubers small, roundish, flattened, somewhat irregular; skin smooth deep red; eyes few, small, deeply sunken; flesh yellowish, fine grained, firm. Ripened in October.

No. 44, *Jordon's Prolific.* Vines of medium strength and size: tubers medium to large, oblong, irregular, flattened; skin smooth yellow; eyes rather numerous, small, and of medium depth; flesh yellowish. Ripened in October.

No. 45, *Jumbo.* Vines strong; tubers large, long, rough, knotted and irregular, tapering toward the stem; skin smooth, yellow; eyes small, of medium depth; flesh white, coarse grained and not firm. Ripened in October.

No. 46, *Knapp's Snowbank.* Vines medium, vigorous; tubers large, roundish or oval; skin smooth, yellow; eyes few, large but shallow; flesh white, firm; tubers even in size and handsome. Ripened in October.

No. 47, *King's Excelsior.* Vines of average size and strength; tubers of medium size, long, branching and irregular; skin smooth, yellow; eyes small, numerous; flesh watery, poor. Ripened in October.

No. 48, *Ladies' Favorite.* Vines of medium height, rather slender; tubers of medium size, oval; skin yellow; eyes small, shallow, few. Ripened middle of September.

No. 49, *Lady Finger.* Vines small, delicate; leaflets small; tubers two to three inches long, one inch in diameter; skin nearly white; eyes small, numerous, deep, giving the tuber a rough appearance. Ripened in October.

No. 50, *Late Beauty of Hebron.* Vines of rank, vigorous habit; bloom white, June 27; tubers medium in size, oblong, flattened, irregular; skin smooth, pale yellow; eyes of average number and size. Ripened in October.

No. 51, *Late Ohio.* Vines of medium strength; tubers large, oblong, sometimes flattened, surface very irregular; the eyes depressed and large; skin smooth, rose color, a deeper shade at seed end; flesh firm, white, fine grained. Ripened last of September.

No. 52, *Late Snowflake.* Vines of medium growth; tubers large, oval or oblong, flattened; skin slightly rough, yellow; eyes few, of average size and depth; flesh firm, white. Ripened middle of September. A fine, even lot.

No. 53, *Lion.* Vines rank and late; stem purplish; tubers small, roundish, flattened; skin smooth, purplish red; eyes few, small and rather deep; flesh decidedly yellow. Ripened first of October.

No. 54, *Lombard*. Vines of low, compact habit; tubers large, roundish or oval; skin smooth, yellow; eyes few, large and shallow; flesh firm, white. Ripened first of October.

No. 55, Magic. Vines large, rank; bloom white, June 28; tubers medium sized, roundish, elongated; skin smooth, yellow; eyes of average size and number, shallow. Ripened first of September.

No. 56, *Matchless*. Vines of medium size and strength; tubers medium in size, roundish or elongated slightly flattened; skin yellow, with a trace of red at seed end; eyes few, small and shallow. Produced a few very fine tubers, but the greater number were small. Ripened in October.

No. 57, *Mug White*. Vines of medium size; tubers large, roundish, somewhat angular; skin smooth, light yellow; eyes few, of medium size, shallow; flesh firm, white. Ripened in October. A handsome and even product.

No. 58, *Moore's Dakota Seedling*. Vines small, weak, slender, stems purple: tubers small, round, elongated; skin rose colored, cracked, rough and scurfy. None of the tubers of market value. Ripened or died first of September.

No. 59, *Morning Star*. Medium sized vines; tubers of medium size, oval or long pear shaped, flattened; skin smooth, yellow; eyes few, small, shallow; flesh fine grained, firm, white. A few fine tubers, but the product mostly rough. Ripened in October.

No. 60, *Murray's Goldflake*. Vines of medium strength; tubers medium to large, oval or inclined to oblong, somewhat flattened and irregular; color a russety yellow; eyes large, few, shallow. Ripened first of October.

No. 61, *New Eximus*. Vines rather short and stocky; tubers medium to large, roundish or oblong, flattened; skin smooth, yellow; eyes few, large; flesh fine grained, firm, white. Majority of the lot handsome, salable tubers. Ripened in October.

No. 62, *New Queen*. Vines of tall, strong habit; bloom white, June 27; tubers large, long, irregular or branching, uneven; skin smooth, yellow; eyes of medium size, not very deep. Ripened first of September.

No. 63, *Newton.* Vines of medium size and vigor; bloom, white, June 27; tubers small to medium in size, irregular, branching, uneven; skin smooth, rose color; eyes of average size and depth. Ripened first of October.

No. 64, *New York State.* Medium sized vines; bloom white, June 27; tubers medium size, oval or oblong, flattened; skin smooth, yellow; eyes small, rather deep; flesh fine, yellowish. Ripened in October.

No. 65, *New Zealand.* Vines of medium size, vigorous; tubers long, ovate, tapering to the stem; skin roughened by small dots, pale rose color; eyes few, of medium size; flesh white. Many of the tubers are branched and irregular. Ripened last of August.

No. 66, *Ohio Fancy.* Vines strong and rank in growth; tubers round in section, elongate, irregular; skin smooth, pale rose; eyes medium in size and number. Ripened last of September.

No. 67, *Peachblow.* Vines rather slender; stems purplish; tubers small or medium in size, oblong, flattened; skin slightly rough, yellowish white, streaked with red; eyes small, rather deep. Ripened in October.

No. 68, *Pootatuck.* Vines strong, vigorous; bloom white, June 27; tubers small to medium in size, very irregular and uneven; skin smooth, pale rose; eyes rather large; flesh watery. An undesirable sort. Ripened last of August.

No. 69, *Prairie Farmer.* Vines large, strong; tubers of medium size, roundish, flattened, regular; skin roughened, yellow; eyes few, rather large, shallow; flesh firm, white. Ripened last of September.

No. 70, *Pride of Ireland.* Vines rank; in bloom July 5; tubers small, oval, irregular; skin smooth, yellow; eyes few, small. Ripened last of September.

No. 71, *Pride of Japan.* Vines vigorous, large; leaflets curled: tubers small, round; skin slightly rough, yellow; eyes small and sometimes deep; flesh firm, white. Ripened last of September.

No. 72, *Pride of the West.* Vines of medium strength; tubers medium in size, roundish or oval; skin smooth, yellow; eyes of average size, shallow, few. Ripened first of October.

No. 73, *President Cleveland.* Vines of average size; bloom white, June 27; tubers small to medium, irregular in form; skin smooth, yellow; eyes large, prominent; flesh soft, of poor quality. Ripened in October.

No. 74, *Purple Blush.* Vines of medium size, rather slender; tubers small, roundish or ovate, slightly flattened, quite regular; skin rough, pale grayish purple; eyes few, large, shallow; flesh rather coarse and watery. Ripened middle of September.

No. 75, *Queen of the Roses.* Vines of medium strength, with purplish stems; bloom white, June 7; tubers small or medium, rough, irregular, rose color: eyes of medium size and not deep. Ripened first of October.

No. 76, *Red Astrachan.* Vines medium size, vigorous, with purplish stems; tubers medium, oval or pear shaped, flattened, quite regular; skin smooth, rose color; eyes rather large, but shallow; flesh firm, white, fine grained. Ripened middle of September.

No. 77, *Red Elephant.* Vines of medium size, with purple stems; leaflets broad, flat, terminal leaflets sometimes two or three toothed; tubers of medium size, oblong, slightly flattened, very irregular, uneven and branching; skin smooth, light red, deepening around the eyes, which are medium in size, but deeply sunken. Ripened in October.

No. 78, *Rocky Mountain Rose.* Vines strong, vigorous; bloom white, June 27: tubers of medium size, oval or oblong, slightly flattened; skin smooth, pale rose color; eyes small, of medium depth. Ripened first of September.

No. 79, *Roger's No. 14.* Medium vines; tubers medium, oval or oblong, flattened; skin smooth, yellow; eyes shallow; flesh firm, white.

No. 80, *Rose's No. 76.* Vines coarse, vigorous, stocky; bloom white, June 5; tubers medium sized, oblong or pear shaped, flattened; skin smooth pale yellow; eyes few, large, shallow; flesh white, firm. Ripened in October.

No. 81, *Rose's Seedling.* Vines of rank growth, with long, light green leaves; tubers large, usually oblong and flattened, but quite irregular; skin roughened, pale rose; eyes variable in size, often deeply set; flesh fairly firm and fine grained. Ripened last of September.

No. 82, *Rural New Yorker No. 2.* Vines medium in size, with purple stems, foliage rather scant; tubers of medium size, ovate, flattened; skin smooth, yellow; eyes of average number and size, usually shallow; flesh rather watery. Ripened last of September.

No. 83, *Seek No Further.* Strong, rank vines, with purplish stems; tubers large, long, ovate, some slightly flattened; skin smooth, rose color; eyes few, large and shallow. Ripened last of August.

No. 84, *Seneca Chief.* Vines of medium height, rather slender; tubers small, oval or elongated, flattened; skin smooth, yellow; eyes of medium size, shallow; flesh yellow. Ripened late in October.

No. 85, *Snowflake.* Vines of medium strength; tubers small or medium, roundish or oval, flattened; skin slightly rough, yellow; eyes few, small, shallow. Gave but a small yield. Ripened the first of September.

No. 86, *Stanton.* Rank vines, with purplish stems; bloom white, June 28; tubers medium in size, oblong, often quite angular; skin smooth, yellow; eyes few and large; flesh yellow, firm. Ripened first of September.

No. 87, *State of Maine.* Vines tall, rank; bloom white, June 28; tubers large, long, oval, irregular, slightly flattened; skin slightly rough, yellow; eyes of medium size, shallow, numerous. Ripened in October.

No. 88, *Sterling.* Medium sized vines; in bloom July 5; tubers small to medium, oval, flattened; skin slightly rough, pale red: eyes small shallow. Ripened in October.

No. 89, *Steuben Beauty.* Rejected on account of error.

No. 90, *Stray Beauty.* No product recorded.

No. 91, *Superb Beauty.* Vines rank growing, with white bloom, June 28; tubers small, very irregular, elongated, much branched; skin smooth, yellow; eyes rather numerous, of medium size and depth. A wholly unsalable lot. Ripened first of September.

No. 92, *Sunlit Star.* Vines tall, rank, with purplish stems; bloom white, June 28; tubers of medium size, irregular, oblong or ovate; skin smooth, pale rose; eyes of average number, rather large, and in some tubers quite deep. Ripened first of September.

No. 93, *Tunxis.* Vines rank in growth; tubers small, poor, irregular; skin russety yellow; eyes small, numerous. Ripened last of September.

No. 94, *Tremont.* Vines rank; tubers small, oblong, flattened; skin smooth, yellow; eyes few, large, prominent; flesh white, firm. Ripened last of October.

No. 95, *Vermont Champion.* Vines of rank growth, with white bloom, June 28; tubers medium or large, elongated ovate; often very irregular and branching; skin smooth, yellow; eyes small and sometimes rather deep. Product contained but few salable tubers.

No. 96, *Victor.* Vines of medium size; tubers medium, roundish or slightly oblong, flattened, regular; skin rough, grayish purple, mottled with yellow; eyes of average size, usually shallow. Ripened in October.

No. 97, *Wall's Orange.* Medium sized vines, with purplish stems; tubers small, flattened, irregular; skin dull orange, with purple eyes; eyes small, of medium depth. Ripened first of October.

No. 98, *Weld's No. 1.* Vines of medium strength; tubers medium sized, oblong, irregular; skin slightly rough, pale rose; eyes small, of average depth. Ripened last of September.

No. 99, *Weld's No. 40.* Vines of average size and vigor; tubers uneven in size, a few large, roundish, flattened, irregular; skin smooth, yellow; eyes few, deeply set. Ripened last of September.

No. 100, *Well's No. 14.* Small, slender vines, with purplish stems; tubers medium in size, oval, flattened, irregular; skin smooth, rose color; eyes of average size and number. Ripened in October.

No. 101, *Weld's Seedling.* Rank growing vines; in bloom July 5; tubers small, irregular, oblong, flattened; skin smooth, pale rose; eyes few, small, shallow; flesh yellowish. Ripened first of September.

No. 102, *White Beauty of Hebron.* Vines rank, vigorous; bloom white, June 28; tubers large, oblong, irregular; skin slightly rough, yellow; eyes small, prominent or deeply set. Ripened first of September.

No. 103, *White Mercer.* Vines medium in height; tubers small, irregular, ovate, rather angular; skin slightly rough, yellow; eyes few, small, shallow. Ripened the first of September.

No. 104, *White Lily.* Vines of medium size; tubers small, irregular, ovate, somewhat angular; skin slightly rough, yellow; eyes few, small, shallow. Ripened in October.

No. 105, *White Seedling.* Vines rank; tubers small, oblong, slightly flattened; skin smooth, yellow; eyes not very numerous, small and shallow; flesh firm, white. Ripened last of September.

No. 106, *White Whipple.* Rank growing vines, with purple stems; tubers of medium size oval or elongated, flattened; skin roughened, purple, with a clash of purple about the eyes, which are small, numerous and deep: flesh yellowish, a trifle coarse. Ripened the middle of September.

No. 107, *White Prolific.* Vines strong, rank in growth; tubers medium in size, oval or oblong; skin slightly rough, pale yellow; eyes few medium sized, shallow; flesh firm, white, fine, grained. Product uneven. Ripened early in September.

No. 108, *Winston's Seedling.* Rank growing vines; in bloom July 5; tubers small to medium, oval, flattened, irregular; skin smooth, pale rose; eyes of medium number, small, shallow. Ripened early in September.

No. 109, *Wood Ants.* Vines of medium habit; tubers medium in size, oval or oblong, slightly flattened, irregular; skin rough, yellow; eyes few, large, shallow; flesh yellowish, rather watery. Ripened the first of September.

No. 110, *Woodbury's White Sport.* Vines of rank growth; bloom white, June 28; tubers large, long, irregular; skin smooth, pale yellow; eyes of medium size, shallow or often protruding; flesh inclined to be soft and watery. Ripened the last of September.

No. 111, *Yankee Notion.* Vines of medium strength; tubers small, oblong, irregular: skin rough, reddish yellow; eyes numerous, small, deeply sunken; flesh yellowish, firm. Ripened in October.

No. 112, *Yosemite.* Strong growing vines, with violet stem; tubers small to medium in size, ovate, flattened, regular; skin slightly rough, violet, with eyes a shade darker; eyes small, but in some specimens rather deep and numerous; flesh firm, white, fine grained. A very pretty table potato. Ripened middle of September.

No. 113, *American Giant.* Rank coarse vines, bloom white, June 28; tubers large, oblong, irregular; skin russety yellow; eyes many, of medium size, rather deep. Ripened last of September.

No. 114, *Beauty of Beauties.* (Stine.) Vines strong, vigorous; tubers large, long, oval or oblong, flattened; skin smooth, yellow; eyes medium in size and number, shallow; flesh white, firm. Ripened last of September.

No. 115, *Beauty of Beauties.* (Bouk.) Vines rank, vigorous; tubers long, oval or oblong, irregular, flattened; skin rough, cracked and scurfy, pale reddish yellow; eyes large, shallow or protruding. The product greatly inferior to that of No. 114.

No. 116, *Beauty of Hebron.* Rank growing vines; abundant white bloom, June 28; tubers medium sized, roundish, oblong or irregular; skin slightly rough, color dull yellow; eyes small, in some specimens rather numerous and deep. A portion of the lot rotting at the heart, January 17. Ripened middle of September.

No. 117, *Beauty of Sheba.* Vines of medium size, vigorous; tubers medium to large, oval, irregular; skin slightly rough, yellow; eyes of medium size and not deep. Gave the largest yield from a pound of seed of any variety tested. Of fair quality. Ripened last of September.

No. 118, *Belle.* Vines rank, with white bloom, June 28; tubers medium to large, oval, flattened, irregular; skin slightly rough, rose color, eyes few and small, not very deep. Ripened middle of September.

No. 119, *Burbank.* A rank growth of vines; tubers large; irregular, oblong, sometimes slightly flattened, often curved and branching; skin slightly rough, pale yellow; eyes rather numerous, small and shallow; flesh white, firm. Ripened the last of September.

No. 120, *California Red.* Vines of vigorous, compact growth; stems purplish, leaflets dark green, curled; in bloom July 5; tubers of medium size, oval or oblong, usually flattened; skin slightly roughened, rose color; flesh firm, white. Ripened middle of September.

No. 121, *Charles Downing.* Vines strong and rank, but foliage rather thin; tubers of medium size, oval, flattened, regular; skin russety yellow; eyes small, shallow; product of fine quality; yield small. Ripened first of September.

No. 122, *Charter Oak.* Vines strong but stocky; leaflets ovate, flat, and more pubescent than usual; bloom July 5, purple; tubers small to medium, roundish or ovate, a little flattened; skin slightly rough, yellow; eyes few, small, shallow; flesh rather coarse and watery; some tubers rotting at the heart, January 17. Ripened the first of September.

No. 123, *Chicago Market.* Vines of rank growth, with purplish stems and white bloom, June 28; tubers of medium size, oblong or elongated, a little flattened and irregular; skin smooth, dull yellow, with a faint rose tint; eyes numerous and deep. Ripened last of September.

No. 124, *Clark's No. 1.* A rank growth of vine; tubers medium to large, long irregular, slightly flattened; skin smooth, dull yellow; eyes of medium size and depth. Ripened the last of September.

No. 125, *Dakota Red.* Vines of medium size, compact growth, with purple stems; leaflets small, curled and rough; bloomed July 5; tubers of medium size, irregular, ovate or elongated, slightly flattened; skin smooth or a little wrinkled, light red; eyes rather large and shallow or protruding; flesh slightly yellow, not quite firm. Ripened the last of September.

No. 126, *Dictator.* Vines of medium, compact growth; tubers large, roundish or oblong, somewhat flattened and irregular; skin russety yellow; eyes few, small and shallow. Ripened last of September. A superior lot; firm and white fleshed.

No. 127, *Dunmore.* Vines rank, stocky; tubers medium in size, oval or oblong; skin smooth, yellow; eyes small, shallow, not numerous. Ripened the last of September.

No. 128, *Earliest and Best.* Rank growing vines, with large leaflets and white bloom, June 28; tubers medium to large, oval or elongated; skin smooth, pale red; eyes of medium size, rather numerous. Ripened the first of September.

No. 129, *Early King.* This lot found to be mixed.

No. 130, *Early Ohio.* Strong growing vines, with purple stems; tubers of medium size, elongated, oval, many irregular and branched; skin roughened by numerous small dots, pale red; eyes of medium size. Not a desirable lot. Ripened the last of August.

No. 131, *Early Queen.* Rank growing vines; tubers medium to large, irregular, oblong, sometimes flattened; skin slightly rough, pale grayish red; eyes of medium size, often deep. Ripened the first of September.

No. 132, *Early Rose.* Rank vines, with white bloom, June 28; tubers medium to large, oval or oblong, much flattened, often irregular; skin smooth, pale rose; eyes medium size, shallow. Ripened the first of September.

No. 133, *Early Sunrise.* Vines of rank growth and dark color; in bloom July 5; tubers large, elongated, oval, pointed, irregular; skin smooth, rose color; eyes of medium size and depth. Ripened the first of September.

No. 134, *Empire State.* Vines of medium growth; in bloom July 5; tubers of medium size, ovate or elongated; skin smooth, yellow; eyes small, rather numerous and deeply set; flesh rather watery; some tubers rotting January 17. Ripened the middle of September.

No. 135, *Fearnaught.* Vines of rank growth; tubers large, long, and tapering to the stem, some flattened and often curved; skin rather rough, pale yellow; eyes rather few and shallow; flesh firm, white. Ripened the last of September.

No. 136, *Garfield.* Vines of low, compact habit; tubers large, oblong, flattened and irregular; skin russety yellow; eyes few, large and shallow. Ripened the last of September.

No. 137, *Hampden Beauty.* Vines of medium, compact growth; bloom white, June 28; tubers large, oblong, irregular; skin smooth, yellow; eyes large and sometimes rather deep. A few tubers scurfy and rotting at the ends. Ripened the first of September.

No. 138, *Hawkeye.* Rank growing vines, with large leaflets; tubers of medium size, long, irregular and branching; skin slightly russety, yellow; eyes small, shallow. A good yield, product not of first quality. Ripened the last of September.

No. 139, *Junkis.* Vines rank, coarse; tubers medium to large, oval or elongated, irregular; skin slightly rough, yellow; eyes numerous, large and deep; flesh firm. Ripened the last of September.

No. 140, *LaFayette.* Medium sized lines, with purple stems: in bloom July 5; tubers small or medium sized, oval or pear shaped, slightly flattened; skin wrinkled, deep rose color; eyes few, very small and shallow. Ripened the middle of September.

No. 141, *Lee's Favorite.* Vines of rank growth and dark color: in bloom July 5; tubers of medium size, irregular, oblong; skin smooth, yellow; eyes rather large, of average number and depth; flesh yellowish, a little coarse. Ripened the first of September.

No. 142, *Magnum Bonum*. Rank growing vines; in bloom July 5: tubers medium or large round or slightly flattened; skin, smooth yellow; eyes few large and shallow; flesh firm, white. An attractive lot. Ripened in October.

No. 143, *Mammoth Pearl.* Vines rank, stocky; tubers large, round or oblong, irregular; skin smooth, yellow; eyes few, large and shallow; flesh firm, white. A fine potato. Ripened the middle of September.

No. 144, *Mammoth White Chief.* Rank, stocky, dark green vines; tubers large, oval, irregular, flattened; skin yellow, smooth eyes of medium size, shallow; flesh firm. A fine lot. Ripened the middle of September.

No. 145, *Mayflower.* Compact growing, dark green vines; tubers large oblong, quite regular; skin russety yellow; eyes of medium size, shallow; flesh firm. A little uneven size; the large ones are very fine. Ripened the middle of September.

No. 146, *McFadden's Favorite.* Vines of medium size, compact; tubers medium in size, irregular, oblong, flattened;

skin smooth, deep rose; eyes few, rather large and of medium depth; flesh yellowish, firm. Ripened the last of September.

No. 147, *O. K. Mammoth.* Medium sized vines; tubers large, oblong, somewhat flattened, quite regular; skin coarse, grayish yellow; eyes few, large but shallow; flesh firm, rather coarse. One of the best as a market variety. Ripened the middle of September.

No. 148, *Ohio Junior.* Rank vines, with purplish stems and dark green leaves; white bloom, June 28; tubers medium in size, elongated oval; skin coarse and rough, pale red; eyes large, shallow. Much resembles the Early Ohio. Half of the lot defective. Ripened the first of September.

No. 149, *Pearl of Savoy.* Strong, rank vines, with white bloom, June 28; tubers large, elongated ovate, generally flattened; skin slightly rough, obscurely grayish rose colored; eyes few, rather large, and in some cases deep; uneven in size and often branched. Ripened last of September.

No. 150, *Perfect Peachblow.* Vines rank, with purplish stems and coarse leaves; in bloom June 5; tubers of medium size, very round and even; skin slightly rough, pale red, with darker eyes, which are few, small and shallow. A handsome and desirable lot. Ripened middle of September.

No. 151, *Pride of Nebraska.* Medium sized vines, with fine, narrow leaflets; tubers small, ovate; skin smooth, yellow, with a purplish dash around the eyes. Ripened in October.

No. 152, *Queen of the Valley.* Row contained two varieties.

No. 153, *Red Kings.* Row contained two varieties.

No. 154, *Red Star.* Vines rank, stocky; tubers large, oblong, flattened, very irregular and angular; skin slightly rough, dull yellow, with an obscure rose tint; flesh fine white. Ripened the middle of September.

No. 155, *Rochester Favorite.* Rank growing vines, with purplish stems and dark foliage: white bloom, June 28; tubers large, oval or oblong, irregular; skin smooth, pale violet; eyes numerous, of medium number and depth. Ripened the middle of September.

No. 156, *Rose's No. 4*. Tall rank vines, with dark foliage and white bloom, June 28; tubers medium to large, oval or pear shaped, flattened; skin slightly rough, pale rose colored; eyes of average size and depth; flesh firm white. Ripened the last of September.

No. 157, *Rundel Rose.** Rank growing dark colored vines, with white bloom, June 28; tubers of medium size, oval, flattened, irregular: skin smooth, yellow; eyes of medium size and depth; flesh yellow. Ripened the last of September.

No. 158, *Rural Blush*. Medium sized vines, with purplish stems, and fine, dark colored leaflets; tubers medium to large, oval, flattened, irregular; skin russety, pale rose; eyes small, sometimes deep. Ripened in October.

No. 159, *Scotch Gray*. Rank growing vines; tubers large, roundish or oblong, a little flattened, quite regular; skin rough, grayish purple, blotched with a little white around the eyes, which are few, large and of medium depth; flesh firm, rather coarse in grain and flavor. An excellent, attractive market potato. Ripened the first of October.

No. 160, *Snowdrop*. Vines of medium compact growth; tubers large, roundish or oblong, slightly flattened, quite regular; skin a little rough, pale yellow; eyes few, large and shallow; flesh firm, white and fine. Rather the finest late potato in the collection. Ripened in October.

No. 161, *State of Maine*. As described under No. 87.

No. 162, St. *Patrick*. Rank growth of vines; tubers of medium size, elongated, ovate or oblong, branching; skin slightly rough, yellow; eyes of medium size, shallow and not numerous; flesh firm, white. Ripened in October.

No. 163, *Summit*. Vines of tall, rank growth, with purplish stems and dark foliage; white bloom, June 28; tubers of medium

* Arundel Rose of some lists.

size, oval or oblong, flattened, regular; skin smooth, dull yellow; eyes rather large, usually shallow, but in some rather deep; flesh yellowish, not entirely firm. Ripened the middle of September.

No. 164, *Sunrise.* Tall, rank vines, with purplish stems and white bloom, June 28; tubers medium or large, oblong, or sometimes much elongated, slightly flattened; skin smooth, yellowish, with an obscure rose tint; eyes small, shallow, and rather numerous. Ripened the first of September.

No. 165, *Vanguard.* Rank growing, dark colored vines, with white bloom, June 28; tubers medium to large, long, ovate or oblong, irregular; skin slightly rough, pale yellow; eyes small, numerous, rather deep. Ripened the middle of September.

No. 166, *Vick's Gem.* Vines of medium size and vigor; tubers medium in size, oblong, smooth, regular; skin smooth, pale yellow; eyes few, large and of medium depth. A potato of excellent quality. Ripened the middle of September.

No. 167, *Watson's Seedling.* Rank growing, dark colored vines with white bloom, June 28th; tubers medium or large, oval or oblong, flattened, irregular; skin smooth, rose colored; eyes of average size and depth. Ripened the middle of September.

No. 168, *White Elephant.* Tall, rank vines with white bloom, June 28th; tubers medium or large, long, irregular, often curved; skin smooth, pale yellow; eyes of medium size and number; flesh inclined to be watery and black at heart. Ripened in October.

No. 169, *White Prize.* Rank growth of vines with white bloom, June 28th; tubers of medium size, oblong, irregular; skin smooth yellow; eyes rather small and inclined to be deep. Ripened the first of September.

No. 170, *White Star.* Vines of rank growth; tubers medium to large, ovate or oblong, flattened, irregular; skin slightly rough, yellow; eyes small, shallow; flesh white, not quite firm. Ripened the last of September.

No. 171, *Alexander's Prolific.* Medium sized vines, dark colored, with white bloom, June 28th; tubers large, pear shaped or oblong; skin russety yellow; eyes of medium size, sunken, giving the tuber an irregular, knotty appearance; flesh white, firm. Ripened in October.

No. 172, *American Giant.* Vines of medium size, rather slender; tubers large, oval or oblong, slightly flattened; skin slightly rough, yellow; eyes of medium size, shallow. Ripened the last of September.

No. 173, *Beauty of Hebron.* Not different from the description of No. 116.

No. 174, *Burbank's Seedling.* Medium sized vines; tubers of medium size, elongated, irregular; skin slightly rough, yellow; eyes rather small, shallow. Ripened the middle of September.

No. 175, *Chicago Market.* Not different from No. 123.

No. 176, *Clark's No. 2.* Seed of the lot proved mixed.

No. 177, *Dakota Red.* As described in No. 125.

No. 178, *Early Maine.* Rank growing, dark colored vines, with white bloom, June 28; tubers medium to large, elongated oval or pear shaped, flattened; skin smooth, pale rose colored; eyes of medium size and depth. Ripened the first of September.

No. 179, *Early Harvest.* As described in No. 27.

No. 180, *Early Sunrise.* As described in No. 133.

No. 181, *Early Ohio.* As described in No. 130.

No. 182, *Empire State.* As described in No. 134.

No. 183, *Great Eastern.* As described in No. 40.

No. 184, *Hale's Early Peachblow.* Vines rather slender and weak; tubers small to medium, oval or oblong; skin smooth, yellow, streaked with red; eyes pink, few, of medium size and deeply set. An uneven lot. Ripened in October.

No. 185, *Pearl of Savoy.* As described in No. 149.

No. 186, *Polaris.* Rank growing vines with white bloom, June 28; tubers medium to large, irregular, elongated, ovate, often flattened; skin slightly rough, pale yellow; eyes rather numerous, small and deep; flesh rather watery and some tubers unsound at heart. Ripened the first of September.

No. 187, *Queen of the Valley.* Vines rank, stocky; in bloom July 5; tubers of medium size, irregular, oblong, flattened; skin russety yellow, with faint rose color at the seed end; eyes rather small, usually shallow, but sometimes deep, giving the tuber a knotty appearance; flesh white, not entirely firm. Ripened in October.

No. 188, *Snowflake.* As described under No. 85.

No. 189, *The Thorburn.* Vines of medium height, rank, with white bloom June 28; tubers of medium size, oblong; skin smooth, reddish yellow; eyes of medium size, not deep. Ripened first of September.

No. 190, *Vick's Extra Early.* Vines of medium growth; tubers, small, oval, flattened, regular; skin slightly rough, yellow; eyes few, shallow. Mostly too small to be of value. Vines remained green into October.

No. 191, *White Elephant.* As described under No. 168.

No. 192, *Early Ohio.* Kansas grown seed.

No. 193, *Early Ohio.* Iowa seed.

No. 194, *Early Ohio.* Dakota seed.

A pound of each of the above three were furnished by a dealer advocating the virtues of northern grown seed. They were planted the same day, in as nearly the same manner as possible, and received the same care. While the result of a single trial on so small a scale does not prove anything conclusively, the results of this trial are in favor of home grown seed, as may be seen by referring to the tabular statement. The product of Kansas seed was the smoothest and best, while that of the Dakota grown pound was a wholly inferior lot.

PEAS.

The list of peas tested comprised one hundred and forty lots of seed, from the following sources: From Robert Buist, Jr., Philadelphia, twenty lots: from W. Atlee Burpee & Co., Philadelphia, thirty lots; from A. B. Cleveland Co., New York, twenty-three lots; from D. M. Ferry & Co., Detroit, Mich., thirty-one lots: from Peter Henderson & Co., New York, one lot; from D. Landreth & Sons, Philadelphia, twenty-eight lots; from U. S. Department of Agriculture, five lots; from J. C. Vaughan, Chicago, two lots. The ground planted was fine, mellow bottom land. The rows were laid out three feet apart and thirty feet of row devoted to each number, carefully marked by a conspicuous stake, with a zinc label tacked on the top.

The seed was sown in drills about three inches deep. The varieties were arranged in alphabetical order, and numbered for convenience in recording observations. The dates of first appearance, first bloom, first edible peas, first ripe peas and full maturity were kept as carefully as possible for each number on the list, with general notes as to appearance, vigor, productiveness and quality, as well as on purity of seed and comparative habits of peas under the same name from different sources. In gathering, a hundred vines were taken in order from each lot, the pods picked, dried and shelled, and the product of shelled peas in ounces and fractions of an ounce recorded. As a waste* sometimes occurred from the shelling of the earlier pods before the row was ripe enough to gather, these results can only be regarded as approximate.

The entire list of peas was planted Saturday, April 28. The following tabular statement shows the list number, name of dealer who furnished the seed, and name of pea, followed by four columns, showing the number of days from planting to first bloom, first edible peas, first ripe and fully ripe. The fifth column gives the product of dried shelled peas to one hundred vines.

* Probably in no case exceeding 1 per cent.

PEAS: RECORD OF PRODUCT BY VARIETIES.

No.	Source of seed.	VARIETIES.	First bloom...	First edible.....	First ripe......	Fully ripe......	Product, in ounces, to 100 vines ......
1	Cleveland...	Alaska, Cleveland's...............	33	44	52	57	3
2	Landreth....	Bishop's Improved Long Pod...	46	56	64	87	18
3	Buist.........	Blue Peter, Early*................	34	45	54	57	5
4	Burpee.......	Blue Peter..........................	33	45	54	57	7
5	Cleveland...	Blue Peter, McLain's............	33	45	53	57	6.5
6	Ferry.........	Blue Peter..........................	33	46	53	57	8
7	Landreth....	Blue Peter..........................	33	45	53	57	6
8	U. S. Dept..	Blue Peter..........................	33	45	53	57	5
9	Henderson..	Blue Beauty.........................	35	46	55	57	7
10	Buist.........	Black Eyed Marrowfat...........	49	58	66	88	18
11	Burpee.......	Black Eyed Marrowfat...........	47	58	66	88	9
12	Cleveland...	Black Eyed Marrowfat...........	46	58	66	88	14
13	Ferry.........	Black Eyed Marrowfat...........	46	58	66	88	11
14	Landreth....	Black Eyed Marrowfat...........	47	58	66	88	17
15	Buist.........	Buist's Premier, Extra Early...	33	44	52	57	6
16	Burpee.......	Burpee's Extra Early*...........	33	46	53	57	4.44
17	Burpee.......	Dan'l O'Rourke*....................	33	44	52	57	4.5
18	Buist.........	Dwarf Blue Imperial.............	45	54	66	83	16.92
19	Burpee.......	Dwarf Blue Imperial.............	45	55	66	88	16
20	Cleveland...	Dwarf Blue Imperial.............	45	54	66	83	16
21	Landreth....	Dwarf Blue Imperial.............	44	54	66	83	28
22	Burpee.......	Earliest of All......................	33	44	53	57	5
23	Ferry.........	Earliest of All......................	33	44	52	57	5
24	U. S. Dept..	Fillbasket	44	54	68	90	18
25	Landreth....	French Canner......................	45	54	65	82	22
26	Buist.........	First Crop, Carter's...............	33	45	52	57	....
27	Cleveland...	First and Best, Cleveland's......	33	45	52	57	6
28	Burpee.......	Invicta	33	45	52	57	4
29	Cleveland...	Kentish Invicta, Cleveland's....	33	45	52	57	3.5

* Seed mixed. Weight of product in this, and in all the following mixed lots, includes only that of the vines apparently true to name.

PEAS: RECORD OF PRODUCT BY VARIETIES—CONTINUED.

No.	Source of seed.	VARIETIES.	First bloom	First edible	First ripe	Fully ripe	Product, in ounces, 10 100 vines.
30	Buist	Kentish Invicta*	33	45	52	57	4
31	Ferry	Kentish Invicta	33	44	52	57	3
32	Landreth	Kentish Invicta	33	45	52	57	3.5
33	Ferry	Kent, Extra Early	33	45	52	57	3
34	Ferry	Large Blue Imperial	44	54	65	90	18.66
35	Buist	Large White Marrowfat	49	60	70	90	25.88
36	Ferry	Large White Marrowfat	47	60	70	90	21
37	Landreth	Large White Marrowfat	46	60	70	90	21
38	Landreth	Landreth's Extra Early	33	45	53	59	7
39	Buist	Lightning, Carter's	33	45	52	59	....
40	Vaughan	Lightning	33	45	53	59	13
41	Vaughan	Maud S., Extra Early	33	45	52	59	3
42	Ferry	McBeth's Pride	33	45	54	59	4
43	Buist	Morning Star, Early*	33	46	52	59	4
44	Burpee	Philadelphia Extra Early*	33	45	53	59	3
45	Landreth	Philadelphia Extra Early	33	45	52	59	4
46	Buist	Royal Dwarf Marrowfat	47	60	66	84	22
47	Landreth	Royal Dwarf Marrowfat	47	56	65	83	14
48	Cleveland	Rural New Yorker	33	44	52	83	4.5
49	U. S. Dept.	Rural New Yorker	33	45	52	70	11.76
50	Burpee	Superlative	44	47	65	75	12
51	Buist	Tom Thumb, Early*	33	46	52	59	4.25
52	Burpee	Tom Thumb*	33	45	52	59	6
53	Cleveland	Tom Thumb, Cleveland's Imp.*	33	45	52	59	4
54	Ferry	Tom Thumb, Ferry's Ex. Early	33	45	52	59	4
55	Burpee	White Marrowfat	53	65	82	93	17
56	Burpee	William I	33	46	52	72	8
57	Burpee	Abundance	38	52	54	78	14
58	Cleveland	Abundance	38	52	54	78	14

*Seed mixed.

PEAS: RECORD OF PRODUCT BY VARIETIES—CONTINUED.

No.	Source of seed.	VARIETIES.	First bloom....	First edible	First ripe...	Fully ripe,	Product, in ounces, to 100 vines....
59	Ferry.........	Abundance, Bliss'..................	35	52	54	78	18
60	Landreth....	Abundance	39	52	54	78	18.33
61	Burpee	Advancer............................	38	49	59	82	4
62	Cleveland...	Advancer, Cleveland's*..........	38	49	59	82	9.47
63	Ferry.........	Advancer, McLean's..............	38	49	63	82	6
64	Landreth....	Advancer, McLean's*............	37	45	65	82	11
65	Buist.........	Alpha, Extra Early................	34	45	53	72	6
66	Burpee.......	Alpha..................................	33	45	53	72	4
67	Ferry	Alpha, Laxton's....................	33	45	53	72	8
68	Landreth	Alpha..................................	33	45	53	72	4
69	Buist.........	American Wonder, Early*......	34	46	54	72	12
70	Burpee.......	American Wonder*...............	34	46	54	73	2
71	Cleveland ...	American Wonder.................	33	45	54	61	2.66
72	Landreth....	American Wonder..................	34	46	54	61	8
73	Buist.........	Champion of England............	39	53	65	82	30
74	Burpee.......	Champion of England............	38	52	65	82	21.42
75	Cleveland...	Champion of England............	44	53	65	82	12.63
76	Ferry.........	Champion of England............	46	56	65	82	18.66
77	Landreth....	Champion of England............	45	55	65	82	14
78	Ferry	Everbearing, Bliss.................	45	56	65	82	16
79	Burpee.......	Everbearing..........................	46	56	65	82	....
80	Landreth....	Everbearing..........................	44	56	65	82	12
81	U. S. Dept..	Emerald Gem.......................	40	51	62	82	....
82	Buist	Eugenie...............................	35	53	63	82	4
83	Cleveland ...	Eugenie...............................	35	52	62	82	12
84	Landreth....	Eugenie...............................	35	52	62	82	13.33
85	Burpee.......	Evolution.............................	51	58	70	95	13.33
86	Landreth....	Fortyfold.............................	46	58	65	83	18.75
87	Cleveland ...	Long Island Mammoth...........	44	56	65	83	8

*Seed mixed.

PEAS: RECORD OF PRODUCT BY VARIETIES—CONTINUED.

No.	Source of seed.	VARIETIES.	First bloom....	First edible	First ripe..	Fully ripe..	Product, in ounces, to 100 vines.....
88	Burpee	Pride of the Market*...........	45	58	66	83	....
89	Cleveland ...	Pride of the Market, Carter's*.	46	59	66	83	16
90	Ferry.........	Pride of the Market*...........	44	59	66	83	16
91	U. S. Dept..	Pride of the Market.............	45	55	66	83	16
92	Buist.........	Premium Gem, Carter's.........	34	46	54	61	2
93	Cleveland ...	Premium Gem, Carter's.........	34	45	54	61	3.15
94	Burpee	Premium Gem*..................	35	46	54	61	6
95	Ferry.........	Premium Gem....................	35	46	54	61	5.55
96	Landreth....	Premium Gem....................	35	46	54	61	5.55
97	Cleveland ...	Prince of Wales.................	45	55	65	81	16.47
98	Burpee	Quality	37	51	59	74	10
99	Burpee	Quantity...........................	45	56	66	78	12
100	Buist.........	Strategem, Carter's.............	40	53	65	82	25
101	Cleveland ...	Strategem, Carter's*...........	45	55	65	82	18
102	Burpee	Strategem*........................	45	55	65	82	14.28
103	Ferry.........	Strategem*........................	41	55	65	82	11.42
104	Landreth....	Strategem*........................	45	55	65	82	13.33
105	Landreth....	Sunrise	35	51	62	78	16
106	Buist.........	Telephone, Carter's.............	39	52	62	82	22.66
107	Cleveland ...	Telephone, Carter's.............	41	53	62	82	10.76
108	Burpee	Telephone.........................	37	54	62	82	11.66
109	Ferry.........	Telephone.........................	45	54	62	82	18.66
110	Landreth....	Telephone.........................	42	54	62	82	10
111	Buist.........	Yorkshire Hero....................	40	52	65	84	26
112	Burpee	Yorkshire Hero....................	49	54	65	84	18.91
113	Cleveland ...	Yorkshire Hero....................	45	54	65	84	21.42
114	Ferry.........	Yorkshire Hero....................	45	54	65	84	18
115	Landreth....	Yorkshire Hero....................	45	54	65	84	16
116	Cleveland ...	Dwarf Sugar.................	38	51	62	74	14

*Seed mixed.

PEAS: RECORD OF PRODUCT BY VARIETIES-CONTINUED.

No.	Source of seed.	VARIETIES.	First bloom....	First edible....	First ripe..	Fully ripe..	Product, in ounces, to 100 vines....
117	Burpee	Dwarf Sugar......................	47	56	68	74	19
118	Buist.........	Dwarf Sugar, Edible Pod......	47	56	68	74	18
119	Ferry.........	Dwarf Sugar, Edible Pod......	47	58	68	74	....
120	Cleveland...	Dwarf Gray Seeded Sugar.....	47	58	68	74	17
121	Cleveland...	Tall Gray Seeded Sugar........	51	62	70	84	13
122	Ferry.........	Tall Sugar, Edible Pod.........	45	62	70	84	16
123	Burpee	Tall Sugar..........................	45	62	70	84	12
124	Landreth....	Tall Sugar..........................	49	62	70	84	16
125	Landreth....	Purple Blossom Sugar...........	46	55	63	74	10
126	Ferry.........	Blue Prussian Field..............	53	61	72	95	20
127	Ferry.........	Common White Field*.........	51	62	74	95	17
128	Ferry.........	Common Blue Field*...........	42	62	74	95	18.88
129	Ferry.........	Golden Vine Field*.............	42	56	72	83	16
130	Ferry.........	American Wonder...............	35	46	54	62	3
131	Ferry.........	Ey. Imp. Dan'l O'Rourke......	33	45	52	62	....
132	Ferry.........	D. M. Ferry & Co's. Ex. Early..	33	45	52	62	2
133	Ferry.........	Ferry's First and Best..........	33	45	52	59	3.5
134	Burpee	McLean's Little Gem*..........	34	47	54	79	17.13
135	Ferry.........	McLean's Little Gem............	34	47	54	62	2
136	Ferry.........	Minimum	34	45	54	59	4
137	U. S. Dept..	Perpetual...........................	56	72	82	103	4
138	Landreth....	Sitka	33	45	52	62	3
139	Landreth....	Tom Thumb........................	35	45	55	62	4
140	Landreth....	Pride of the Market..............	45	62	65	82	....

* Seed mixed.

NOTES ON VARIETIES.

No. 1, *Cleveland's Alaska.* Vines slender, twelve to eighteen inches high; pods short and round; pea of good quality; when ripe, small, smooth, bluish green.

No. 2, *Bishop's Improved Long Pod*. Vines strong and rank, sixteen to twenty inches high; pods two to three inches long, well filled; peas medium to large, smooth or pitted, yellow, good.

No. 3, *Early Blue Peter*. This seed, from Robert Buist, was mixed with a considerable number of seeds of a tall, late growing sort. The Blue Peter vines did not differ from the others of the name.

No. 4, *Blue Peter*. Vines stout, six to eight inches high; thick, dark foliage, mottled with whitish spots; pods good sized, well filled; pea medium sized, smooth or pitted often flattened, of a bluish green color, and of good quality; stood the dry weather well.

Numbers 5, 6, 7 and 8. Similar in all respects to No. 4.

No. 9, *Blue Beauty*. Vines ten to twelve inches high; a sturdy grower, with dark green foliage; pod two inches long, well filled; peas small, smooth or slightly pitted, bluish green; quality good. An excellent second early sort.

No. 10, *Black Eyed Marrowfat*. Rank vines, growing two to three feet high: rather light colored; pods long, scattering, well filled; peas medium to large, brownish yellow, with black eyes. A productive late sort, and remains long in season.

Nos. 11, 12, 13 and 14. Same as No. 10.

No. 15, *Buist's Premier, Extra Early*. Vines slender, twelve inches high, rather tender; pods scattering, not well filled; peas small, smooth or pitted, yellow or pale green; quality good.

No. 16, *Burpee's Extra Early*. Vines of medium strength, eighteen inches high, with dark green foliage; pods scattering, not well filled; peas small, smooth, pale green or yellow. Seed mixed with a later sort, apparently field peas.

No. 17, *Dan'l O' Rourke*. Vines slender, eighteen inches high; pods medium sized, scattering; peas small, smooth, pale green or yellow. Seed mixed with a coarse, late variety.

No. 18, *Dwarf Blue Imperial*. Vines twelve to fifteen inches high, stout, with dark green foliage; pods two to three inches long; peas large, smooth or slightly pitted, bluish green or yellow. A productive sort, and stands dry weather well.

Nos. 19, 20 and 21. Same as No. 18.

No. 22, *Earliest of All.* Vines slender, twelve to eighteen inches high, light colored, tender, and injured by heat; pods well set, small and well filled; pea small, smooth, pale green. Quality good.

No. 23. Similar to No. 22.

No. 24, *Fillbasket.* Vines two to three feet high; leaflets two to five, dark green, flat and smooth; pods of good length; pea medium sized, bluish green.

No. 25, *French Canner.* Vines two or three feet high, rank growth; pods two to three inches long, narrow and curved, well filled; peas small to medium, smooth, yellow. A hardy, productive pea, but of rather poor quality.

No. 26, *Carter's First Crop.* Vines slender, twelve inches high, injured by heat; pods small, well filled; peas small, smooth, pale green.

No. 27, *Cleveland's First and Best.* Vines slender, twelve to eighteen inches high; pods medium, well filled; peas small, smooth or pitted, pale green or yellow. Does not stand heat well.

No. 28, *Invicta.* Vines slender, twelve to eighteen inches high; color light green; somewhat tender; pod medium size; pea medium, smooth, bluish green.

No. 29, *Cleveland's Kentish Invicta.* Vines slender, twelve to eighteen inches high; pods medium, well filled; pea small to medium, pale green.

Nos. 30, 31 and 32 similar to 29 in all respects. The seed of lot 30 badly mixed with those of another sort.

No. 33, *Extra Early Kent.* Vines twelve to eighteen inches high, rank and vigorous; pods medium; pea small, smooth, pale green or yellow.

No. 34, *Large Blue Imperial.* Vines rank, two feet high, dark green; pea large, smooth, bluish green, of good quality.

No. 35, *Large White Marrowfat.* Vines rank, dark green, two to three feet high; pods large, well filled; peas medium to large, smooth or pitted, pale yellow. A hardy, productive pea and long in season.

Numbers 36 and 37 are in no way different from 35.

No. 38, *Landreth's Extra Early.* Vines of medium strength, twelve to eighteen inches high, color light green; slightly fired by hot winds; pods medium, abundant, well filled; pea small, smooth or pitted, yellow, of good quality.

No. 39, *Carter's Lightning.* Vines slender, twelve to fifteen inches high, tender, and injured by heat; pods scattering, medium sized: pea small, smooth or pitted, pale green or yellow.

No. 40, *Lightning.* Same as No. 39.

No. 41, *Extra Early Maud S.* Vines slender, twelve to eighteen inches high; somewhat tender, affected by drouth and heat; pods short; pea small, smooth or pitted, yellow.

No. 42, *McBeth's Pride.* Vines of medium strength, fairly hardy; pods good sized, well filled; pea small to medium, smooth or pitted, pale green, of good quality.

No. 43, *Early Morning Star.* Vines slender, twelve to fifteen inches high, tender, and quickly injured by heat; pods scattering and uneven; pea small, smooth, yellow or pale green.

No. 44, *Philadelphia Extra Early.* Vines rank and vigorous, twelve to eighteen inches high; pods medium sized, well filled; pea small, smooth or pitted, yellow.

No. 45, *Philadelphia Extra Early.* Similar to above, but more slender in habit.

No. 46, *Royal Dwarf Marrowfat.* Vines strong, rank growing, two to three feet high; color a medium green, blotched. Not to be distinguished from the Large White Marrowfat. Pea large, smooth or pitted; light yellow.

No. 47, *Royal Dwarf Marrowfat.* Vines strong, eighteen to twenty inches high; foliage dense, dark green; stipules very large; pods smaller than those of No. 46; pea medium sized, smooth, yellow.

No. 48, *Rural New Yorker.* Vines slender, eighteen inches high; leaflets small, color light green; tender, and quickly injured by heat; pods medium; pea small to medium, smooth or pitted, yellow.

No. 49. Not different from No. 48.

No. 50, *Superlative.* Vines rank and coarse, twenty-four to thirty inches high; pods long, well filled; pea medium sized, smooth or pitted, yellow green or light brown, of good quality. Stands drouth well.

No. 51, *Early Tom Thumb.* (Buist.) This row, while containing the characteristic Tom Thumb, had about half the vines of a taller late variety.

No. 52, *Tom Thumb.* (Burpee.) A close, compact growth, six to ten inches high; leaflets small, light green, mottled; pods medium sized; pea small, smooth, yellow. In this lot were three vines of a later pea.

No. 53, *Cleveland's Improved Tom Thumb.* This lot was also badly mixed with a large-growing sort.

No. 54, *Ferry's Extra Early Tom Thumb.* Similar to No. 52, but the vines lower.

No. 55, *White Marrowfat.* Vines of strong growth, two feet high; pods medium; pea medium, smooth or pitted, round, yellow.

No. 56, *William I.* Vines slender, eighteen to twenty inches high; pods of uneven size, and not well filled; pea medium, smooth or pitted, yellow; much injured by heat.

No. 57, *Abundance.* Vines strong, coarse, twelve to twenty inches high; color dark green; pods long, not evenly filled; peas medium to large, wrinkled, dull green or yellow, of superior quality.

Nos. 58, 59 and 60. Same as 57.

No. 61, *Advance.* Vines of medium strength, but of vigorous growth; pods of medium length; peas medium to large, wrinkled, pale green or yellow; quality good. Rather tender during dry weather.

No. 62, *Cleveland's Advance.* (Cleveland.) Similar, but mixed with seed of another sort.

No. 63, *McLean's Advancer.* Like No. 61.

No. 64, *McLean's Advancer.* (Landreth.) Seed badly mixed.

No. 65, *Extra Early Alpha.* Vines slender, twelve to eighteen inches high; tender, and badly injured by hot winds; pods uneven in size and not well filled; pea medium to large, wrinkled, pale green or yellow, of excellent quality.

Nos. 66, 67 and 68. Same as No. 65.

No. 69, *Early American Wonder.* (Buist.) A mixture of American Wonder and a tall-growing sort.

No. 70, *American Wonder.* (Burpee.) Seed mixed as above.

No. 71, *American Wonder.* (Cleveland.) Vines six to eight inches high; foliage compact, dark green; pods short; pea medium sized, flattened, wrinkled, pale green, of good quality; not productive.

No. 72, *American Wonder.* (Landreth.) Similar to No. 71, but more vigorous and productive.

No. 73, *Champion of England.* Vines of coarse, rank habit, eighteen inches high; pods medium to long, well filled; pea medium to large, wrinkled, green or yellow; a productive and valuable sort, of excellent quality.

Nos. 74, 75 and 76. Similar in all respects to No. 73.

No. 77, *Champion of England.* Vines of shorter and more compact habit than the Champion of England listed under Nos. 73–76; leaflets smaller; pea not different.

No. 78, *Bliss' Everbearing.* Vines of strong, rank growth, dark green, twelve to eighteen inches high; pods medium to large; pea large, flattened, wrinkled, pale green or yellow.

No. 79. Same as above.

No. 80. Similar to No. 78, but plants a poor stand and unhealthy.

No. 81, *Emerald Gem.* Vines of slender growth, foliage scattering; pods few, short and not well filled. Of little value so far as determined by the present trial.

No. 82, *Eugenie.* Vines tall succulent, coarse growing, tender, and much injured by heat and wind; pea medium to large, wrinkled, light yellow. Quite different in habit from the Eugenie of Nos. 83 and 84.

No. 83 *Eugenie.* Vines of medium strength, twelve to sixteen inches high, rather tender; pods medium size; peas medium to large, wrinkled, yellow.

No. 84. Same as No. 83

No. 85, *Evolution.* Vines vigorous, twelve to eighteen inches high; foliage dense, dark green; pods three to four inches long, broad, not evenly filled; peas large, wrinkled, dull yellow, medium in quality.

No. 86, *Fortyfold.* Vines of medium strength and foliage, twelve to eighteen inches high; pods abundant, two to three inches long, but not well filled, averaging but two to three peas in a pod; pea large, wrinkled, green or yellow, of good quality.

No. 87, *Long Island Mammoth.* Vines rather slender, eighteen to twenty-four inches high; pods large and loose: three to four peas in a pod: peas medium, smooth, pitted or wrinkled, pale greenish yellow, of good quality.

No. 88, *Pride of the Market.* (Burpee.) About half of this seed proved to be of another sort.

No. 89, *Pride of the Market.* (Cleveland.) Vines stocky and vigorous, eight to twelve inches high; pods broad, three to four inches long, abundant, and well filled; peas medium sized, flattened, wrinkled, pale green or yellow. Seed slightly mixed.

No. 90, *Pride of the Market.* (Ferry.) Similar to the above. Seed mixed.

No. 91, *Pride of the Market.* (U. S. Department of Agriculture.) Vines slender, twelve to eighteen inches high; foliage thin, light colored; pods medium, well filled; peas range from small to large; smooth or pitted, pale green, yellow or brown. Entirely distinct from Pride of the Market of other lots.

No. 92, *Carter's Premium Gem*. Vines of medium strength, compact, eight to twelve inches high; pods short, well filled pea medium sized, wrinkled pale green.

No. 93. Similar to No. 92.

No. 94, *Premium Gem*. (Burpee.) Seed mixed.

Nos. 95 and 96. Same as No. 92.

No. 97, *Prince of Wales*. Vines strong, eighteen to twenty-four inches high, dark green; pods two to three inches long, well filled; pea large, wrinkled, yellow, of excellent quality.

No. 98, *Quality*. Vines of medium strength, ten to twelve inches high; foliage rather fine, compact; pods numerous but short; earlier pods not well filled, but later product giving three to six peas to the pod; peas medium sized, flattened, wrinkled, pale green or yellow, of best quality.

No. 99, *Quantity*. A growth very similar to No. 98; pods a little larger; edible five days later than the Quality. Flavor not so good. The dried peas cannot be distinguished in the two varieties.

No. 100, *Carter's Stratagem*. A coarse, short, vigorous growth; color dark green; pods medium, abundant; pea large, wrinkled, pale green or yellow, of good quality.

Nos. 101, 102, 103 and 104. Similar to No. 100, but seed more or less mixed in all.

No. 105, *Sunrise*. Vines rank, eighteen to twenty-four inches high, dark green color; pods two to three inches long, abundant, at first not well filled, later much better; pea large slightly wrinkled, yellow, of excellent flavor. Resists drouth well.

No. 106, *Carter's Telephone*. Vine of medium growth, eighteen to twenty-four inches high; color medium green; pods medium; pea medium to large, wrinkled, pale green or yellow, of excellent quality.

Nos. 107, 108, 109 and 110. Similar in all respects to the above.

No. 111, *Yorkshire Hero.* Vines short and strong, foliage dark mottled; pods large, abundant; peas large, flattened, wrinkled; color pale green or yellow; quality excellent. A hardy sort.

Nos. 112, 113, 114 and 115. Not essentially different from the above.

No. 116, *Dwarf Sugar.* Vines of medium strength, compact, twelve to eighteen inches high; bloom white; pods two to three inches long, curved laterally, thin, and fitting close to the peas so as to show the position of each; peas small, round and smooth, yellow, of inferior flavor. This sort quite distinct from the other *Sugar Peas* and is about a week earlier. A prolific variety.

No. 117, *Dwarf Sugar.* Vines of medium size, twelve to eighteen inches high; foliage abundant, bloom purple; pods three to four inches long, curved laterally and wrinkled; peas small, round, smooth; color gray or chocolate, with fine purple splashes; flavor strong and unpleasant.

Nos. 118, 119 and 120. Not different from No. 117.

No. 121, *Tall Gray Seeded Sugar.* Vines coarse, rank, two to three feet in height; blossoms purple; pods abundant, long, curved laterally, wrinkled; peas medium sized, gray or chocolate, splashed with purple; flavor strong and unpleasant.

Nos. 122, 123 and 124. Same as above in all respects.

No. 125, *Purple Blossom Sugar.* Every way similar to No. 117 excepting a trifle earlier. When large enough to shell the flavor of the Sugar Peas is strong, and they are exceedingly difficult to shell from the thinness of the pods. They were little affected by drouth.

No. 126, *Blue Prussian Field.* Vines tall, vigorous, foliage fine, dark, heavy; pods medium, compact; pea small to medium, round, smooth or pitted, bluish green or yellow. Stood dry weather well.

Nos. 127, 128 and 129. In these lots the seed was more or less mixed.

No. 130, *American Wonder.* Not different in description from No. 71.

No. 131, *Early Improved Daniel O'Rourke.* Vines of medium or slender growth, sixteen to twenty inches high; pods medium sized; abundant; pea medium, smooth or pitted, yellow, slightly larger than in No. 17.

No. 132, *D. M. Ferry & Co.'s Extra Early.* Vines slender, eighteen inches high; pods scanty, of medium size, well filled; pea medium, smooth, yellow; growth much damaged by heat.

No. 133, *Ferry's First and Best.* Very similar to No. 132; tender, and damaged by heat.

No. 134, *McLean's Little Gem.* (Burpee.) Vines of medium compact growth, twelve inches high; pods medium, well filled; pea of medium size, wrinkled, pale green or yellow, of good quality; this lot was mixed with a tall, later growth.

No. 135, Same as No. 134, but seed unmixed.

No. 136, *Minimum.* Vines six inches high; pods medium, compact; pea of medium size, flattened, wrinkled, yellow, of excellent quality.

No. 137, *Perpetual.* Vines eighteen to twenty inches high, rank, succulent; foliage light colored; leaflets and stipules broad, thick and fleshy; bloomed very late, and when the crop was gathered, Aug. 9th, the vines were still green and in bloom; pods of medium size; pea large, wrinkled, yellow, of excellent flavor.

No. 138, *Sitka.* Vines slender, twelve to eighteen inches high, tender, and much damaged by heat; pods of medium size; pea small, smooth, greenish yellow, of excellent quality.

No. 139, *Tom Thumb.* Not different from the Tom Thumb previously described.

No. 140, *Pride of the Market.* (Landreth.) This was the only unmixed lot of this pea on the list; vines about twelve inches high, rank, dark green, with an abundance of long, well filled pods; peas large, tender, and of excellent flavor.

TOMATOES.

The list of tomatoes comprised eighty-three lots. From each packet of seed 100 seeds were sown, April 26, at a uniform depth in shallow boxes. These were placed in cold frames, and, as the seed germinated, a record was made of the number of plants from each lot of 100 seeds. The plants were afterwards properly thinned out, and were grown in the boxes until ready for the open ground. Upon June 19 six plants, as nearly uniform as possible, were set for each lot, in clean, mellow loam, each plant being given a space five feet square.

The subsequent treatment consisted in keeping the ground clean and mellow, and giving the vines a severe clipping with a sharp corn knife, two or three times, as they began to meet across the rows. As many of the plants bloomed for some time before any fruit was set, a column is given to the number of days from sowing of seed till the first fruit was observed. As the fruits ripened, those of each lot were gathered separately and weighed, a sufficient number being counted to give, approximately, the average weight of a single fruit of each variety.

The record of weights was continued for the entire season, and the total includes the weight of green fruit upon the vines at the first frost.

No.	Source of seed.	VARIETIES.	No. of plants from 100 seeds	NUMBER OF DAYS FROM SEED. First bloom.	NUMBER OF DAYS FROM SEED. First fruit set.	NUMBER OF DAYS FROM SEED. First ripe.	TOTAL YIELD OF SIX PLANTS. Lbs.	TOTAL YIELD OF SIX PLANTS. Oz.	Green fruit at frost, in preceding total, pounds	Average weight of single fruit, ounces
1	Burpee	Acme	76	70	76	111	132	9	62$\frac{1}{2}$	2.80
2	Cleveland	Acme	72	72	78	113	112	4	62$\frac{1}{2}$	5.36
3	Ferry	Acme	67	72	78	107	140	11	50	2.46
4	Landreth	Acme	77	72	82	116	118	4	43$\frac{3}{4}$	4.50
5	Burpee	Advance, Extra Early	84	70	78	109	121	9	56$\frac{1}{4}$	2.06
6	U. S. Dept.	Advance, Early	12	70	78	113	91	14	56$\frac{1}{4}$	4.68
7	Buist	Beauty, Buist's	61	72	89	113	139	15	100	5.25
8	U. S. Dept.	Beauty	85	74	82	116	128	14	62$\frac{1}{2}$	4.05
9	Landreth	Bermuda, Extra Early	31	70	74	109	143	2	50	3.91
10	U. S. Dept.	Boston Market	15	74	81	111	120	8	43$\frac{3}{4}$	3.28
11	Cleveland	Canada Victor	11	70	78	107	104	11	37$\frac{1}{2}$	4.18
12	Ferry	Canada Victor	56	67	76	107	83	6	31$\frac{1}{4}$	2.47
13	Cleveland	Cardinal	68	72	78	109	129	15	87$\frac{1}{2}$	3.25
14	Burpee	Cardinal, Burpee's	85	70	82	116	146	12	56	4.00
15	Ferry	Cherry, Yellow	58	67	72	100	9	12	*	.14

*Total weight not kept.

No.	Source of seed.	VARIETIES.	No. plants from 100 seeds	NUMBER OF DAYS FROM SEED.			TOTAL YIELD OF SIX PLANTS.		Green fruit at frost, in preceding total, lbs.	Average weight of single fruit, ounces
				First bloom.	First fruit set.	First ripe.	Lbs.	Oz.		
16	Burpee	Cherry, Red	53	70	76	102	21	1	*	.26
17	Ferry	Cherry, Red	64	70	72	102	27	15	*	.21
18	Ferry	Cincinnati Purple	64	70	78	109	79	10	50	4.70
19	Burpee	Climax, Burpee's	79	72	78	111	102	11	43¾	2.55
20	Ferry	Conqueror, Early	81	70	78	107	138	13	37½	2.45
21	Cleveland	Conqueror, Early	69	70	78	109	115	7	50	3.61
22	Landreth	Cook's Favorite, The	62	70	78	107	100	10	37½	4.52
23	Landreth	Early Jersey, Extra Early	62	70	78	107	80	15	25	4.52
24	Burpee	Essex Hybrid	77	70	79	109	69	4	25	3.26
25	Ferry	Essex Hybrid, Early	59	72	79	111	100	10	37½	3.07
26	Cleveland	Essex Hybrid, Early	91	70	77	105	116	4	43¾	3.00
27	Burpee	Faultless, Early	77	70	77	105	93	4†	31¼	3.00
28	Landreth	Fejee	26	70	78	105	91	6	25	2.77
29	Ferry	Golden Queen	84	70	78	111	110	0	50	5.09
30	Burpee	Golden Queen	74	72	81	116	72	2	25	4.63

*Total weight not kept. †Five plants.

No.	Source of seed.	VARIETIES.	No. of plants from 100 seeds	Number of days from seed.			Total yield of six plants.		Green fruit at frost in preceeding total, lbs	Average weight of single fruit, ounces
				First bloom.	First fruit set.	First ripe.	Lbs.	Oz.		
31	Burpee	Golden Trophy	85	72	93	126	109	10	81¼	4.53
32	Cleveland	Golden Trophy	48	70	78	116	113	1	50	3.75
33	Landreth	Golden Trophy	75	70	78	116	146	8	50	5.50
34	Cleveland	General Grant	80	74	82	105	102	9	25	4.25
35	Landreth	General Grant	66	70	82	105	102	9	12½	3.23
36	Landreth	Grape	60	65	76	105	4	9	*	.03
37	Cleveland	Hathaway Excelsior	77	72	81	113	75	1	31¼	2.25
38	Landreth	Hathaway Excelsior	63	74	85	109	78	7	37½	2.36
39	Ferry	Hundred Day, Extra Early	99	67	76	102	70	10	12½	3.26
40	Landreth	Ivory Ball	61	74	81	124	40	0	25	1.71
41	Burpee	King Humbert	75	66	70	105	61	7	18¾	1.45
42	Cleveland	Large Smooth Red, Early	56	72	78	111	74	2	25	4.63
43	Burpee	Livingston's Beauty	68	72	78	109	89	0	43¾	4.41
44	Cleveland	Livingston's Beauty	66	70	78	107	86	11	31¼	5.54
45	Ferry	Livingston's Beauty	69	72	81	111	76	13	25	6.25

*Total weight not kept.

No.	Source of seed.	VARIETIES.	No. of plants from 100 seeds	NUMBER OF DAYS FROM SEED.			TOTAL YIELD OF SIX PLANTS.		Green fruit at frost, in preceding total, pounds	Average weight of single fruit, ounces
				First bloom.	First fruit set.	First ripe.	Lbs.	Oz.		
46	Cleveland	Livingston's Favorite	79	72	78	105	73	4	25	4.80
47	Ferry	Livingston's Favorite	69	70	78	111	91	10	25	3.66
48	Burpee	Livingston's Favorite	48	72	78	109	71	11	25	2.81
49	Cleveland	Livingston's Perfection	60	72	78	107	105	7	50	5.17
50	Burpee	Livingston's Perfection	74	74	78	111	84	13	25	5.03
51	Ferry	Livingston's Perfection	71	72	78	113	91	5	31¼	4.54
52	Burpee	Mayflower	46	70	78	105	111	14	50	3.38
53	Cleveland	Mayflower	81	70	82	111	95	15	50	7.46
54	Cleveland	Mikado, The	77	72	88	107	68	10	37½	5.00
55	Burpee	Nesbit's Victoria	55	70	78	107	14	4	*	.81
56	Ferry	Optimus	22	72	84	109	61	5	25	4.00
57	Cleveland	Optimus	28	72	78	109	98	13	18¾	4.75
58	Burpee	Optimus, Early	78	70	78	111	91	1	25	3.92
59	Ferry	Paragon	70	70	78	109	71	15	18¾	3.74
60	Burpee	Paragon	52	72	78	116	95	5	43¾	4.90

* No fruit gathered after frost.

No.	Source of seed.	VARIETIES.	No of plants from 100 seeds	NUMBER OF DAYS FROM SEED.			TOTAL YIELD OF SIX PLANTS.		Green fruit at frost, in preceding total, pounds	Average weight of single fruit, ounces
				First bloom.	First fruit set.	First ripe.	Lbs.	Oz.		
61	Landreth	Paragon	71	76	91	....	53	13	37½	5.27
62	Landreth	Peach	77	82	85	....	50	9	31¼	2.00
63	Ferry	Pear, Red	89	72	78	109	10	11	*	.31
64	Landreth	Pear Shaped, Red	64	70	76	102	19	12	*	.51
65	Burpee	Pear Shaped, Yellow	56	70	76	105	22	7	*	.32
66	Landreth	Pear Shaped, Yellow	29	67	76	109	33	2	*	.54
67	Ferry	Plum, Yellow	67	70	76	109	21	1	*	.74
68	Buist	Prize Belle	42	70	78	116	87	9	50	4.23
69	Ferry	Queen	87	70	78	109	71	6	37½	2.91
70	Burpee	Round Yellow, Small	14	70	82	....	5	13	*	.10
71	U. S. Dept	Reed's Island Beauty	67	70	78	111	59	†14	25	4.42
72	Vaughan	Scoville's Hybrid	84	70	78	107	91	12	31¼	4.69
73	Burpee	Scoville's Hybrid	76	72	78	120	81	1	37½	5.07
74	Burpee	Strawberry (no record made)	....	....	....	....	....	....	....	....
75	Cleveland	Strawberry (no record made)	....	....	....	....	....	....	....	....

No.	Source of seed.	VARIETIES.	No. of plants from 100 seeds	NUMBER OF DAYS FROM SEED.			TOTAL YIELD OF SIX PLANTS.		Green fruit at frost, in preceding total, pounds	Average weight of single fruit, ounces
				First bloom.	First fruit set.	First ripe.	Lbs.	Oz.		
76	Burpee	Trophy	78	70	88	120	57	5	12½	6 79
77	Ferry	Trophy	75	70	79	....	33	0	12½	5.00
78	Burpee	Turner Hybrid	67	72	82	116	35	6	12½	6.44
79	Burpee	Upright or Tree	10	100	126	*	12	6	....	....
80	Vaughan	Volunteer (24 seeds)	19	72	78	109	85	15	31¼	3.18
81	Burpee	White Apple	73	74	81	116	31	6	12½	1.00
82	Ferry	White Apple	91	74	86	120	28	13	12½	1.35
83	Burpee	Wonder of Italy	75	70	78	113	28	7	†	.91

* No fruit ripened. † No record of green fruit.

No. 45, *Nesbit's Victoria.* Vines similar to those of No. 54, but finer and smoother; fruit inferior, pear shaped, red.

Nos. 56, 57 and 58, *Optimus.* Fruit oval or roundish, smooth, firm fleshed and fine; color light red.

Nos. 50, 60 and 61, *Paragon.* Above medium size, oval, flattened, sometimes ribbed or rough; usually thick fleshed and fine; color light red.

No. 62, *Peach.* Fruit somewhat peach shaped, slightly pubescent, deep purplish red; thin fleshed and of little value, except as a novelty.

Nos. 63 and 64, *Pear Shaped Red.* Sufficiently described by the name. Small, and valued only for preserves or pickles.

Nos. 65 and 66, *Pear Shaped Yellow.* Similar to above, except in color.

No. 67, *Plum, Yellow.* More pear shaped, sides flattened, slightly longer than No. 15. Excellent for preserves.

No. 68, *Prize Belle.* Fruit irregular, oval, slightly flattened and ribbed; of medium quality.

No. 69, *Queen.* A light red tomato of no special merit.

No. 70, *Round Yellow, Small.* Identical with No. 15.

No. 71, *Reed's Island Beauty.* Fruit oval, flattened, smooth, regular. An excellent tomato.

No. 72, *Scoville's Hybrid.* Fruit above medium size, oval, flattened, smooth, light red.

No. 73, *Scoville's Hybrid.* Fruit oval, concave, slightly ribbed, light red.

Nos. 74 and 75, *Strawberry Tomato,* or *Ground Cherry.* No record made.

Nos. 76 and 77, *Trophy.* Fruit thick fleshed, but often rough and uneven; color light red.

No. 78, *Turner Hybrid.* The vines with terminal leaflets large, broad and entire; fruit large, deep red, smooth and solid. Not very productive.

No. 79, *Upright, or Tree.* A stiff tree-like plant, with heavy, wrinkled foliage; very late and slow in growth, the first bloom appearing one hundred days after the seed was planted. But one fruit set, and that did not mature.

No. 80, *Volunteer.* Fruit of medium size, roundish, flattened, bright red, smooth and solid. The later ripening fruits were small and inferior to the first.

Nos. 81 and 82, *White Apple.* Fruit small, round, smooth, creamy white, semi-transparent. Apparently identical with No. 40, *Ivory Ball.*

No. 83, *Wonder of Italy.* Broadly pear shaped, with the sides flattened; color light red. Valuable only for preserves and pickles.

REPORT OF THE BOTANICAL DEPARTMENT.

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W. T. SWINGLE, *Assistant Botanist.*

SORGHUM BLIGHT.

During the season, several varieties of sorghum grown on the College farm and elsewhere suffered from a disease whose presence was indicated by red or reddish blotches on leaves, leaf sheaths and roots. When severe, it resulted in the complete destruction of the sorghum plants, but when the disease was mild, the growth of the sorghum was only slightly checked. This disease was not noticed until early in July, at which time careful observations and investigations were begun. These were continued through the season, and the results are given in detail below.

The recorded history of this disease, so far as accessible literature indicates, is as follows: In 1883, Prof. S. A. Forbes,* while studying the diseases of sorghum and broom corn and the insects infesting these plants, in Illinois, concluded that fungi might be wholly or in part the cause of the damage done. He accordingly sent specimens for examination to Prof. T. J. Burrill, of the Illinois University. Although the latter failed at this time to discover the cause of the disease, yet in July, 1886, he detected in the diseased plants numerous bacteria within the affected tissues, which proved to be the specific micro-organism of the disease. Prof. Burrill named this parasitic organism *Bacillus Sorghi.* An account of the disease and the

*In Thirteenth Report of the State Entomologist of Illinois.

investigations made were given by him in the Proceedings of the Eighth Annual Meeting of the Society for the Promotion of Agricultural Science (1887), and in *The Microscope,* Nov., 1887 (Vol. VII, No. 11).

PREVALENCE OF THE DISEASE.

The sorghum on the College farm was planted in plats, in two fields nearly a half mile apart. One series (D) was on ground occupied by sorghum last year, while the others (A, B and C) were on land which had never been occupied by sorghum.

Series A consisted of single rows, several rods long, of 39 varieties of saccharine sorghums.

Series B was immediately north of the preceding, consisting of the same number of somewhat longer rows of Kansas Orange. About half the rows were from seed obtained from a Kansas City firm, and the other from seed grown in Wabaunsee county, Kansas.

Series C was a duplication of some of the varieties in series A.

The soil in which series A, B and C were planted was of a uniform character, and the treatment was the same, except that some rows of series B were manured with several different fertilizers.

In series D, the plats were of considerable size, and consisted of eight fodder plants. The sorghum raised on this ground the previous year was in all probability affected with a mild form of the disease. Old stalks which had remained in the field over winter showed plainly that the sheaths had been stained red in a manner similar to that caused by the disease. When ensilage was being made (in 1887) from this sorghum, some of the finely chopped material accumulated on the floor under the machine. In the course of a few days these pieces of sorghum, and especially bits of the stalk, were stained red, presumably by the disease, though since cultures were not made this cannot be positively asserted. These facts were noted in 1887, though no serious disease of the sorghum was suspected.

In the present year (1888), the disease appeared among the

College varieties, causing much damage. For a time it was supposed that the injuries were due to the attacks of insects, but the rapid spread and increasing damage induced a careful examination and study of the disease, beginning July 11. At this time, the Kansas Orange from seed from Wabaunsee county was very badly attacked, at least three-fourths of the crop being destroyed. The Kansas Orange from seed from a Kansas City firm was suffering but little from the disease. Some of the rows of the latter had been treated with fertilizers, namely, superphosphate, nitrate of soda, lime, and plaster. In no case could any difference be observed between these rows and the others which were not so treated. Later in the season, the difference between the two Kansas Orange plats became more marked. When ready to harvest, that grown from seed from Kansas City yielded a fair crop, while at least ninety per cent. of that grown from the Wabaunsee county seed had been destroyed. The north ends of the rows of both varieties were shaded by a row of trees, and these were much more diseased; but on the west side of the plat of Kansas Orange from Wabaunsee county seed, a half dozen rows, which were adjoining a millet field, were much less severely attacked by the blight. The difference between these and the other rows was not temporary, but continued throughout the season.

It should be mentioned that differences were observed in the panicle, internodes and character of the stalk of the Kansas Orange grown from the seed from the two sources mentioned above, and it is perhaps probable that they were two distinct varieties.

Of the varieties in series A, the following were but slightly attacked, the injury to the plants being inappreciable:

No. 1, Dutchess' Hybrid.
No. 2, Amber and Orange crossed.
No. 3, A new variety.
No. 4, Late Orange.
No. 5, Early Gooseneck.

No. 6, Whiting's.

No. 7, A new variety.

No. 8, Price's.

No. 9, Kansas Orange.

No. 10, Africa.

No. 11, Chinese sugar cane.

No. 12, Central American.

No. 13, White India, was at first seriously attacked, but later the disease made no further progress.

The following were somewhat diseased:

No. 14, Honey Drip.

No. 15, Medium Orange.

No. 16, White African.

No. 17, Honey Dew.

No. 18, White Amber.

No. 19, Golden Rod.

No. 20, South Carolina Early Orange.

No. 21, Gooseneck.

No. 22, Enyama.

No. 23, New Orange.

Of the following four varieties, very many (more than three-fourths) of the plants were destroyed by the disease:

No. 24, Russel's.

No. 25, Early Amber.

No. 26, Early Orange.

No. 27, Link's Hybrid.

The following two were badly attacked, though not to the same extent as Nos. 24–27:

No. 28, Swain's Early Golden.

No. 29, White Mammoth.

No. 30, Silver Top, was very badly blighted; at least three-fourths of the plants had been destroyed previous to July 23d.

No. 31, Little Sumac, was scarcely diseased.

Nine-tenths of the following two were destroyed:

No. 32, India.

No. 33, Red Top.

No. 34, Wabaunsee, was considerably diseased.

The following two were badly diseased; at least three-fourths destroyed:

No. 35, Honduras.

No. 36, Honey Cane.

No. 37, Liberian from Alabama seed, No. 38, Liberian from Missouri seed, and No. 39, Liberian from Kansas seed, were much injured.

The non-saccharine varieties of fodder plants (series D) were as follows:

No. 4, Rural Branching Sorghum, was not damaged by the blight.

No. 5, Kaffir Corn, was slightly diseased.

No. 6, Yellow Milo Maize: Early in the season this was but slightly diseased, but at the end of the season at least ninety-five per cent. of the plants were destroyed. They did not die rapidly, but became peculiarly stunted and branched.

No. 7, Pearl Millet: This was badly killed early in the season, especially where the plants were thin. The characteristic stains were not observed, and no cultures were made to determine the cause of the disease; therefore, the blight heretofore referred to may not in this case have been present.

No. 8, Doura: About one-half of the plants of this variety was killed, the principal damage occurring early in the season.

No. 9, African Millet, was damaged mostly in July. About two-thirds of the plants were destroyed.

No. 10, Japan Maize (a variety of Indian Corn), was not attacked by the disease.

No. 11, Teosinte, was also entirely free from the disease.

A plat of sorghum, in the same field with the above, but several rods distant, was sown thickly in summer, on land previously occupied by wheat. This was but slightly attacked by the disease.

A field of sorghum, (probably Red Top,) about a mile west of the College, belonging to Mr. Pierce, was examined August 8, 1888. The seed had been sown thickly, and during a violent wind a few weeks previous had been blown almost flat. In the meantime it had become mostly upright, until a day or two before the observation, when a strong southwest wind again blew much of it down. The plants near the margin and in a strip in the middle of the field were upright, but the others were lying prostrate, with the heads bent upwards. The leaves and stalks showed little signs of the disease, but the roots were badly attacked, and the plants yielded easily to a slight pull. On August 15, it was observed that many of the stalks had broken, and in such case a red stain extended upward in the pith. A very bright yellowish-red stain was often seen on the sheath surrounding the head. In such cases, aphidæ (plant lice) were universally present. Cultures were made, but in no case were the micro-organisms causing the blight obtained.

In the latter part of August (1888), a field of sorghum (variety unknown) eight miles east of Manhattan was seen to be badly attacked by the blight. About one-third of the plants were destroyed—some parts of the field attacked much more than others. No cultures were attempted, but the characteristic stains were observed.

Leaves from affected sorghum plants, grown at Sterling, Rice county, Kansas, were sent for examination July 20 and August 1 (1888), by Mr. W. P. Clement, of the Sterling Sirup works. The characteristic stains were found on nearly all these specimens, and cultures were made, as will be mentioned later. There is no doubt but that the blight heretofore referred to was there prevalent, at least in a mild form. Damage might also have been caused by chinch bugs, or otherwise, as mentioned in the notes accompanying the specimens. Some of the varieties suffered more from the attack than others.

THE CHARACTER OF THE INJURIES TO THE PLANTS.

The diseased plants invariably presented blotches of red discoloration on the leaves or leaf sheaths. These stains were more numerous and brighter on the inner surface of the sheaths. In fact, the first discoloration to be noticed was invariably on this surface. It often began on the extreme upper portion, at or on the ligule, and extended downwards. The blotches were very irregular in shape, but mostly more or less elongated. They were sometimes limited laterally by the large longitudinal veins, or the fibro-vascular bundles, that extend parallel through the sheath and blade. The blotches would widen out in many cases, so as to involve the whole surface. Very small dots and irregular patches, near the large blotches, were usually present. These would increase in size, and blend with adjacent ones. In most cases a very decided tendency to downward extension in lines or bands could be seen, limited below by the node, or joint, of the stem, which is the place of attachment of the leaf sheath. A very faint orange discoloration was usually the first indication of the diseased spots or portions. The coloration would become deeper, various shades of red would follow, and finally the diseased portions became very dark—almost black.

The colored figures on Plates I and II show some of the stages in the progress of the disease. The sheaths seen on Plate I show the earliest discoloration, on the inner surfaces, and those on Plate II show very advanced stages, involving both the inner and outer surfaces, as well as the entire intervening tissue.

The vitality of the affected parts finally became completely exhausted. The tissue could be easily crushed, and the interior showed the same deep coloration. The exterior of the leaf sheath in the earliest stages of the disease presented no blotches nor signs of discoloration, but very soon evidences of disease could be seen here also. The blotches always corresponded to similar patches within, yet in no case became bright colored. None of the small dots or patches near the large blothes, as on the interior surface, were here noticed.

Very frequently, but not invariably, the blade also presented blotches or patches of discoloration. In some cases these were very regular both in shape and distribution, and all the leaves of the plant were similarly and abundantly marked. In other cases only scattering and irregular blotches could be seen. Elongated bands of discoloration, irregularly limited by the veins of the leaf, were in some cases noticed. The coloration was sometimes bright, but usually dull and dark. It is not likely that all these are directly associated with the disease in question; though some of them were proven to be so, others are doubtless referable to other causes.

The leaf sheath remained, until a late stage of the disease, closely adherent to the stem in the normal manner. Not even small insects could effect an entrance so as, perhaps, to cause by their presence the irritation that might result in discolored blotches. But later, especially in stalks that were not upright, the sheath often became partially separated from the stem, and in this recess chinch brigs occasionally congregated. Flies were noticed about the plants, and aphidæ in a few cases were also abundant, but these could not be associated directly with the disease, or regarded as its cause.

The roots of the diseased plants were examined, and found to be affected also. The characteristic coloration, though obscured by adhering soil, was present. Figures 1 and 3, in Plate III, show the stains on the underground portions of young plants. The outer (or cortical) portion of each affected rootlet presently lost its vitality, and would peel or slip off upon the slightest pressure. The plant, when diseased to this extent, could be very easily pulled out of the soil. The lowest roots were usually first attacked, and often entirely destroyed, so that a few of the uppermost only supported the plant. In severe cases the stem at the junction of the roots was also affected, and for some distance upward the central portion of it was discolored, and the tissue more or less disorganized. The stem, in all other cases, seemed to be free from the disease, except where it had in some way been wounded. In fractures or other wounds, the characteristic coloration could be seen, indicating the entrance of the disease.

The general effect on the plant was to reduce its vitality. When diseased but slightly, it attained its normal size, and, aside from slight local discolorations, presented its usual appearance. But if the roots became diseased, the plant manifested signs of imperfect nutrition, a sickly yellow discoloration being very noticeable. A low and stunted growth was the result. In case of some varieties there was abundant branching from near the ground, but generally the plants perished soon after being attacked.

Since few observations were made regarding the microscopical injuries sustained by the host plant, the following account is taken from Prof. Burrill's article in the Proceedings of the Eighth Annual Meeting of the Society for the Promotion of Agricultural Science (1887), pp. 34 and 35:

"The cell walls are in nowise injured, so far as can be made out by the microscope, except that they are stained throughout with red. The first change observed in the cell contents is a shrinking of the protoplasm, as when treated with alcohol. It separates from the cell wall and appears rigid, instead of havits normal plastic consistence. The chlorophyll granules, if present, lose their green color and break up into smaller granules. Shrinking still continues, and the mass becomes tinted with red. From this time on the change does not appear to be always the same. Sometimes the shrunken mass seems tough, and remains like a lump in the middle of the cell. In other cases it breaks up into granular debris immersed in water. If starch grains existed at first, they are decomposed. At length the whole substance passes into what seems to be an emulsion of oily matter in water. The spherical particles are dark red, and usually exhibit Brownian or molecular motion. In certain cells minute starch grains, of uniform size and shape, like little double convex lenses, occur in great numbers, and oscillate rapidly in the cell fluids. They may be easily mistaken for microbes; but iodine stains them blue, revealing their nature. They have been observed only near the borders of the diseased areas, within red-stained cells. The surfaces of the walls of the cells, from which the contents have disappeared, seem to have a granular deposit upon them. Here, again, one needs caution in looking for bacteria, as the deposited granules often appear somewhat like them. The liquid itself in the diseased cells is reddish in color, and certainly stains the cellulose of the walls beyond the area actually penetrated by the microbes."

No chemical analysis of the cane juices was made to determine, if possible, the effect of the blight on its composition. But in the Fourth Biennial Report of the State Board of Agriculture of Kansas, Prof. E. B. Cowgill gives, in his "Report on the Sorghum Industry in 1884," a statement of the "analysis of juices of canes injured by parasitic fungi," as follows:

September 30, Orange — most affected canes selected: Sp. gr., 1.0617; per cent. glucose, 7.85; per cent. sucrose, 3.49; and per cent. of other solids, 3.76.

The average of two analyses, September 29 and October 15, of Orange, (not diseased,) as reported by him, are as follows: Sp. gr., 1.0818; per cent. glucose, 1.3; per cent. sucrose, 13.32; and per cent. other solids, 5.03.

That the "parasitic fungi" referred to was the sorghum blight *(Bacillus Sorghi* BURRILL), can perhaps be reasonably assumed, as affected leaves, sent to the Botanical Department of the College at the time and yet preserved, show characteristic stains of the disease. He also observed that "after a time the canes in the worst patches broke and fell. Whenever the conditions were favorable to the healthy development of the plant, its vigor overcame the deleterious influence of the parasite, and no injury was observable."

GENERAL ACCOUNT OF BACTERIA.

The *Bacillus Sorghi,* causing the sorghum blight, belongs to a large group of very minute organisms called *Bacteria.* These consist of a single cell, or several loosely united cells, which are often of exceeding small size, in some cases not larger than 1/50000 inch in diameter. In shape, the micro-organisms may be spherical *(Micrococcus),* rod shaped *(Bacterium* and *Bacillus),* or spirally curved *(Spirillum).*

Nearly all bacteria can be grown on nutrient media, such as boiled potatoes and other vegetables, vegetable infusions, and beef broth. Most of them grow best at a temperature of from 98° to 100° F. When grown on a firm medium, such as boiled potato, a compact mass of cells immersed in a colorless substance is formed. This mass, called a *zooglœa,* differs in shape, color, consistency, size, etc., in different species, so that very many of them may be identified by these characteristics alone. When grown in liquids, the cells usually have the power of motion, and are diffused throughout the medium, causing a cloudy or opalescent appearance of the previously clear fluid. At length, in most forms, a membrane develops on the surface, which, like the zooglœa formed on solid media, differs in different species.

Micro-organisms grow so rapidly under favorable conditions, that in twenty-four hours the progeny of a single individual may number millions. They propagate by cell division, and in some genera, especially when nourishment becomes scanty, by the formation of spores. Owing to their extremely small size, these spores, and also, to a certain extent, the vegetative cells, may float in the air. In fact, they are so abundant that a momentary exposure to the air is usually sufficient to render a culture impure. Bacteria are also widely distributed in water. Very many of the diseases of animals, and a few diseases of plants, are caused by them.

CHARACTERS OF THE *BACILLUS SORGHI.*

The cells of this species vary much in size and shape, being from $1\frac{1}{3}$–4 by ½–1¼ µ, but mostly 1½–3 by ¾–1 µ. The cells containing spores are the widest. The young cells are rod shaped, with usually abruptly rounded ends, while the fully mature spore-bearing cells are often nearly elliptical in outline. Every gradation between these may be seen in Plate IV, Figs. 1 and 3.

The cells are usually single, or, at most, only in pairs, though sometimes, especially in old fluid cultures, they are arranged in long chains, as seen in Plate IV, Fig. 2. Often these chains are very long, and approximately parallel. These are very rarely composed of spore-bearing cells.

The spore formation is first recognized by a minute spot or zone in the center of the cell remaining unstained, while the rest of the cell stains as usual. As spore formation progresses, the stain-resisting space becomes larger and slightly oval, until, when the spores are fully mature they occupy a considerable portion of the cell. The substance outside of the spore becomes smaller, and, when the spores are ripe, is seen as a dot at either end of the cell; in shape, it is usually concave on the side facing the spore, but is sometimes sharply rounded. The spores meanwhile, have acquired a cell wall of their own, and at length, when the wall of the parent cell breaks, or is dissolved, the spores are set free. All stages of spore formation are shown in Plate IV, Fig. 3.

The spores are oval or oblong in shape, and are about .6-.9 by 1-1.2 µ. They are not colored by any common stain, though, according to Prof. Burrill, "aniline red, with carbolic acid, does stain them." The development of spores into cells has not been watched, owing to lack of opportunity to make hanging-drop cultures, but in many cases all intermediate forms between spores and mature cells were seen in the same culture. In these cases, the staining capacity became greater as the cells became larger. It seems probable that in this species the spores do not germinate, but develop into vegetative cells by a simple increase in size.

In staining capacity, *Bacillus Sorghi* is only medium when compared with other species. Methyl violet, aniline violet and methyl green all stain the cell contents strongly; aniline green, Bismark brown and aniline red nearly as well but with the methyl blue and aniline blue at command, no stain could be obtained. Hæmatoxylon and aniline black stain the cell wall slightly, while fuchsine seems to stain both the cell wall and cell contents. Of these dyes, methyl violet acted most powerfully, though aniline violet or methyl green usually showed the details of structure better.

The zooglœa vary with the culture medium used and with the age of the culture. On potato, the typical color is pearly white, though there is sometimes a slight tinge of yellow or pink. The surface is free from minute roughness, which gives a pulverulent appearance to the zooglœæ of several similar species, though it is wrinkled, except when the culture is very young. The zooglœa is usually thin, but becomes somewhat thicker with age, though it never is sticky. When very old, it is of a dirty white color and very much wrinkled. On agar agar, the general characters are much the same as on potato, but the growth is slower and the resulting zooglœæ thinner. The margin is usually crenate. In fluid cultures, the membrane was often smooth and pitted, but sometimes irregularly wrinkled.

GENERAL ACCOUNT OF CULTURES MADE.

In making potato cultures, sound tubers were selected, carefully cleansed, and then placed on a rack just over boiling water for about half an hour. The tubers were allowed to cool somewhat, and then were removed with a pair of forceps sterilized by heating. They were cut in two halves by a knife which was from time to time sterilized. As soon as cut, the halves were each placed under tumblers on glass plates, both having been previously sterilized by heating several hours in a dry chamber at 150-160° C. (200-220° F.)

In case the culture was from a diseased leaf or sheath, the method of starting the cultures was as follows: The diseased portion was flamed for an instant to destroy any foreign germs on the surface; it was then scratched with a sterilized knife and broken in two; a recently-heated platinum needle was then plunged into the diseased tissue and instantly placed on the surface of the tuber. The tumbler was now labeled and placed in an incubator, where a constant temperature of about 99° F. (37° C.) was maintained. These cultures were liable to be contaminated from the air, since the tumblers did not fit the plates closely. But even when contaminated thus, the growth of the foreign organism always began where the tuber touched the plates, and very seldom reached the cut surface.

The character of the growth of the *Bacillus Sorghi* on potato has been given elsewhere.

In all, fifteen potato cultures were started directly from diseased sorghum plants, mostly grown at Manhattan. Of these, eight gave pure cultures of *Bacillus Sorghi,* two remained sterile, and five were impure. The cultures made when the disease was first noticed were much more successful than those made late in the season. Whenever the part used to start the culture was dried up or hard, it was very difficult to obtain a pure culture. Very many cultures were started from other cultures to test their purity; in this case a minute quantity of the fluid containing the germs or a fragment of the zooglœa was transferred to the surface of the tuber.

Beef broth was used for a culture medium before the agar agar was obtained. It was prepared as follows: Lean beef was chopped up fine and allowed to soak all night in cold water; then it was boiled for perhaps an hour, the fat skimmed off, and the remaining fluid strained through a cloth to separate the particles of meat; then the liquid was filtered into a sterilized flask, and usually made neutral by adding carbonate of soda. The flask was then stopped with a plug of sterilized cotton. The flask and contents both were now heated to boiling for from fifteen minutes to half an hour for several successive days; by this time all contained germs had been killed. Sterilized test tubes, likewise stopped with cotton, were now partially filled with the broth, and were ready to be used in cultures.

The cultures were started by removing the plug an instant and touching the liquid with the infected platinum needle. It was, however, more difficult to obtain pure cultures, as any foreign germs were not restricted in their growth, but also spread all through the fluid. Only five beef broth cultures were inoculated directly from diseased parts, and only two of these gave pure cultures of *Bacillus Sorghi.* The cultures used in inoculating were always started from a zooglœa on some solid medium.

Agar agar cultures were made with beef broth which had been solidified by adding about one per cent. of agar agar or Japan isinglass. This causes the broth to solidify at a temperature of about 40° C. (104° F.) It was treated the same as beef broth, except that it was poured into the test tube while warm, and the tubes were inclined while the medium solidified. This gave an increased surface. The growth of the bacteria on this medium is not so rapid as on potatoes, but otherwise much the same. The agar agar was not obtained till about the middle of August, when the disease was not so severe. Sixteen cultures were inoculated directly from diseased tissue, and of these eight gave the *Bacillus Sorghi*, four remained sterile, and four were impure or contained other organisms.

A few cultures were made in sorghum juice, but owing to the great difficulty encountered in filtering it they were abandoned. In one of the cultures made, cells of *Bacillus Sorghi* were observed in motion. The motion was very slow compared to that of some other bacteria, but was clearly perceptible. For instance, in one case a cell moved 25 µ, or 9 times its length, in fifteen minutes, while inorganic particles in the fluid at the same time showed only the Brownian movement.

Early in September, a few cultures were made on portions of rather young sorghum stems treated much the same as potatoes; that is, the long pieces were boiled a considerable time, and then cut up into small portions and placed under tumblers. They were used with the hope of obtaining the characteristic stain, but nothing of the kind was observed.

In general, the cultures made early in the season gave much better results than those made later. Most of the cultures were made from diseased plants grown on the College farm, but a few were from other sources. About a dozen were made from diseased canes sent from Sterling, Rice county, but owing to the moulded condition of the parts when they arrived, but few of the cultures were entirely pure, although *Bacillus Sorghi* was obtained in at least half the cultures. One of the cultures from diseased cane sent from Sterling gave a *Micrococcus*, shown in Plate IV, Fig. 4, which, however, had nothing to do in causing the blight.

In one case, a chinch bug was taken from a badly blighted plant and a culture started from its body. In this case, three species of micro organisms were obtained, one of them being *Bacillus Sorghi.*

INOCULATION EXPERIMENTS.

To prove that Bacillus Sorghi really causes the sorghum blight, several inoculation experiments were made, of which the following is a condensed account:

Inoculation No. 1. The middle part of a leaf of Kansas Orange, almost entirely free from disease, was wetted on both surfaces with a beef-broth culture containing the organism. This was on July 28. On August 2, the leaf was examined. It had been scratched across with lead pencil to mark the portion inoculated. These scratches were now visible as distinct red marks running across the leaf, but most prominent on the midrib. On the lower surface, especially, many minute red specks could be seen, which were more numerous at the end of the area inoculated. This may be explained by the fact that the leaf hung down, and the inoculating fluid had run to the end of the part wetted. In one place, a drop had run beyond the area inoculated, and its track was made manifest by a line of red specks. Where the leaf had not been touched by the inoculating fluid, it was yet free from disease.

Inoculation No. 2. On the same day, another plant, also of Kansas Orange, was inoculated from the same culture fluid. In this case, the inside of the sheath was wetted by pulling the sheath a short distance from the stalk and dropping in the culture fluid. No effects could be seen in this instance.

Inoculation No. 3 was made the same evening, with same culture fluid, on a variety said to be Red Top, growing on a farm at a distance from the College. In this experiment, the upper sheaths were wetted all over on the outside.

Inoculation No. 4 was the same as No. 3, except that a single leaf was wetted on both surfaces.

On August 8, they were examined. No. 3 showed a few red streaks where the edges of the sheaths overlapped, and also the ligule was discolored, though the stains did not in most cases extend down on the inside of the sheath. But one sheath was considerably discolored.

In No. 4 no effect could be seen.

Inoculation No. 5. On August 8, a healthy leaf of Red Top was inoculated by scratching and pricking with a previously heated needle. Then the middle third of the leaf was wetted on both surfaces with a beef-broth culture of Bacillus Sorghi. On August 15, the leaf was examined. The holes, especially on the under side. were surrounded by a narrow red margin. The scratches were not very red, except where they crossed the midrib, where there was a pronounced red stain, perhaps 1/10 inch wide. Where the midrib was pricked, there were small fusiform red specks.

Inoculation No. 6. On August 8, another plant in the same field was inoculated as follows: A healthy leaf was selected, and injured with a needle, which was from time to time plunged into a diseased sheath from another plant. On August 15, the leaf was removed and examined. Where scratched, and especially where the scratches crossed the midrib, there was a red stain. In this case the most prominent stains were on the lower surface.

On August 9, several sorghum plants (variety unknown), growing in another field, and also a grass and Indian corn, were inoculated from the same broth used in No. 5.

Inoculation No. 7. A leaf and sheath of sorghum were wetted, having previously been injured by a sterilized needle. On August 15, the plant was examined. About the holes were seen pronounced red spots, which extended much farther lengthwise of the leaf than crosswise.

Inoculation No. 8. A head, nearly if not quite past blooming, was placed in the culture fluid. When examined, no effect of the inoculation could be seen.

Inoculation No. 9. was on a corn plant. The leaves were injured and wetted, but in no case was any injury produced.

Inoculation No. 10. A plant of wood grass *(Chrysopogon nutans)* was thoroughly wetted, but no effects were seen.

Inoculation No. 11. On August 18, two pots of Early Amber sorghum, grown in pots in the greenhouse, from soil obtained there, were selected for the inoculation. They had been intended for use in soil tests, and had been raised in large, unprotected pots. At the time of inoculation, a few showed red stains on the axis cylinder. In all cases, however, the leaves were entirely healthy. A bell jar was now placed over each pot, and the plants in the one were thoroughly wetted with a beef-broth culture of the micro-organism, while those in the other were not disturbed. The leaves of the ones inoculation resisted wetting, and the fluid collected in drops or ran down to the junction of the leaf and sheath. By August 21, the effects of the disease could be clearly seen on the inoculated plants. The leaves showed slight red stains and streaks of lighter green, while some of the sheaths also had red stains. Wherever a drop of the inoculating fluid had collected there was a red spot. The plants which had not been inoculated showed no signs of the disease. A few days later, two of the inoculated plants were figured as seen in Plate III, Figs. 3–6.

It will be seen from these few experiments, that of the nine sorghum plants inoculated six showed the stains of the disease; that corn and Wood grass, when similarly treated, showed no signs of any injury. It will be seen from No. 11, that young as well as old plants are capable of being artificially diseased.

SOIL TESTS.

Early in August, experiments were begun to determine whether the disease germs had the power of remaining in the soil and afterwards transmitting the blight directly to other sorghum plants.

The first six experiments were made as follows: Soil collected on the College farm in April was used for Nos. 1, 3 and 5, and soil from the greenhouse for Nos. 2, 4 and 6. The soil from the farm was collected for another purpose on the site of a sorghum field of the previous year. Sorghum (series D) planted here after this soil was collected was very much diseased. The soil from the greenhouse was obtained far from any sorghum fields.

The pots were placed in the greenhouse, and watered with the other plants from a tank of rain water. Nos. 1 and 2 were African Sorghum in the two soils used; Nos. 3 and 4 African Millet; and Nos. 5 and 6 Rural Branching Sorghum. The plants came up, and grew with apparently equal vigor in both kinds of soil. No stains could be observed on the upper leaves, but the plants in soil from the old sorghum field frequently showed stains on the lowest leaf. It may be that the blight would have appeared on the other leaves if the plants could have been kept longer, but owing to their rank and slender growth it was necessary to throw them out in about a month.

In one respect a great difference was observed in regard to the plants grown in the different soils. In those raised in soil from the old sorghum field, the portion of the stem (axis cylinder) between the seed and the surface of the soil became very speedily stained of a deep red color; while the same variety planted in soil from the greenhouse, but otherwise under the same conditions, showed such injuries not at all or only to a slight extent. Thus, on August 10th, ten plants of African millet were pulled up from both Nos. 3 and 4. The ten plants from No. 3 were *all but one diseased* in the manner described, while the ten plants from No. 4 were *all but one free* from disease. The African Sorghum and Rural Branching Sorghum, being varieties less liable to the disease than African Millet, showed fewer stains, and, hence, less difference between the plants grown in the two soils. Cultures were made at once from these diseased stems, and gave a remarkably large per cent. of pure cultures of a *Bacillus* which seemed to be very much like the usual form of *Bacillus Sorghi*, though it differed in some respects, especially in that when young the cells had the appearance of being granular within. However, in older cultures, this difference disappeared. This form of the organism was used in inoculation No. 11 and produced the stains shown on Plate III, Figs. 3-6. The same plate also shows (Fig. 2) the appearance of a healthy plant of African millet (soil test No. 4) grown in greenhouse soil, and a diseased one (Fig. 1) grown in soil from old sorghum field (soil test No. 3).

When the plants in these soil tests became older, all became more or less diseased, though in all cases those grown in greenhouse soil were less blighted. It may be that the disease spread from one pot to another, since they were close together, and not protected in any way. In the older plants, not only was the axis cylinder diseased, as shown in Plate III, Fig. 1, but also the principal roots of the plant, starting from just below the surface of the ground.

These experiments are especially interesting from the fact that the sorghum planted later on the soil used in Nos. 1, 3 and 5 was very much blighted.

In case of soil tests Nos. 7 and 8, Late Orange sorghum was planted on August 22. In No. 7 the soil was collected on the same day, from the field which in April furnished the soil for Nos. 1, 3 and 5. The soil for this test was obtained about the roots of a plant of Yellow Milo Maize that had been killed by the blight. The soil for No. 8 was obtained at the same time and at the same place, but was heated to 160° C. (220° F.) for several hours, to kill any contained germs. Both were placed under bell jars in the greenhouse as soon as planted, and watered from a tank of rain water. The soil in No. 8 did not, however, remain sterile, probably because of the water used; and the experiment was further vitiated by the fact that the seed planted was very poor, and only three plants grew in No. 8 and nine in No. 7. Moreover, the Late Orange is one of the varieties but slightly susceptible to the blight; yet, when the plants were removed and examined, on September 13, a great difference could be observed between the plants in the two pots. Those grown in heated soil were almost free from stains, while the axis cylinders of those grown in soil not so heated were deeply stained, and even in some cases shriveled.

Soil tests Nos. 9, 10 and 11, planted on October 18 with Yellow Milo Maize, were conducted on much the same plan as in Nos. 7 and 8, but with more care. The soil in No. 9 was collected as in No. 7— about the roots of plants of Yellow Milo Maize killed by the blight. In No. 10, the soil was from the same place, but was carefully sterilized by heating six hours to a temperature of 200° C. (392° F.). In No. 11, the soil was from the greenhouse. All were placed under sterilized bell jars in a new part of the greenhouse. Nos. 9 and 11 were watered from the tank at the greenhouse, but No. 10 with sterilized distilled water.

Some of the plants in the tests were collected on October 27, and the remainder on October 31. The total number of sound and of diseased plants in each case is as follows: In No. 9, one healthy and fourteen more or less diseased; in No. 10, thirty-three sound and eight slightly diseased; in No. 11, seven healthy and eight diseased.

The presence of so large a number of diseased plants in No. 11 would seem to indicate that either the soil or water, or both, had become infested with the disease, producing *Bacilli*.

These soil tests seem to warrant the conclusion that the disease is transmissible, to some extent at least, through the agency of the soil.

CONCLUSION.

It will be seen from the foregoing, that the causes and symptoms are for the most part already known; yet there are several questions in reference to the disease that demand further investigation; and a report of subsequent work will be given when additional data or conclusions warrant publication.

It should be observed, however, that prevention of the disease to a greater or lesser extent is certainly possible. The minute organisms, or *Bacilli*, which cause the disease continue to live in the old stalks, as successful cultures at the time of this writing clearly proves. Prof. Burrill found them in the stalks that had remained in the field the entire winter. It is evident, therefore, that the old stalks and stubble should be destroyed. It is not sufficient to plow them under, as in such case the disease-producing germs will not likely be destroyed. THEY SHOULD IN ALL CASES BE BURNED. The more carefully the diseased plants are collected, and in this manner destroyed, the more effectually the disease is likely to be checked.

A rotation of crops is also advisable, and in no case should land that may probably contain the micro-organisms be planted to sorghum. Prof. Burrill observed that the disease was more abundant in those fields in which diseased plants had grown the previous year. In one field of the College farm, (plats in series D,) the disease in a mild form prevailed the previous year. However, in the field containing the other plats, more than a quarter of a mile distant, and where the severest form of the disease prevailed among some of the varieties, no sorghum had ever been planted. The field was previously in grass. Neither had sorghum been cultivated in any of the fields immediately adjacent. While, therefore, the mode of infection from year to year is still obscure; it is yet perhaps safer in practice to assume that this may occur through the medium of the soil. Prudence would, therefore, dictate an observance of the above suggestion.

BRANCH KNOT OF THE HACKBERRY.

A disease of hackberry trees *(Celtis occidentalis* L.), causing the formation of "knots," composed of usually more or less compact twigs on the branches, has been noticed for some time past, in the vicinity of Manhattan. The disease is found on both wild and transplanted trees. Those however, in the dense woods, are seldom attacked, while isolated individuals are especially liable to the disease. It has also been noticed in other parts of the State. Mr. S. C. Mason saw in

Salina (spring of 1883) trees quite disfigured by the disease; also, later, at Wakefield, where, as in the former case, the trees had been transplanted. Trees affected with the disease were noticed three years ago, in Brown county, by Mr. J. S. Hazen. They were native trees, eight or ten inches in diameter, but the knots were not numerous. He also noticed the same on young trees transplanted to a dooryard. They became so badly disfigured as to require removal. Though knowledge of the distribution of the disease is limited, it undoubtedly occurs all over the State.

The disease was supposed to be caused by insects, and no special observations were made until last March (1888). It was then discovered that the buds on the knots were infested with a powdery mildew and a gall-mite. The mildew proved to be a new species, and was accordingly described in the JOURNAL OF MYCOLOGY, Vol. IV (188/8), pp. 93 and 94, as follows:

Sphærotheca phytoptophila KELL. & Sw.-Mycelium very sparse; perithecia globular, dark brown or black, obscurely reticulate, 60–80 micr., mostly 65-75 micr., in diameter; appendages few, more or less evanescent, dark brown, irregular, but usually about 6 micr. in diameter, and mostly longer than the diameter of the perithecia, often septate. Asci large, hyaline, broadly oval, containing 8 spores, which are hyaline, oval, regular in size, 15x24-28 micr. Conidial stage: Mycelium more abundant, conidiophores hyaline, erect, total height (including conidia) 150–220 micr. by 9–13 micr. in diameter, conidia oval hyaline, continuous, granular within, 15x21–29, mostly 15x27 micr. On *Celtis occidentalis*, Manhattan, Kansas.

The fungus is found associated with *Phytoptus* (an undescribed species) on hackberry *(Celtis).* The distortions caused by the insect, or perhaps by both insect and fungus, consist of a multitude of abnormal, more or less abortive, branchlets, that form a compact knot ½ to 1½ inches in diameter; a few of the branchlets are prolonged a few inches, and themselves bear smaller knots of similar structure. The abortive branchlets have excessively numerous buds, all infested by the insect and covered by the fungus. The conidial stage is found associated with the perithecia, and sometimes even extending out on the twigs to the under side of the leaves. The perithecia are found in the spring, but do not mature their spores till late fall or winter.

The gall-mite, a species of *Phytoptus,* may also be, as noted above, an undescribed species. This is a very interesting case of co-parasitism of two very different forms. As far as seen, these two organisms, the one vegetable and the other animal, are always associated together. Whether they could live independently of each other, and if so, what effect each might have on the host-plant little is at present known, though it is hoped that culture experiments can be made the coming year to determine these points. A few buds were observed apparently free from the mildew but infested by the mite; they were distorted less than usual and the twigs bearing them were distorted very slightly.

CHARACTER OF THE INJURIES PRODUCED.

The infested trees bear knots, composed of numerous abortive branchlets, which often bear secondary knots. These masses of twigs are readily visible, even at a considerable distance, both in winter and in summer, though of course they are more easily seen after the leaves have fallen from the trees. These knots are usually most abundant on the lower branches of the tree, but in some cases large knots were seen on the topmost branches. The injuries to the tree consist (1) of disfiguration, sometimes ruining it as an ornamental plant; (2) in waste of nourishment consumed in building knots, useless to the tree, which otherwise would have contributed to the growth of branches and leaves and (3) of decay of the branches attacked; this decay extends, usually, no further than the branches attacked, but sometimes it involves the trunk also.

Of the injuries mentioned, the first is perhaps the most important, though the second and third may lower the vitality, and cause the dwarfing, or even death, of the whole tree. The first appearance of the disease is almost invariably in the buds, on wood at least one year old. The infested buds at this stage present the same characters as those of older distortions, which will be described below. They are, however, usually small, and often there are many small swollen ones, instead of a single large bud. Rarely the bud is killed at this stage, and the knot progresses no further. Usually, however, these infested buds produce the following year shoots which often make a vigorous growth, and bear numerous buds, or similar abortive branchlets. The buds are more numerous than usual along the whole twig, but especially so near and at the base; they are also all diseased. The infested twigs may readily be detected at this time, by reason of the greater number of buds, which are usually of greater diameter than normal ones.

During the following year, the development of the knot varies somewhat, according to the vigor of the branch attacked. If the latter is healthy, and making rapid growth, its buds develop into branchlets similar to the original branch, and these secondary diseased twigs may also produce diseased twigs in the same manner. If this mode of growth is continued several years, a loose or open cluster of diseased twigs is formed. Such an infested branch may grow several feet in length, bearing numerous diseased lateral branches along its whole length. But in all cases the infested buds or secondary knots are more numerous toward the base of the branch attacked. If on the other hand, the attacked branch be weak, the growth after the second year is different: the lateral buds fail to develop, and only those at the base grow, producing a multitude of abortive twigs, themselves clothed with perfect buds only near the base. When this mode of development continues several years a very compact knot is formed, having a firm, woody center, often an inch or more in diameter. This knot is clothed with very numerous dwarfed twigs, liberally supplied with the infested swollen buds at the base.

These two types of knots are shown in Plates V and VI. It is readily seen that the knot represented in Plate V is much more open than the one in Plate VI, yet neither shows the extremes; many are much more open or diffuse than the one shown in Plate V, and again many are much more compact than the one in Plate VI, and show few or no secondary knots on the twigs. In fact, every gradation may be seen on the same tree; the lower, less vigorous branches bearing the compact form, and the topmost and rapidly growing ones usually bearing the open form.

The healthy buds of the hackberry vary considerably in size and shape, some of them being as much as 4 mm. long and 2 mm. in diameter and conical, while others are flattened and are much smaller, being from 1 to 2½ mm. long. All are in in color some shade of brown, the larger ones being lighter, and all are regular in outline, smooth and end in a point. The bud consists of a short axis clothed with many rudimentary green, bract-like leaves and a number of brown, lifeless scales, closely enveloping and protecting the delicate shoot within. The outer scales are regular in outline and thickness, and clothed with many or few hairs. Their cells are small, rounded, thick walled, and often filled with a brown or reddish pigment. The inner scales or bract-like leaves differ from the former in being smaller and often somewhat distorted by pressure. Their cells have thin walls, and contain chlorophyll, as does also the central axis. The epidermis of all the scales is regular, except that some of the cells are developed into hairs.

The diseased buds are also very variable in shape and size, the smallest being as small as the smallest healthy buds, while others are as much as 7 mm. or more in length. They are of greater diameter than healthy buds of the same length. They are very commonly 3 mm. or more in diameter, while normal buds are rarely more than 2 mm. Often they are nearly as broad as long, which is never the case in healthy buds. Besides the difference in size and shape, the diseased buds differ from normal ones in being of a grayish or cinereous color, in their more or less irregular outline in cross section, in not being definitely and sharply pointed, in being crowded very closely on the twigs, and in being more open and hairy. All the parts are more or less distorted by the parasitism of the gall-mite and mildew. The bracts are usually increased in size, and more of the inner leaves are scale-like. They are irregularly bent, and their surfaces are no longer sensibly parallel, but warted and furrowed in a most irregular manner. Owing to increase in size of the parts, the bud is more or less open, instead of normally compact and solid. The epidermal cells of all the affected scales and axis are very abnormal. The distortion often extends to nearly all the cells of a scale, but the epidermal layer is always affected most extensively. The hairs are usually numerous, and often enlarged at the base. Thus, while the normal hairs are usually not more than 25 µ in diameter, the hairs on diseased parts are often twice as broad below. In length, they do not differ from those on healthy parts, but the ends are very often curved.

The outer bud scales are most severely attacked by the mildew, but perithecia, or fruiting bodies, may also be found covering the inner scales, and even on the central axis. In this respect, the fungus is peculiar, as members of the group to which it belongs usually are found only on the surface. The gall-mites, on the contrary, seek the inner, living parts, and are found most abundantly in the spaces between the young leaves at the base.

Since the knots rarely, if ever, originate on wood less than one year old, they are not found on the ends of the branches, though occasionally they seem to be terminal. The reason for the latter case is found in the fact that sometimes, after the knot is two or three years old, it absorbs so much nourishment that the original branch beyond the knot dies and breaks off. In many cases diseased twigs grow more rapidly in size, and are more numerous than healthy twigs of the same branch. These facts seem to indicate that a considerable amount of nourishment is consumed by the knotty branches. And when it is remembered that hundreds or even thousands of these distortions may occur on a single tree, it may readily be seen that the health of the tree might be seriously impaired. The knots usually continue to grow many years. Examples were abundantly found which must have been at least six or eight years old. Finally, the portion of the branch bearing the knot dies, or the knot itself dies, leaving an excrescence on the branch. In many cases, a line of decayed wood could be traced downward on the branch from a knot, though the latter appeared to be composed of living tissue. The knots often occur on short branches, and in such case the decay is very apt to involve the trunk also. A branch once attacked rarely completely recovers, being dwarfed or killed outright.

To what extent the injuries to the host are due to the fungus, rather than to the mite, could not be determined, as they were always associated together in the numerous cases observed. It is probable that they both have a considerable share in the production of the knots.

GENERAL CHARACTERS OF THE POWDERY MILDEWS.

The mildew, or *Sphærotheca* of the hackberry knot belongs to the family called by botanists *Erysipheæ*, which is included in the great group ASCOMYCETES, bearing the spores in sacks, or *asci*. The *Erysiphyeæ* inhabit living plants, their usually abundant white mycelium forming a powdery coating on the affected parts. It consists of branched, septate, colorless threads, which, unlike the mycelium of most parasitic fungi, do not enter the tissues of the host. These mycelial threads press closely to the epidermal cells, and at intervals fasten themselves by means of flattish expansions, which differ in shape and size in different species. According to De Bary,* delicate tubes arise from the under surface of these expansions, pass through the epidermis and swell out inside the cell into a bladder-like body, varying in shape in the different species.

In most if not all species, there arises, usually during summer, simple, erect, rather short hyphæ, called *conidiophores*, which produce at the end (by constriction) numerous oval or spherical, thin-walled, colorless cells, called summer spores, or *conidia*. These are carried about by the winds, and by their germination and growth serve to rapidly spread the parasite. In a few species, only this summer-stage is known, but it is probable that all have another, or winter-stage. This is known to be the case for most of the species. The winter-stage is a

* Comparative, Morphology and Biology of the Fungi, Mycetozoa and Bacteria. Authorized English translation by H. E. F. Garnsey, M. A., and Isaac B, Balfour, M, A., F. R. S. 1887, pp. 19 and 20.

true fructification resulting from an act of fertilization similar to that occurring in the higher plants.

The roundish black bodies, which are produced, are called *perithecia.* They are furnished with few or many radiating appendages (Plate IV, Figs. 9 and 10). These vary in length and shape in the different genera, and are generally larger and much firmer than the threads of the mycelium. The perithecia are sometimes large enough to be seen without the aid of a lens, appearing like minute black dots. Their wall, or outer covering, is composed of many dark, firm cells. Within is found one or more large cells (asci), each filled with several (sometimes only two, but usually eight) bodies called spores, or *ascospores.* In spring, these spores germinate and "put out a short germ tube, which, on a suitable substratum, namely, the living epidermis of certain Phanerogams, sends out, first of all, a *haustorium* into a cell of the epidermis, and there develops into the filamentous branched thallus [mycelium], which spreads over the whole surface." *

The following simple key exhibits the salient characters of the principal genera of *Erysipheæ:* †

Perithecia with a single ascus (1).
Perithecia with several asci (2).
1. Appendages similar to the mycelium . . . . SPHÆROTHECA.
1. Appendages dissimilar, ends dichotomous . . . . PODOSPHÆRA.
2. Appendages similar to the mycelium. . . . ERYSIPHE.
2. Appendages dissimilar to the mycelium (3).
3. Appendages simple-not forked at the tip (4).
3. Appendages dichotomously branched at the tip . . . . MICROSPHÆRA.
4. Appendages curved at the tip . . . . UNCINULA.
4. Appendages needle shaped inflated at base, PHYLLACTINIA.

Two species of *Erysipheæ* have been heretofore reported on the hackberry, both belonging to the genus *Uncinula.* ‡

*DeBary, l. c., p. 225.

† For a fuller account with, figures, see Burrill, Bulletin I11. State Lab. Nat. Hist., Vol. II, Art. VI, pp. 395-397.

‡ *Uncinula parvula* C. and P.: Erysiphei of U. S., in Journal of Bot., 1872. Burrill, l c. p. 409. And *Uncinula plœocheta,* B. and C. *(Plœocheta Curtisii,* SACC and SPEG.) For a full account of this species, see Tracy & Galloway in Bot. Gaz., Vol. XIII (1888), pp. 29-32. It differs from *U. parvula* in its much larger perithecia and very numerous appendages, which are clavate in immature specimens. Both species occur on hackberry leaves.

A species of *Microsphæra (M. erineophila* PK.*) has been reported on the distortions caused by a *Phytoptus* on the leaves of birch. It is not stated whether the fungus is always associated with the mite. Other than this, we know of no species, except *Sphærotheca phytoptophila* KELL. & SW., which is so closely associated with a *Phytoptus.*

CHARACTERS OF THE MILDEW OF THE HACKBERRY KNOT.

In this species *(Sphærotheca phytoptophila),* the mycelium is always sparse. It is most abundant on the new growth in spring and early summer, when it covers the young buds and the portion of the twig adjacent to them, or even extends out as far as the under surface of the leaves. It is composed of hyaline (colorless), branched, sparingly septate threads 3–10 µ (mostly 4–6 µ) in diameter. What seemed to be the expansions for attaching the threads to the epidermis was seen in several specimens. They were small, oblong, flattened, being but slightly larger than the normal hyphæ. No haustoria were seen, the epidermal cells being so distorted as to make it very difficult to get a good section. Arising from the mycelium, in spring and early summer, were seen the conidiophores, which were on some specimens very numerous. They were erect, unbranched, and tapered from the diameter of the mycelium at the base (4–6 µ) to 12–18 µ at the top. Their total height (including the conidia) was from 150 to 220 µ. Above they became many septate, and merged into the conidia, which were constantly falling off at the top. The conidiophore showed scarcely any constriction at the few septa towards the base, but above the cells were barrel-shaped. The free conidia were oval, elliptical, or sometimes cylindric-elliptical. They were 20–30 µ long and 12–18 µ wide, but were usually 25-28 µ long and 13–15 µ wide; they were colorless, thin walled and granular within. The height of the conidiophores is sufficient to expose them to the wind. The conidia drop off

*Bulletin of the Torrey Botanical Club, Vol. X., p. 75, Burrill, l. c. p. 419.

on the slightest disturbance, and therefore they are readily blown from branch to branch, or even to other trees.

The formation of the perithecia begins as soon as that of the conidiophores, and soon may be seen in all stages of growth. At first they are composed of hyaline cells however, which, become colored before the appendages are developed. The mature perithecia are dark brown or black, and approximately spherical in shape, though one diameter is often slightly longer. They range from 56 to 80 µ in diameter, but are mostly 66 to 78 µ. The outer wall is composed of polygonal cells, which may be irregular or approximately hexagonal in outline. (Plate lV. Figs. 9 and 10.) They are very seldom triangular or quadrate. In size, the cells vary from 9 to 22 µ in diameter, but are mostly 14 to 20 µ long, and 10 to 15 µ wide, being sometimes isodiametric, but usually longer in one direction. The appendages arise somewhat irregularly, but mostly from the side of the perithecium nearest the substratum. They begin as a simple enlargement of a cell of the outer wall. In number, they are variable, being from 4 to 12 or more, usually 5 to 10. They vary yet more in shape and size. Sometimes they are short, thick, and irregularly bent, and again long and slender, being from less the diameter of the perithecium to 400 µ or more in length; they are 4 to 12 µ in diameter at base, sometimes tapering to 3 µ at the free end. The ends of the largest appendages are often hyaline and seemed to be broken off, but the shorter ones have rounded ends. It is quite probable that the long appendages really become a part of the mycelium, and serve to absorb nourishment. Only one of the two branches into which they often divide becomes developed the other remaining abortive. They are usually of the same color as the perithecium at the base, but sometimes become lighter toward the ends. They are very brittle after the maturity of the perithecium. The interwoven appendages of the very numerous perithecia form a coating on the affected bud scales, which may be easily mistaken for dark-colored mycelial threads, especially since the true mycelium has by this time nearly disappeared.

The inner wall of the perithecium is very evident in this species. It is thicker at the base of the ascus, gradually becoming thinner upwards. As seen in mature specimens, it usually incloses from one-half to three-quarters of the ascus. It readily separates from the outer wall, and often remains around the ascus when the perithecia are crushed. In perithecia, collected in June, the inner wall sometimes nearly or quite inclosed the ascus. The cells of this envelope are approximately the same shape as those of the outer wall, but vary more in size in the same perithecium. They are from 9 to 20 µ in diameter, and in the thickest portion about 5 to 6 µ thick. Some of the cells are filled with minute granular matter, and others are empty.

The ascus is broadly oval, and nearly filled with the eight sporidia. The wall is thickest at the sides (1½-2 µ). At each end there is a thin area, the larger one below, where the wall is only .5–.6 µ in thickness. This character can scarcely be detected when the ascus is immature and filled with protoplasm but at maturity it is very evident. The asci are from 59–78 µ long, and from 36-58 µ wide, being usually 60–70 by 40-55 µ. The length of the ascus is nearly as great as the diameter of the perithecium.

The sporidia are large, oval or elliptical, and range from 20–32 µ in length, and from 11–17 µ in width, being mostly from 22–30 by 12–16 µ in width. They are granular, or often coarsely granular. Some of them were observed to be nearly ripe in summer, and some still immature in January, but most of them mature in autumn.

PARASITES OF THE MILDEW.

A parasite, known to botanists as *Cicinnobolus Cesatii* De Bary, was found on the conidial stage of the *Sphærotheca.* It attacked the conidiophores and prevented the formation of conidia. Sometimes the spore cases of the parasite were attached directly to the mycelium of the mildew. It has long been known, both in Europe and America, as a beneficial parasite of various *Erysipheæ.* It consists of subspherical, oval pyriform or irregular perithecia, which either occupy a part of the conidiophore, or are seated on the mycelial threads. When it attacks the conidiophore, one of the lower cells swells up and is seen to contain a darker reticulate body, namely; the young perithecia of the *Cicinnobolus.* To this are attached very delicate mycelial threads, clearly seen in fresh specimens. As the perithecium develops, the upper part of the conidiophore shrivels and dies, but usually does not fall off. The mature perithecia are of a yellowish color, and from 75–110 μ long and 22–50 μ wide, usually 75–90 by 28–34 μ.* Their wall is composed of cells somewhat similar to these of the perithecia of the *Sphærotheca,* but the cells are often quadrate. They are about 4–9 μ in diameter. The perithecia are filled with sporules, which are hyaline, oval or oblong, straight or curved, continuous, and often contain a spot or granule at both ends. In size, they are from 6-10 by 2–3½ μ. Besides this parasite, several other fungi were found associated with the *Sphærotheca,* apparently all saprophytic, namely, a *Fusarium*, a *Microsporium* and a *Phoma.*

AN ACCOUNT OF THE GALL-MITE.

The gall-mite associated with the mildew belongs to the genus *Phytoptus,* which is one of the ACARINI, a family which includes the red spiders, cheese mites, sugar mites, etc. The gall-mites have four legs ending in a claw and a feather-like organ, a tubular beak or rostrum, including a pair of maxillae ; and a long, usually cylindrical, transversely striated abdomen, ending in a sucker. All the species are extremely small, and all feed on the tissues of plants. Most of the species live in

*According to Saccardo, Syll. III, p. 216, No. 1293, and F. Von Thuemen, Pilze des Weinstockes, pp. 178–180, the size of the perithecia is 25-35 by 9–15 μ: and of the spores, 2½–3 by 1 μ. But a measurement of European specimens showed that they are larger. Specimens of *Cicinnobolus Cesatii* DE BARY, on *Salvia glutinosa* L., in Rabenhorst Fungi Europæi, No. 1733, had perithecia 48–85 by 24–40 μ and sporules. 6–8 by 2–3 μ: specimens on *Vitis vinifera,* under the name of *Cicinnobolus Oidii Tuckeri* MOHL, in Rab. Fungi Europæi, No. 2215. had perithecia 30–55 by 15–27 μ — sporules not seen. A measurement of the figures in De Bary's Comp, Morph. and Biol., Eng. Trans., 1887, p 247, Fig. 119, gave for the two perithecia the sizes 82 by 43 μ, and 83 by 35 μ. Three sporules gave the sizes 6½ by, 2½ μ, 10 by 3½ μ and 9 by 3½ μ, according to the magnification given in the printed explanation. Forms similar to that on *Sphærotheca phytoptophila* were found on the mycelium of some *Erysiphea* on *Echinospermum Virginicum* LEHM.

galls or distortions on the leaves; a few are found in buds. They have no winged state, but are able to move slowly by means of their legs and abdominal sucker. They moult several times before maturity.

The mites, or *Phytopti,* of the hackberry, very abundant in the infested buds, are found in winter only in the inner green parts, between the bracts or rudimentary leaves. It is probable that they attack all parts of the bud, or even the leaves and twigs, during the summer months.

In color, these mites are a faint pink; the body is elongate-cylindrical, or sometimes flattened-ovoid. The mature individuals are from 100 – 190 μ long and from 20 – 50 μ broad. The common size of the cylindrical form is from 120-190 by 36-48 μ. The legs bear a feather-shaped organ having five pinnæ on each side. The abdomen is marked with 50 – 70 (usually 55 – 65) striæ, which in a few cases are branched, The striæ are less numerous below than on the sides. As many as eight pairs of hairs were seen arising from various part; of the body; all were seated on small tubercles. The smallest of young *Phytopti* seen in knots collected in summer was 60 μ long and 28 μ wide.

REMEDIES FOR MITES.

Since mites have no winged stage, and can move but slowly, it is readily understood why the disease which they may in part cause does not rapidly spread from tree to tree. They probably fall, or are blown from one branch to another. It has also been said that the wind wafts them about on leaves or broken twigs, and that birds carry them in their plumage. Various remedies have been proposed, most of them having reference to species inhabiting leaves. It appears that sulphur, applied in several ways and various combinations, has proven most effectual. Mixtures of soap, sulphur and water, also soap suds and other preparations, have been used. These are effectual when they reach the mites, but when the latter are protected by the galls which they inhabit, it is almost impossible to eradicate them by such methods. A very effectual remedy is to pick off the infested leaves and burn them — a process that can be resorted to only when the plants are small, or of sufficient value to warrant the expense. It might be desirable in some cases to cut down and burn the entire infested tree, to prevent a farther spread of the disease. The remedies, it will be noticed, are such as might perhaps be applied with some degree of success for the destruction of the powdery mildews.

REMEDIES.

In applying remedies for the branch knot of the hackberry, it is to be remembered that the destruction of both the mildew and mite is to be aimed at. Owing to the protection afforded to both by the bud scales, it is probable that no solution or powder can be found which will kill the parasites, and not, at the same time, the buds also, if applied in winter. In summer, however, the case is different. At this time, the spores of the mildew are not protected by thick-walled cases or perithecia, as they are in winter. The summer spores and mycelium, or vegetative threads, are quite delicate, and easily destroyed; and the mites at this season are not so effectually protected by the bud scales. Sulphur and its compounds are valuable remedies both for gall-mites and mildews.

By pruning off the knots, and taking care to remove every twig that bears infested buds, or, if the tree is badly infested, cutting off all the branches which bear knots, in winter, and burning them and then spraying during the summer, it is probable that the disease may be entirely eradicated. In selecting young trees for transplanting, care should be taken to select only those that are entirely free from any signs of the disease. None should be taken from the near vicinity of infested trees. The coming season will perhaps afford opportunities to test various remedies, concerning the results of which communication will be made later.

EXPERIMENTS IN CROSS-FERTILIZATION OF CORN.

A large number of varieties of corn was planted May 5th; after an interval of about ten days the same kinds were again planted in an adjacent row. This was repeated, after a similar interval, a third and a fourth time. In this way, ripe pollen and receptive pistils (silk) were secured for crossing varieties that ordinarily mature at different times. The plat was not cultivated throughly, the hoe being used instead of cultivator. This would account partially for the small ears that were generally obtained and possibly also in part, for failure in securing successful results in many cases. Some varieties failed to germinate or perished later and some were not used, so that the experiments were limited to those named in the table below.

The plan of effecting the desired fertilization was as follows: When the tassel had attained its full growth and the pollen was about to be discharged, it was enclosed in a paper or cloth sack. At first manila bags were used, but they were found to be too stiff to handle and tie satisfactorily, and were injured by rains; they were therefore abandoned. Cloth sacks were found effective and satisfactory. Cotton cloth was selected whose meshes were smaller than the diameter of the pollen grains; it therefore prevented the passage of the same. In order to test the efficiency of this cloth, ears were enclosed in several cases, but no pollen introduced: in all such cases no grains at all were fertilized, thus proving that the cloth was an effectual barrier to the passage of the pollen.

The sacks were made of pieces of cloth 18 inches square folded once and sewed on the side and one end. The uppermost leaf was usually enclosed with the tassel in the sack, which was then tied tightly, so as to prevent the pollen from falling out, and yet not so tightly as to injure the stalk. In a few cases, the pollen was used from tassels not previously enclosed. Absence of date of enclosure of tassel, in the table below, indicates such cases. The ear just before the emergence of the silk was enclosed by similar cloth — a cylinder instead of a sack being used. This was slipped over the stalk, which was accomplished without injury to the blades by pressing them upwards close to the stem. The blade at the ear was generally cut away in order to secure the latter more effectually. The upper end of the cloth cylinder was tied closely to the stalk with soft twine. In some cases the stalk was surrounded by a layer of cotton before tying, but it was afterwards abandoned, as the entrance of the pollen could without this precaution be effectually prevented. The lower end of the cloth cylinder was tied closely to the stalk just below the ear. The cloth was large, and loose enough to allow proper growth of the ear. No pollen could now reach the pistils, or silk, unless artificially supplied. Desired crosses could therefore be made, or self-fertilization brought about, at will.

Examination of the pollen or pistils and experimentation on windy days was so far as possible avoided. The tassels not wanted were generally cut off and removed from the field and there was no other corn in the immediate vicinity.

The mode of applying the pollen was as follows: The sack over the tassel of the variety whose pollen was desired was carefully removed and carried to the ear to be fertilized. The cloth cylinder covering the latter was loosened below and lifted so as to expose the silk, on which the pollen was then copiously sprinkled by hand. The cloth cylinder was then readjusted and tied again. The sack was usually replaced over the tassel from which it was taken. The ear remained inclosed by the cloth not only until the silk was entirely withered and dead, but in the majority of cases until the grains were ripe and the ears removed from the stalk.

No full record of observations was kept in regard to other details than those presented in the tables and notes given below; yet it might here be mentioned that the silk, when not fertilized upon its first emergence, remained receptive a few days. In fact, it remained fresh in some cases at least many days; whether it remained receptive to the pollen an equally long period of time, no experiments were made to determine. The silk, or pistils, from the young grains (ovaries) nearest the base of the ear emerge from the husks earliest, and a single, but very early, application of pollen may account for the full development of the grains only on that part. For observations on this subject, see an article by A. A. Crozier, in the Botanical Gazette, Vol. XIII, No. 11.

It will be seen from the table and notes below that forty-one varieties were used in the experiments. The number of attempts to induce self-fertilization were five, of which three were successful, namely, Nos. 10, 18, 35, * and two were unsuccessful.

In three cases fertilization was attempted with pollen from the same variety of corn, but produced by a different stalk. Of these, but one (No. 36) was successful.

The number of cases of cross fertilization attempted was sixty-six, of which thirty-nine were successful and twenty-seven unsuccessful.

Of the successful crosses, twenty-three were made on the flint and dent varieties. Doubtful evidences of the effect were observed in five cases, (Nos. 9, 11, 14, 16, 24,) and in the remaining eighteen (Nos. 1–8, 12, 13, 15, 17, 19–23, 25,) there were no visible effects whatever of the cross.

Three successful crosses were made on soft or table corn; of three, one (No. 26) showed no signs of the cross, but the other two (Nos. 27 and 28) did show clearly the effects.

On the varieties of sweet corn ten successful crosses were made. Six of them showed unmistakable evidence of effects in the ears, namely. Nos. 30, 31, 32, 37, 38, 39; two were doubtful, namely, Nos. 34 and 40; and two (Nos. 29 and 33) presented no visible evidence whatever.

The successful crosses made with the varieties of pop corn were three in number. In one case (No. 41) there seemed to be no evidence of the effects. The other two ears were accidentally destroyed before they had been examined.

* These and the following figures refer to the corresponding numbers in the paragraphs headed "Notes on Ears obtained."

It is of course not impossible that ample evidence of the effects of the crossing may be seen the second year. Accordingly, the doubtful cases, as well as those presenting this year no evidence whatever of the crossing, will be planted next season to obtain any evidence that may then appear.

Besides the five attempts to induce self-fertilization in plants of some varieties in the manner detailed above, another having the same end in view was carried out, as follows: Three stalks were enclosed a few days before the maturity of the pollen and protrusion of the silk, in three separate boxes nine feet high, and three and three and one-half feet respectively in the two horizontal dimensions. The east and west sides of each box were made of wood, with a window sash and glass inserted in the upper part. The north and south sides and top were covered with a continuous piece of cotton cloth, of the same quality as that used in the experiments explained above. The boxes were made "pollen tight." One box was not opened until the corn was dead, at the end of the season. It was observed that when the pollen was ripe and discharged, it fell in abundance on the protruding fresh silk. The stalk in the second box was artificially fertilized with its own pollen; that is, the box was entered and pollen taken from the tassel and placed by hand on the freshly exposed silk — the box being again made pollen tight. The stalk in the third box was supplied with pollen from stalks of the same variety grown outside of the box, applied in abundance by hand. Its tassel had been previously enclosed, preventing the possibility of self-fertilization. The stalks grew with apparent full health and vigor — but possibly might have been checked somewhat by their growing against the cloth covering at the top of the box, pushing it upward, and becoming themselves much bent. The result was the same in all the cases, namely, no successful fertilization — no grains at all appearing on the cob. Had but one stalk been experimented upon, namely, that in the first box, and no control plants been used as those in the second and third boxes, the conclusion might have been similar to that of Prof. I. P. Roberts, of the Experiment Station at Ithaca, N. Y., in case of his experiment detailed in Studies in Practical Agriculture, Cornell University, 1887, p. 26, namely: That *it pointed strongly toward the incapacity of the corn plant to close-fertilize.* But *cross fertilization,* although under similar conditions, was likewise unsuccessful. It seems proper, therefore, to regard this experiment as absolutely worthless, so far as regards positive evidence pointing toward the incapacity of corn to self-fertilize.

LIST OF VARIETIES.

The greater number of the field varieties planted were obtained from the Farm Department, and their full history is given in the report of that Department. Such varieties as were not obtained from this source were from either the Horticultural Department, the local seed dealers, or the neighboring farmers.

The following list gives in alphabetical order the names of the varieties planted, followed by the numbers under which they are given in the table, and also the most obvious characters of the kernels (not ears):

Adams' Early Table, Nos. 58-61: White nearly smooth soft dent.
Angel of Midnight, No. 47: Yellow flint.
Brick's Boston Market Ensilage, Nos. 52, 53: Medium white dent.
Brick's Premier Sugar, Nos. 83-87: Small white sweet.
Bullock's White Prolific. Nos. 17-21: White dent.
Calico, No. 56: Nearly white dent, irregularly streaked with red.
Champion White Pearl, No. 22: Large white dent.
Compton's Early, Nos. 26-28: Yellow flint.
Cory Sweet, Nos. 74-77: Large reddish sweet.
Early Golden Lenawee, No. 25: Small yellow dent.
Early Landreth Market, Nos. 68, 69: Smooth white soft.
Early Red Blazed, Nos. 33–36: Yellow flint, often tinged with red.
Early White Dent, No. 29: White dent.
Early Yellow Hathaway, Nos. 30-32: Light yellow dent.
Ellm's Early Yellow, No. 15: Yellow flint.
Extra Early Adams' Table, Nos. 62–67: Nearly smooth soft dent.
Golden Pop Corn, Nos. 94–96: Yellow smooth.
Improved Shoe Peg, No. 46: Large white dent.
Johnston's Early White, No. 48: Long white dent.
King Philip (eastern seed), Nos. 1–6: Red-brown flint.

King Philip (western seed), Nos. 11, 12: Red dent, tipped with white.
Landreth Sugar, Nos. 78-81: Long white sweet.
Leaming, Nos. 23,24: Small yellow dent.
Longfellow, Nos. 7–10: Yellow flint.
Mammoth White Surprise, No. 39: Medium, white dent.
Murdock's, No. 45: Medium, yellow dent.
Normandy Giant, Nos. 37, 38: Long white dent.
Northern Pedigree, No. 88: Small white sweet.
Perry's Hybrid, No. 82: Medium, white sweet.
Pride of the North, No. 16: Small yellow dent.
Queen of the Prairie, Nos. 13-14: Small yellow dent.
Rice Pop Corn, Nos. 89, 90: Small white pointed.
Sanford's Ensilage, Nos. 50, 51: White flint.
Self Husking, Nos. 42, 43: Reddish or brownish yellow flint.
Silver Lace Pop Corn, Nos. 91–93: Large white smooth.
Stabler's Early Sweet, Nos. 70-73: Small white sweet.
St. Charles, No. 49: Medium, white dent.
Waushakum, No. 44: Yellow flint.
White, No. 57: Medium, white dent.
White Flat Ensilage, Nos. 54, 55: Medium, white dent.
Yellow Mammoth, Nos. 40, 41: Yellow dent.

EXPLANATION OF THE TABLE.

The following table gives the details of all the fertilization experiments, except those in which the whole stalk was enclosed in a box.

The first column gives the serial number of the plant; the second, the name of the variety; the next three, the date of enclosure of the ear, and dates of fertilization. In these columns, the first figure gives the number of the month; thus, 6 is June, 7 is July, and 8 is August; the number after the dash is the day of the month. The column headed "Source of Pollen" gives the name of the variety furnishing the pollen used to fertilize the ear, and in parenthesis following the name, the serial number of the plant. The column headed " Result " tells whether an ear was obtained or not, and in case there was, refers by a figure to the right to the account given in "Notes on Ears Obtained" following the table. The next column gives the date of the enclosure of the tassel; when no date is given, the pollen was obtained without enclosing the tassel. The last column, headed "Variety Fertilized," tells on what variety the pollen was used and in parenthesis gives the serial number of the plant.

For example: No. 3 is King Philip; the ear was enclosed on July 26, and fertilized on July 26, 27 and 28, by pollen from Longfellow, No. 10. The cross was successful, and an account of the ear obtained is given in "Notes on Ears Obtained," No. 2; on July 26, the tassel was enclosed, and its pollen was used to fertilize King Philip, No. 12, and Yellow Mammoth, No. 41.

No.	NAME OF VARIETY.	Date of enclosure of ear.	Date of first fertilization.	Date of repeated fertilization.	SOURCE OF POLLEN.	Result.	Date of enclosure of tassel.	VARIETY FERTILIZED.
1	King Philip	7–30	7–30	8–1	White Flat Ensilage (54),	Ear[1]		
2	King Philip						7–27	Longfellow (8). Improved Shoe Peg (46).
3	King Philip	7–26	7–26	7–28, 7–27	Longfellow (10)	Ear[2]	7–26	King Phillip (12). Yellow Mammoth (41).
4	King Philip	8–1	8–4		Early Red Blazed (36)	Ear[3]		
5	King Philip	7–6	7–9		Early Yellow Hathaway (from farm)	Ear[4]		
6	King Philip						7–8	Leaming (23 and 24).
7	Longfellow	7–5	7–9		Early Yellow Hathaway (30)	Ear[5]		
8	Longfellow	7–24	7–31		King Philip (2)	Ear[6]		
9	Longfellow	8–1	8–2		Early White Dent (29)	Ear[7]		Stabler's Early Sweet (73).
10	Longfellow						7–25	King Philip (3).
11	King Philip	7–30	8–1		White Flat Ensilage (55),	No ear		
12	King Philip	7–30	8–1		King Philip (3)	No ear	8–4	Adams' Early Table (60) Landreth Sugar (78).
13	Queen of the Prairie						7–25	Yellow Mammoth (40).

No.	NAME OF VARIETY.	Date of enclosure of ear.	Date of first fertilization.	Date of repeated fertilization.	SOURCE OF POLLEN.	Result.	Date of enclosure of tassel.	VARIETY FERTILIZED.
14	Queen of the Prairie.....	....	....	....	....	....	7 25	Bullock's White Prolific (17). Normandy Giant (38).
15	Ellm's Early Yellow.....	6-30	7-9	....	Extra Early Adam's Table (67)........	No ear...	7-2	Northern Pedigree (88).
16	Pride of the North.......	7-25	7-30	....	Mammoth White Surprise (39)........	Ear[8].....	....	....
17	Bullock's White Prolific........	7-28	7-30	....	Queen of the Prairie (14)	No ear...	....	....
18	Bullock's White Prolific........	7-30	8-13	....	Golden Pop Corn (95)....	Ear[9].....	....	....
19	Bullock's White Prolific........	....	....	....	....	....	8-2	Bullock's White Prolific (20). Golden Pop Corn (96). Stabler's Early Sweet (71).
20	Bullock's White Prolific........	8-1	8-3	....	Bullock's White Prolific (19)........	No ear...	....	....
21	Bullock's White Prolific........	8-2	8-4	....	Self........	Ear [10]...	....	Self.
22	Champion White Pearl..	7-10	7-21	....	Normandy Giant (37)....	Ear [11]...	....	....
23	Leaming........	7-9	7-10	....	King Philip (6)........	No ear...	....	....
24	Leaming........	7-8	7-10	....	King Philip (6)........	No ear...	....	....
25	Early Golden Lenawee..	7-3	7-9	....	Brick's Premium Sugar, (83 and 84)........	Ear[12]....	....	....

No.	NAME OF VARIETY.	*Date of enclosure of ear.*	*Date of first fertilization.*	*Date of repeated fertilization.*	SOURCE OF POLLEN.	*Result.*	*Date of enclosure of tassel.*	VARIETY FERTILIZED.
26	Compton's Early						7–6	Brick's Premier Sugar (85).
27	Compton's Early	7–30	7–30	8–1	Adams' Early Table (59),	No ear		
28	Compton's Early	8–8	8–10		Golden Pop Corn (95)	Ear[13]		
29	Early White Dent	8–1	8–10		Golden Pop Corn (95)	Ear[14]	8–1	{ Longfellow (9). Early Red Blazed (35).
30	Early Yellow Hathaway	7–8	7–9		Sanford's Ensilage (51)	Ear[15]	7–8	Longfellow (7).
31	Early Yellow Hathaway						7–27	Early Red Blazed (34).
32	Early Yellow Hathaway						8–1	White (57).
33	Early Red Blazed	7–3	7–9		Angel of Midnight (47)	No ear	7–3	Early Landreth Market (69).
34	Early Red Blazed	8–1	8–1	8–3	Early Yellow Hathaway (31)	Ear[16]		
35	Early Red Blazed	8–1	8–2	8–4	Early White Dent (29)	Ear[17]		
36	Early Red Blazed						8–1	King Philip (4).
37	Normandy Giant						7–21	Champion White Pearl (22).
38	Normandy Giant	8–1	8–2	8–3	Queen of the Prairie (14),	No ear		

No.	NAME OF VARIETY.	Date of enclosure of ear.	Date of first fertilization.	Date of repeated fertilization.	SOURCE OF POLLEN.	Result.	Date of enclosure of tassel.	VARIETY FERTILIZED.
39	Mammoth White Surprise	7–28	7–30		Self	Ear[18]	7–28	{ Self. { Pride of the North (16).
40	Yellow Mammoth	7–25	7–27	7–31	Queen of the Prairie (13),	Ear[19]		
41	Yellow Mammoth	7–30	8–1	8–2	King Philip (3)	Ear[20]		
42	Self Husking	6–29	7–6		*Extra Early Adam's Table* (63)	Ear[21]	6–29	Extra Early Adams' Table (63).
43	Self Husking						7–2	Waushakum (44).
44	Waushakum	7–5	7–9		*Self Husking* (43)	No ear		
45	Murdock's						7–10	Brick's Premier (87).
46	Improved Shoe Peg	7–30	7–31	{ 8–1 } { 8–2 }	*King Philip* (2)	Ear[22]		
47	Angel of Midnight							Early Red Blazed (33).
48	Johnston's Early White	7–25	7–26	7–28	Self		7–25	Self.
49	St. Charles	7–28	7–30	8–1	*Stabler's Early Sweet* (70)	No ear		
50	Sanford's Ensilage	7–2	7–6	7–9	*Cory Sweet* (75, 76 and 77)	Ear[23]		
51	Sanford's Ensilage	7–3	7–11		King Philip (from farm),	No ear		Early Yellow Hathaway (30).

No.	NAME OF VARIETY.	Date of enclosure of ear.	Date of first fertilization.	Date of repeated fertilization.	SOURCE OF POLLEN.	Result.	Date of enclosure of tassel.	VARIETY FERTILIZED.
52	Brick's Boston Market Ensilage						7–26	Rice Pop Corn (90). Silver Lace Pop Corn (93).
53	Brick's Boston Market Ensilage							Rice Pop Corn (90).
54	White Flat Ensilage						7–28	King Philip (1).
55	White Flat Ensilage	7–30	7–31	8–2	Landreth Sugar (81)	Ear[24]	7–30	King Philip (11).
56	Calico	7–26	7–31		Adams' Early Table (61),	Ear[25]		
57	White	8–1	8–3		Early Yellow Hathaway (32)	No ear		
58	Adams' Early Table	7–9	7–10		Early Landreth Market (68)	No ear		
59	Adams' Early Table						7–30	Silver Lace Pop Corn (92). Compton's Early (27).
60	Adams' Early Table	7–31	8–2		King Philip (12)	Ear[26]		
61	Adams' Early Table						7–30	Calico (56).
62	Extra Early Adams' Table	6–29	6–30		Self	No ear	6–29	Self.
63	Extra Early Adams' Table	6–29	7–1		Self Husking (42)	No ear	6–29	Self Husking (42).

No.	NAME OF VARIETY.	Date of enclosure of ear.	Date of first fertilization.	Date of repeated fertilization.	SOURCE OF POLLEN.	Result.	Date of enclosure of tassel.	VARIETY FERTILIZED.
64	Extra Early Adams' Table	7–4	7–6	....	Compton's Early (from farm)	No ear...	....	....
65	Extra Early Adams' Table	....	....	....	....	....	6–29	Cory Sweet (75 and 76).
66	Extra Early Adams' Table	6–30	7–2	....	Ellm's Early Yellow (from farm)	Ear[27]....	....	....
67	Extra Early Adams' Table	....	....	....	....	....	6–29	Ellm's Early Yellow (15).
68	Early Landreth Market	7–5	7–6	....	Early Golden Lenawee (from farm)	Ear[28]....	7–5	Adams' Early Table (58).
69	Early Landreth Market	7–5	7–6	....	Early Red Blazed (33) ...	No ear...	....	....
70	Stabler's Early Sweet...	7–28	7–30	7–31	Landreth Sugar (79)......	Ear[29]....	....	St. Charles (49).
71	Stabler's Early Sweet...	7–30	8–3	....	Bullock's White Prolific (19)	No ear...	....	Rice Pop Corn (89).
72	Stabler's Early Sweet...	8–1	8–10	....	Golden Pop Corn (95)....	Ear[30]....	....	....
73	Stabler's Early Sweet...	7–25	7–30	7–31	Longfellow (9)........	No ear...	....	....
74	Cory Sweet........	6–29	6–30	7–2	Self Husking (from farm)	Ear[31]....	....	....
75	Cory Sweet........	6–29	7–5	....	Extra Early Adams' Table (65)	Ear[32]....	6–29	Sanford's Ensilage (50).

No.	NAME OF VARIETY.	Date of enclosure of ear.	Date of first fertilization.	Date of repeated fertilization.	SOURCE OF POLLEN.	Result.	Date of enclosure of tassel.	VARIETY FERTILIZED.
76	Cory Sweet	6–29	7–1		Extra Early Adams' Table (65)	Ear[33]	6–29	Sanford's Ensilage (50).
77	Cory Sweet						7–6	Sanford's Ensilage (50).
78	Landreth Sugar	7–26	8–4		King Philip (12)	Ear[34]		
79	Landreth Sugar	7–25	7–27	7–28	Self	Ear[35]	7–25	Self. Stabler's Early Sweet (70).
80	Landreth Sugar	7–25	8–4		Landreth Sugar (81)	Ear[36]		
81	Landreth Sugar	7–30	7–31	8–3	Sorghum (several varieties)	No ear	7–30	White Flat Ensilage (55). Landreth Sugar (80).
82	Perry's Hybrid	7–27	7–28	7–30, 8–1	Rice Pop Corn (90)	Ear[37]		
83	Brick's Premier Sugar						7–2	Early Golden Lenawee (25).
84	Brick's Premier Sugar							Early Golden Lenawee (25).
85	Brick's Premier Sugar	7–2	7–8	7–9	Compton's Early (26)	Ear[38]		
86	Brick's Premier Sugar	7–5	7–11		Silver Lace Pop Corn (91)	Ear[39]	7–5	Silver Lace Pop Corn (91).
87	Brick's Premier Sugar	7–21	7–25		Murdock's (45)	No ear		

25

No.	NAME OF VARIETY.	Date of enclosure of ear.	Date of first fertilization.	Date of repeated fertilization.	SOURCE OF POLLEN.	Result.	Date of enclosure of tassel.	VARIETY FERTILIZED.
88	Northern Pedigree......	6–30	7–6	....	Ellm's Early Yellow (from farm and 15)............	Ear[40]....	....	....
89	Rice Pop Corn............	7–26	7–30	7–31	Stabler's Early Sweet (71)	No ear...	....	....
90	Rice Pop Corn............	7–25	7–28	7–30, 8–1	Brick's Boston Market Ensilage (52 and 53)...	Ear[41]....	7–27	Perry's Hybrid (82).
91	Silver Lace Pop Corn...	7–3	7–11	....	Brick's Premier Sugar (86)......................	No ear...	....	Brick's Premier Sugar (86).
92	Silver Lace Pop Corn...	7–27	7–30	8–1	Adams' Early Table (59),	Ear[42]....	....	....
93	Silver Lace Pop Corn...	7–27	7–28	7–30	Brick's Boston Market Ensilage (52)............	Ear[43]....	....	....
94	Golden Pop Corn.........	8–1	8–10	....	Golden Pop Corn (95)....	No ear...	....	....
95	Golden Pop Corn.........	....	....	....	....	....	8–3	Golden Pop Corn (94). Stabler's Early Sweet (72). Early White Dent (29). Compton's Early (28). Bullock's White Prolific (18).
96	Golden Pop Corn.........	8–1	8–3	....	Bullock's White Prolific (19)......................	No ear...	....	....

NOTES ON EARS OBTAINED.

1. *King Philip* (1) fertilized by *White Flat Ensilage* (54). When enclosed, the silk was just emerging, but apparently protected by husks from possible pollination; was fertilized at once. The ear was well filled, though small, and showed no signs of crossing.

2. *King Philip* (3) fertilized by *Longfellow* (10). The ear was small, but well filled, and did not show any signs of crossing.

3. *King Philip* (4) fertilized by *Early Red Blazed* (36). The resulting ear was small, but had well developed kernels at the tip; showed no evidence of crossing.

4. *King Philip* (5) fertilized by *Early Yellow Hathaway* (from farm). When fertilized, the silk was rather short, and there was not much pollen, but the resulting ear, which was six inches long, had eight well filled rows; looked exactly like King Philip.

5. *Longfellow* (7) fertilized by *Early Yellow Hathaway* (from farm). When the ear was fertilized, the silk was just appearing, but the end of the ear was opened and three or more inches of the silk exposed. The pollen was very good. The ear resulting was eight inches long, had eight well filled rows, and looked exactly like Longfellow.

6. *Longfellow* (9) fertilized by *King Philip* (2). The ear was very small, but had six kernels exactly resembling Longfellow in color and shape, though somewhat smaller. There was no evidence of the cross in this case.

7. *Longfellow* (8) fertilized by *Early White Dent* (29). The ear was large, but badly smutted. The six good kernels not destroyed by smut looked exactly like those planted.

8. *Pride of the North* (16) fertilized by *Mammoth White Surprise* (39). The ear was small, but quite well filled; the kernels were yellow, somewhat like Pride of the North, but had a slight reddish tinge unlike either of the varieties. In shape, the kernels showed no evidence of a cross.

9. *Bullock's White Prolific* (18) fertilized by *Golden Pop Corn* (95). When the ear was fertilized, the pollen was not good—old but abundant, The mature ear was eight inches long, moderately well filled, but had a vacant space near the base. Some of the kernels showed a yellow coloration, which was, however, also observed in the ears raised on the College farm; otherwise there were no signs of crossing.

10. *Bullock's White Prolific* (21) fertilized by *self*. The ear was only four inches long, but had fourteen well filled rows. The kernels were large and vigorous, and a very few showed a tinge of yellow.

11. *Champion White Pearl* (22) fertilized by *Normandy Giant* (11). When fertilized, silk was short, ends small, not vigorous. The mature ear had kernels only near the middle. The two varieties crossed looked so much alike that it was difficult to decide whether there was any evidence of crossing or not.

12. *Early Golden Lenawee* (25) fertilized by *Brick's Premier Sugar* (83 and 84). A large quantity of pollen was used in fertilizing, most of which cohered in lumps. The silk was from two to four inches long. The resulting ear had a cob four inches long but only four kernels, which, however, showed no signs of a cross.

13. *Compton's Early* (28) fertilized by *Golden Pop Corn* (95). The ear was attacked by insects, and also moulded somewhat, but there were perhaps thirty kernels, mostly towards the apex. These did not give any evidence of crossing.

14. *Early White Dent* (29) fertilized by *Golden Pop Corn* (95). The ear was of the usual length, had some kernels missing, and a few kernels with a slight tinge of yellow. Perhaps there was evidence of the cross in this case, but a few ears raised on the College farm also showed some yellow kernels; so it is probable that the seed was not pure.

15. *Early Yellow Hathaway* (30) fertilized by *Sanford's Ensilage* (51). When inclosed, showed a very little silk;

when fertilized, the silk was rather short (one to three inches long), pollen good but not abundant. The resulting ear had many scattered kernels, which showed no signs of the cross.

16. *Early Red Blazed* (34) fertilized by *Early Yellow Hath–away* (31). No kernels were formed, though a well developed cob was produced.

17. *Early Red Blazed* (35) fertilized by *Early White Dent* (29). The ear, which was short, but well filled, showed all the characters of the kernels of the Early Red Blazed planted, even to the occasional tinge of red.

18. *Mammoth White Surprise* (39) fertilized by *self.* A small ear resulted, which looked exactly like the kernels planted and specimens from farm, except that the kernels were not in contact, and hence were more rounded.

19. *Yellow Mammoth* (40) fertilized by *Queen of the Prairie* (13). In this case both the varieties crossed were yellow dent, but the resulting ear, which was ten inches long and had twelve moderately well–filled rows, looked exactly like Yellow Mammoth in size, shape, etc., of the kernels. There was no evi–dence of crossing.

20. *Yellow Mammoth* (41) fertilized by *King Philip* (3). The ear, which was about seven inches long and had perhaps fifty kernels in regular rows at the middle, showed no signs of the cross.

21. *Self Husking* (42) fertilized by *Extra Early Adams' Table* (63). When fertilized, the silk was two to three inches long. The ear was twelve inches long and moderately well filled, especially towards the apex. There was no evidence of crossing. It is very probable that the vacant space of about two inches near the base of the ear was due to the fact that the silk from there, being oldest and longest, was not in a receptive condition when the ear was fertilized.

22. *Improved Shoe Peg* (46) fertilized by *King Philip* (2). The ear moulded, and had only a few perfect kernels, which, however, showed no signs of the cross.

23. *Sanford's Ensilage* (50) fertilized by *Cory Sweet* (75, 76 and 77). When fertilized, the silk was two to four inches long; when re-fertilized, the pollen was not good, and the silk very long. The ear had only a few kernels, all of which resembled Sanford's Ensilage.

24. *White Flat Ensilage* (55) fertilized by *Landreth Sugar* (81). When fertilized, the pollen was very abundant and fresh. The ear was eight inches long and moderately well filled. Some of the kernels showed a tinge of yellow, but otherwise there was no evidence of the cross. Perhaps this yellow coloration was due to impure seed.

25. *Calico* (56) fertilized by *Adams' Early Table* (61). The resulting ear was about seven inches long, and fairly well filled towards the tip. The kernels were like those of Calico planted, even to the peculiar red streaks. Showed no effects of the cross.

26. *Adams' Early Table* (60) fertilized by *King Philip* (12). The ear had several short quite well developed rows near the base. There was no evidence of the cross.

27. *Exta Early Adams' Table* (66) fertilized by *Ellm's Early Yellow* (from farm). When fertilized, the silk was one-half to two inches long. The ear had several rows, quite well developed at the base. The kernels were a dent variety, nearly white in color, but showing a slight yellowish color. In this case there seemed to be some effect of the cross visible the first year, as the ear was clearly different from Extra Early Adams' Table planted.

28. *Early Landreth Market* (68) fertilized by *Early Golden Lenawee* (from farm). The pollen was scanty at the first fertilization, and at the second fertilization the silk was long and pollen medium. The resulting ear was about seven inches long and had perhaps an hundred mature kernels, in rows which were defective towards the base and tip. The kernels were nearly the shape of Early Landreth Market, but all showed a distinct yellowish color. The effect of the cross could be plainly seen.

29. *Stabler's Early Sweet* (70) fertilized by *Landreth Sugar* (79). The ear was short but well filled. The kernels were more like Stabler's Early Sweet in size, shape, and particular shade of color.

30. *Stabler's Early Sweet* (72) fertilized by *Golden Pop Corn* (95). A very small ear resulting, showed kernels with a smooth surface and of a yellow color. Though the kernels were larger than Golden Pop Corn and not so deep a yellow, there was certainly evidence of crossing the first year.

31. *Cory Sweet* (74) fertilized by *Self Husking* (from farm). The small ear moulded somewhat, but had a few perfect kernels. These were all smooth, and of a light yellow color, with a faint tinge of brownish near the base of the kernel; shows clearly the effect of the cross.

32. *Cory Sweet* (75) fertilized by *Extra Early Adam's Table* (65). The ear was only about three inches long, but was well filled, and seemed to show the effects of the cross. The kernels were all broad and short, and of a pronounced reddish color; most of them were wrinkled, but some of them were lighter and nearly or quite smooth. This ear seemed to show some effects of the cross the first year.

33. *Cory Sweet* (76) fertilized by *Extra Early Adams' Table* (65). The stalk was broken by accident in the latter part of July. The ear had only four kernels, and these looked like sweet corn.

34. *Landreth Sugar* (78) fertilized by *King Philip* (12). A small ear resulted, but was afterwards destroyed by mice.

35. *Landreth Sugar* (79) fertilized by *self.* When first fertilized, the silk was erect — just emerging from the husks. The ear was six inches long, well filled, and looked like the seed planted.

36. *Landreth Sugar* (80) fertilized by *Landreth Sugar* (81). The resulting ear was short, but well filled, and looked like the seed planted.

37. *Perry's Hybrid* (82) fertilized by *Rice Pop Corn* (90).

The ear was short, but had several well filled rows. In size, the kernels were nearly like Perry's Hybrid, but resembled Rice Pop Corn in being for the most part perfectly smooth. Some effect of the cross could be clearly seen in this instance.

38. *Brick's Premier Sugar* (85) fertilized by *Compton's Early* (26). The ear was eight inches long, with eight well filled rows of the entire length. The kernels were much more like Compton's Early than like Brick's Premier Sugar, and were of a dull yellow color. Nearly all were a smooth flint, but a few showed signs of wrinkling near the tip. This affords a very good example of the visible effects of the cross seen the first year.

39. *Brick's Premier Sugar* (86) fertilized by *Silver Lace Pop Corn* (91). When fertilized, the silk was several inches long and pollen good. The resulting ear had a few scattering rows, mostly towards the tip. The kernels were white and nearly smooth, having but a slight indentation at the tip. They were larger than Silver Lace Pop Corn, however. Again there is clear evidence of crossing seen the first year.

40. *Northern Pedigree* (88) fertilized by *Ellm's Early Yellow* (from farm and 15). When fertilized, a great quantity of pollen was used, both from farm and from 15. The silk was not much exposed. The mature ear was short and not well filled having perhaps seventy-five kernels, in interrupted rows. The kernels were like Northern Pedigree, except that some of them were nearly smooth, indicating a tendency to become a flint variety. Another ear not enclosed showed nearly the same variation. It is somewhat doubtful whether in this instance any effect of the cross could be seen.

41. *Rice Pop Corn* (90) fertilized by *Brick's Boston Market Ensilage* (52 and 53). The ear was only four inches long, but was well filled. The kernels showed no evidence of the cross, except perhaps in being slightly larger than the Rice Pop Corn planted.

42. *Silver Lace Pop Corn* (92) fertilized by *Adams' Early*

Table (59). A small ear was formed, but was destroyed by mice.

43. *Silver Lace Pop Corn* (93) fertilized by *Brick's Boston Market Ensilage* (52). The ear formed was destroyed by mice before it was carefully examined.

GERMINATION OF WEED SEEDS.

The table below gives a series of tests for the purpose of determining the number of weed seeds capable of germination in the soil at different depths. Thirty cubic inches of soil were taken in each case, put in flower pots of suitable size, and placed in the laboratory. They were carefully cared for, and watered as required, the object being to make the conditions as favorable as possible for the germination of all the seeds that might be therein contained.

After an interval of several days, the plants that had appeared above the surface were counted and removed. At the same time the soil was poured out of the pot and carefully searched for seedlings that had not yet reached the surface. The soil was then returned to the pot and cared for as before. When seedlings again appeared at the surface, the counting was repeated in the manner indicated. The soil was not thrown aside until ample time had been allowed for the germination of all the seeds that it might contain. The total number of seedlings that appeared above the surface is given in the column headed "Surface Germination," and the total number found below the surface is given in the column headed " Internal Germination. "

As the plants were removed very early, it was impossible to determine the species, but it was noted whether they were of the *monocotyledonous* (endogenous), or *dicotyledonous* (exogenous) group. Unless otherwise indicated under the head of "Remarks," the soil was taken from fields near the buildings of the College, and therefore belongs to that known as "second bench.” It would be characterized as a “sandy loam,” though in many cases the sand is very small in quantity.

Where any number is repeated, as *6a, 6b, 6c,* etc., it indicates that the soil was taken from the same locality, a few inches apart, and at the same date. Among the first ten numbers, where the depth is given as one inch care was not taken to measure accurately, as was done in all the subsequent cases; However, it was almost exclusively “surface soil,” and it is thought best to retain also these results. The tests were fewer in number than at first contemplated, but will be in the future, repeated, multiplied and varied. Further comment and summarizing are therefore, postponed.

Number	Depth in inches	Date of collection — No. of month and day	SURFACE GERMINATION.		INTERNAL GERMINATION.		TOTAL.		Grand total	REMARKS.
			Monocotyledons	Dicotyledons	Monocotyledons	Dicotyledons	Monocotyledons	Dicotyledons		
1	1	6–9	1	1	....	....	1	1	2	Soil from young Catalpa plantation, recently cultivated.
2	1	6–9	....	1	....	1	....	2	2	Soil plowed in spring; covered with weeds 2 to 4 inches high.
3	1	6–9	6	5	4	....	10	5	15	Soil plowed in spring, and again recently.
4	1	6–9	....	5	1	1	1	6	7	Soil taken from field in oats.
5	1	6–9	13	1	8	....	21	1	22	Soil from plat of tame grass of several years' standing.
6*a*	1	6–11	....	....	....	....	....	....	0	
6*b*	1	6–11	....	1	....	....	....	1	1	Soil from corn field, previously in rye (plowed under in spring); cockle burs previously abundant.
6*c*	1	6–11	....	....	....	....	....	....	0	
7*a*	1	6–19	....	....	....	....	....	....	0	
7*b*	1	6–19	....	....	....	....	....	....	0	Soil from corn field, in corn last year; recently plowed; very weedy before last plowing; weeds — sunflowers and flea-bane.
7*c*	1	6–19	....	3	....	....	....	3	3	
8*a*	7	6–19	....	....	....	....	....	....	0	
8*b*	7	6–19	5	....	....	....	5	....	5	
8*c*	7	6–19	7	....	....	....	7	....	7	
9*a*	1	6–19	9	....	....	....	9	....	9	Neglected soil near road; covered with young weeds, mostly Fox-tail grass; soil plowed in spring.
9*b*	1	6–19	3	....	....	....	3	....	3	
9*c*	1	6–19	....	1	....	....	....	1	1	

Number.	*Depth in inches.*	*Date of collection — No. of month and day.*	SURFACE GERMINATION. *Monocotyledons.*	SURFACE GERMINATION. *Dicotyledons.*	INTERNAL GERMINATION. *Monocotyledons.*	INTERNAL GERMINATION. *Dicotyledons.*	TOTAL. *Monocotyledons.*	TOTAL. *Dicotyledons.*	*Grand total.*	REMARKS.
10*a*	1	6–21	1	1	....	....	1	1	2	
10*b*	1	6–21	....	....	....	....	....	....	0	Bottom land; oat field; soil cultivated many years.
10*c*	1	6–21	....	1	....	....	....	1	1	
17*a*	1	8–1	....	2	....	....	....	2	2	
17*b*	1	8–1	1	11	1	5	2	16	18	Recently plowed soil: previously in oats.
17*c*	1	8–1	....	....	2	6	2	6	8	
18	1	8–1	....	1	1	1	1	2	3	
19	1	8–1	....	1	....	....	....	1	1	Soil in alfalfa for several years.
20	6	8–1	....	2	....	1	....	3	3	
21*a*	1	8–1	....	....	....	....	....	....	0	
21*b*	1	8–1	....	....	....	....	....	....	0	
21*c*	1	8–1	....	....	....	....	....	....	0	
22	4	8–1	....	....	....	....	....	....	0	Soil from *corn field, not recently* plowed; *corn* standing; no weeds.
23*a*	10	8–1	....	....	....	....	....	....	0	
23*b*	10	8–1	....	....	....	1	....	1	1	
23*c*	10	8–1	....	....	....	....	....	....	0	

Number	Depth in inches	Date of collection — No. of month and day	Surface germination. Monocotyledons	Surface germination. Dicotyledons	Internal germination. Monocotyledons	Internal germination. Dicotyledons	Total. Monocotyledons	Total. Dicotyledons	Grand total	Remarks.
24*a*	1	8–1	1	....	3	....	4	....	4	Millet field; millet removed a week previous.
24*b*	1	8–1	6	....	6	....	12	....	12	
24*c*	1	8–1	1	....	1	....	2	....	2	
25*a*	2	8–1	....	7	1	2	1	9	10	
25*b*	2	8–1	....	1	1	1	1	2	3	
25*c*	2	8–1	....	....	....	....	....	....	0	
26*a*	5	8–1	1	3	1	2	2	5	7	
26*b*	5	8–1	1	2	....	2	1	4	5	
26*c*	5	8–1	1	2	....	....	1	2	3	
27	8	8–1	....	....	....	....	....	....	0	
28*a*	1	8–1	....	1	....	....	....	1	1	Bean field adjacent to the preceding.
28*b*	1	8–1	....	....	....	....	....	....	0	
28*c*	1	8–1	....	....	....	....	....	....	0	
29*a*	2	8–1	....	2	....	....	....	2	2	
29*b*	2	8–1	....	1	....	6	....	7	7	
29*c*	2	8–1	....	1	....	....	....	1	1	
30*a*	5	8–1	....	2	....	1	....	3	3	
30*b*	5	8–1	....	2	....	5	....	7	7	
30*c*	5	8–1	....	....	....	6	....	6	6	

Number	Depth in inches	Date of collection — No. of month and day	Surface germination: Monocotyledons	Surface germination: Dicotyledons	Internal germination: Monocotyledons	Internal germination: Dicotyledons	Total: Monocotyledons	Total: Dicotyledons	Grand total	Remarks
31*a*	1	8–8	....	....	....	....	....	....	0	Corn field; no weeds; corn standing.
31*b*	1	8–8	....	1	....	....	....	1	1	
31*c*	1	8–8	....	....	....	....	....	....	0	
34	1	8–8	....	1	....	....	....	1	1	Clean stubble soil, previously in wheat; thoroughly fertilized with stable manure the previous year.
37*a*	4	8–8	....	1	....	....	....	1	1	
37*b*	4	8–8	....	1	....	....	....	1	1	
39	7	8–8	1	1	....	....	1	1	2	
48	1	8–8	1	....	....	....	1	....	1	Millet field; in grass for several years previous.
49*a*	10	8–8	....	....	....	....	....	....	0	
49*b*	10	8–8	....	....	....	....	....	....	0	
49*c*	10	8–8	....	....	....	....	....	....	0	
50*a*	3	8–8	....	....	....	....	....	....	0	
50*b*	3	8–8	....	....	....	....	....	....	0	
50*c*	3	8–8	....	....	....	....	....	....	0	
51*a*	1	8–8	....	....	....	....	....	....	0	Sorghum field; a thin growth of sorghum, but an abundance of purslane.
51*b*	1	8–8	....	1	....	....	....	1	1	
51*c*	1	8–8	....	1	....	....	....	1	1	
52*a*	1	8–8	....	1	....	....	....	1	1	

Number	Depth in inches	Date of collection — No. of month and day	Surface germination: Monocotyledons	Surface germination: Docotyledons	Internal germination: Monocotyledons	Internal germination: Dicotyledons	Total: Monocotyledons	Total: Dicotyledons	Grand total	Remarks
54	1	8–8	1	....	....	....	1	....	1	Same field as above; soil shaded by maples.
63*b*	1	8–23	1	....	....	....	1	....	1	Corn field; clean soil; corn standing.
63*c*	1	8–23	1	....	....	....	1	....	1	
63*f*	1	8–23	5	....	....	....	5	....	5	
64	1	8–23	2	....	....	....	2	....	2	Bean field adjoining the last.

FUNGOUS PARASITES OF WEEDS.

It might be supposed that all fungi are injurious, but this is far from being the truth. A good example of their beneficial action is seen in the diseases of injurious weeds caused by them. Very many of the weeds of agriculture are attacked by these parasites, which often appreciably diminish their number and vigor. There are in fact very few weeds not having one or more fungi preying upon them. Often the same parasite affects several different weeds, and also, in a few cases, is injurious by attacking cultivated plants. One hundred and thirteen *species* of fungi are at present known to inhabit the ninety-eight weeds of the State considered especially troublesome. The following list of what are considered to be the twenty worst weeds of the State, with the number of parasites inhabiting each, may prove instructive. All of the fungi included in this list are strictly parasitic, and are more or less injurious to the plant attacked.

Portulaca oleracea L.— Purslane	1
Abutilon avicennæ GÆRT.—Indian mallow, Velvet leaf	1
Vernonia Baldwinii TORR.—Iron weed	6
Erigeron Canadensis L.—Fire weed, Flea-bane	2
Ambrosia artemisiæfolia L.-Bitter–weed, Roman worm–weed, Rag weed	3
Ambrosia *psilostachya* D.C.—Bitter–weed, Roman worm–weed, Rag weed	1
Xanthium Canadense MILL.—Cocklebur, Colt–bur	2
Helianthus annuus L.—Common Sunflower	5
Chrysanthemum Leucanthemum L.—Ox–eye daisy	0
Arctium Lappa L.—Burdock	0
Convolvulus sepium L.— Bindweed	1
Solanum rostratum DUNAL.—Bull nettle, Beaked Horse-nettle	0
Datura stramonium L.—Jimson weed	1
Amarantus retroflexus L.—Common Amaranth, Redroot, Pigweed	2
Polygonum Pennsylvanicum L.—Knot weed, Smartweed	1
Polygonum Muhlenbergii WATS.—Sour dock	1
Euphorbia marginata PH.—Snows–on–the–mountain, White–top milkweed	5
Panicum sanguinale L.—Crab grass	2
Setaria glauca BEAUV.—Pigeon grass, Summer fox–tail grass	0
Cenchrus tribuloides L.—Sandbur, Hedgehog grass	1
Total number of parasites	35
Number of duplicate entries	3
Total number of different parasites	32

The damage to the weed may be done either when the plants are very small, after they have grown to some size, or even when the seeds are maturing. Usually the attack is confined to some particular part of the plant, as leaf, stem, or fruit; but sometimes the whole plant is attacked indiscriminately. When seedlings are attacked, often a very large per cent. of them are killed. In such cases the beneficial action of the fungi is often unnoticed, owing to the small size of the plants attacked.

In a space about eighteen feet square, in the College orchard, early last spring, three hundred small plants of an evening primrose (*Œnothera sinuata* L.) were counted. Of these, at least ninety per cent. were badly attacked by the downy mildew (*Peronospora Arthuri* FARL), which formed a velvety coating on the under side of the leaves. Very many of the plants died without making any further growth, while others were attacked as they grew, so that simply mowing the land a few times prevented the formation of a single seed. In another case, a square rod of waste land was found by actual count to contain 890 plants of one rag weed (*Ambrosia psilostachya* DC.), and thirty of another (*Ambrosia artemisiæfolia* L.) Of the former, at least 95 per cent. of the tops were killed and three-fourths of the plants completely destroyed, roots and all, by a species of rust (*Puccima Xanthii* SCHW.) *Every* plant was more or less attacked. Of the later, only a few plants were killed by the rust, though many were slightly attacked. Both species had grown to full size, and undoubtedly would have produced seed had it not been for the parasite.

Another way, as yet little recognized, in which fungi may prove beneficial, is, by attacking the fungous, or insect, parasites of valuable plants. Such species are rapidly being found, and it is probable that some of them will prove to be of the greatest importance.

It is hoped that opportunity will be found the coming season to ascertain whether or not these beneficial parasites can be artificially spread.

The destructive character of many of these maladies caused by parasitic fungi renders it highly desirable that means be found both to infect healthy plants and to extend the natural range of the diseases.

OTHER EXPERIMENTS NOT COMPLETED.

Investigations and experiments in connection with several other subjects have been already begun but cannot be reported until later. Prominent among these may be mentioned a kind of rot in potatoes, smut in oats, and various experiments with fungicides.

EXPLANATION OF THE PLATES.

PLATE I. — SORGHUM BLIGHT.

FIG. l. —Portion of the leaf sheath (Late Orange), showing an early stage of the disease, with stains on the ligule and inner surface.

FIG. 2. — Portion of the sheath (Kansas Orange), with stains on the blade, ligule and inner surface, with a downward extension of the disease.

PLATE II. — SORGHUM BLIGHT.

FIG. 1. —Portion of stalk (Kansas Orange), with the discoloration on the external surface of the sheath, showing an advanced stage of the disease.

FIG. 2. — Portion of inner surface of sheath (Kansas Orange), showing a very advanced stage of the disease.

PLATE III. — SORGHUM BLIGHT.

FIG l. — Young plant (African Millet), grown in soil from field of diseased sorghum, showing diseased portion. — Soil Test No. 3.

FIG. 2.— Young plant grown in soil supposed to be free from the disease-producing *Bacilli*. — Soil Test No. 4.

FIGS. 3, 4, 5 and 6. — Portions of young plants (Early Amber), showing stains characteristic of the disease, all artificially produced. — Inoculation No. 11.

PLATE IV. — SORGHUM BLIGHT AND HACKBERRY KNOT.

FIG. 1. — Ordinary actively growing cells of *Bacillus Sorghi* BURRILL, showing variation in size and shape; x 2, 000.

FIG. 2. — The same in chains, from fluid cultures; x 2,000.

FIG. 3. — The process of spore formation and mature spores; x 2,000.

FIG. 4. — A *Micrococcus* obtained in cultures from diseased sorghum (from Sterling); x 2,000.

FIGS. 5 and 6. — *Bacilli* occasionally found as impurities in cultures, from diseased sorghum; x 2,000.

FIG. 7.— A conidiophore of *Sphaerotheca phytoptophila* KELL. and Sw., showing the formation of conidia: x about 250.

FIG. 8.— A conidium, or summer spore; x about 250.

FIG. 9.— A perithecium, with appendages: x about 250.

FIG. 10.— A mature perithecium burst open, showing an ascus with spores protruding; x about 250.

FIGS. 11 and 12.— Ripe asci, containing spores: x about 250.

FIG. 13.— Sporidia, or ascospores; x about 250.

PLATE V. — HACKBERRY KNOT.

Figure from a photograph showing a knot of the hackberry, of the open type, growing on a vigorous branch.

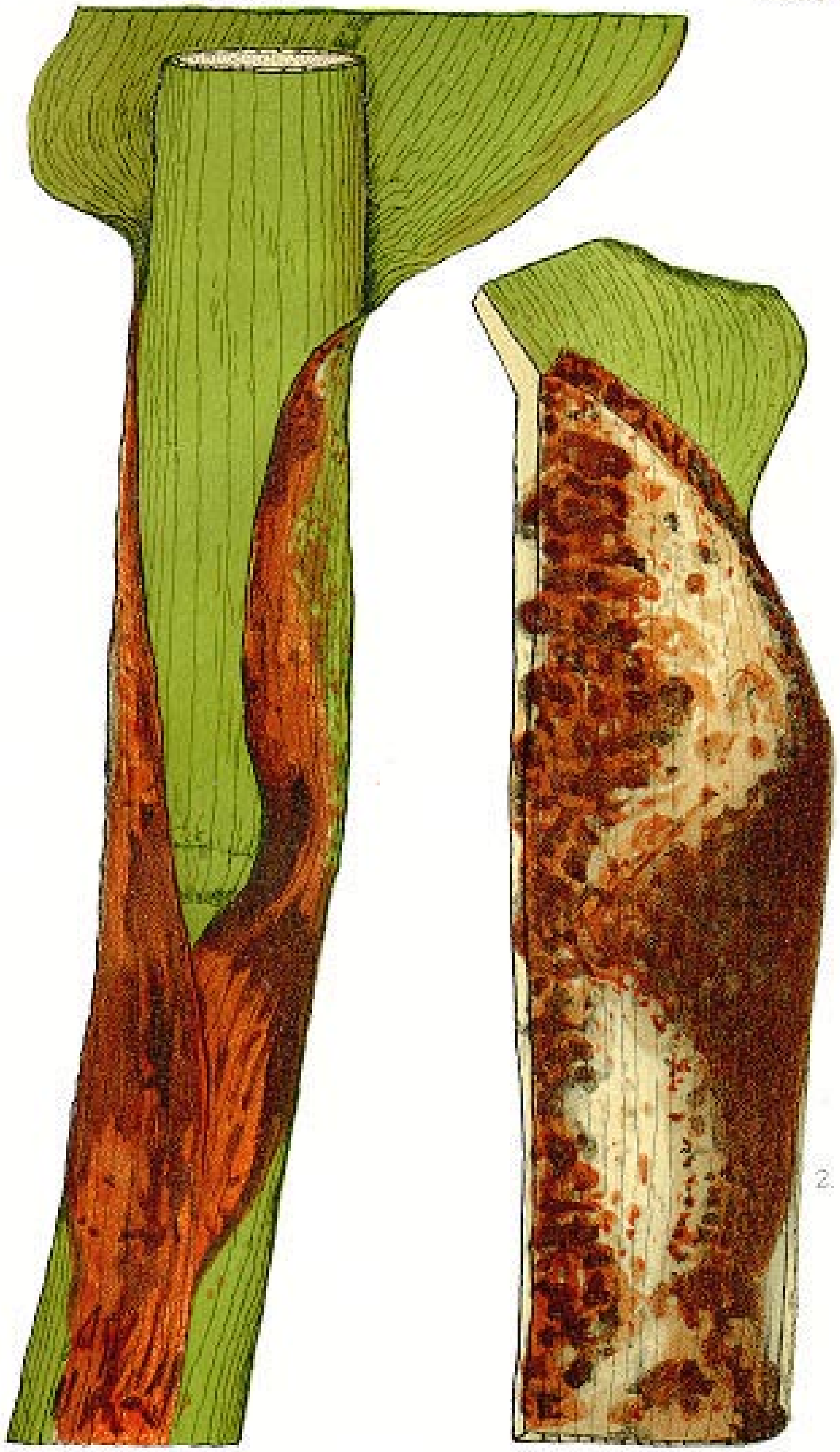
PLATE VI. — HACKBERRY.

Figure from a photograph of a hackberry knot, more compact, and growing on a less vigorous branch.

Botanical Department.

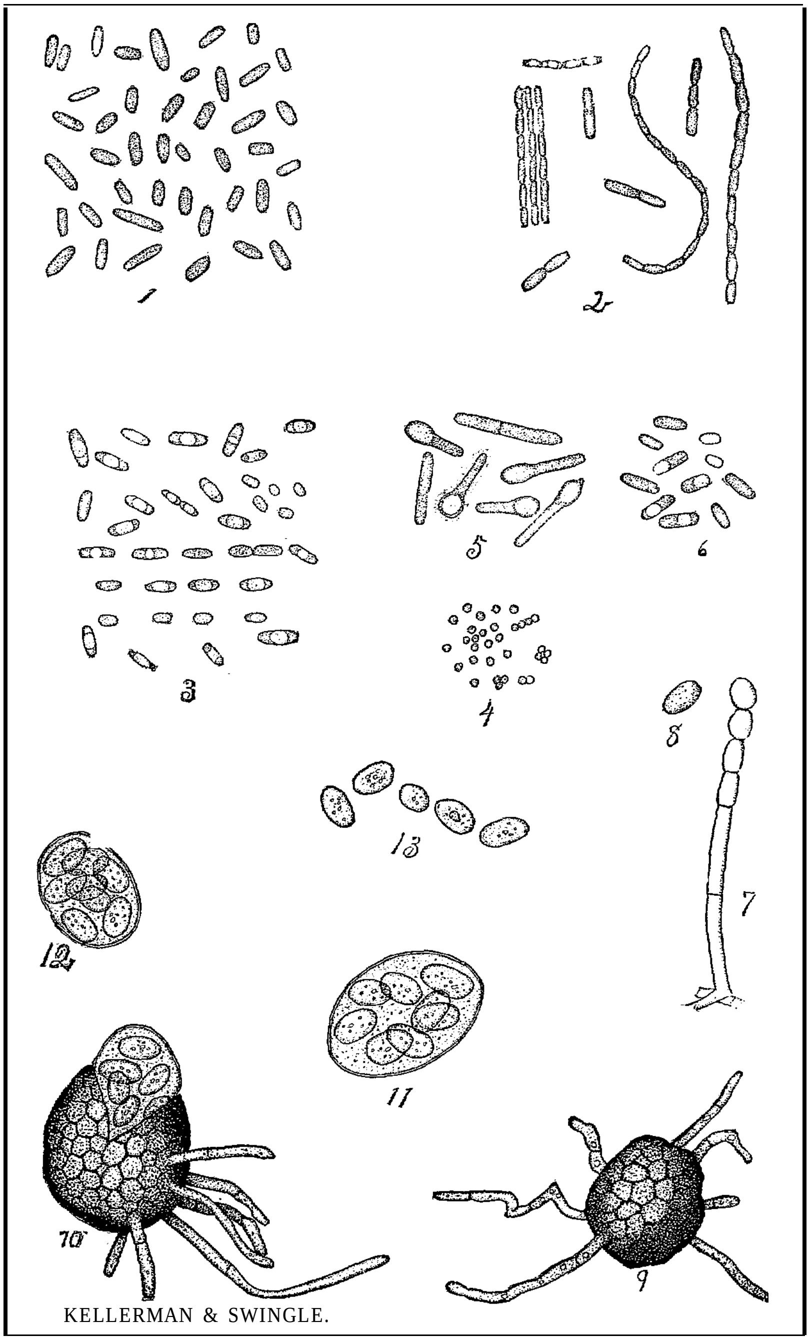
Plate I

SORGHUM BLIGHT.

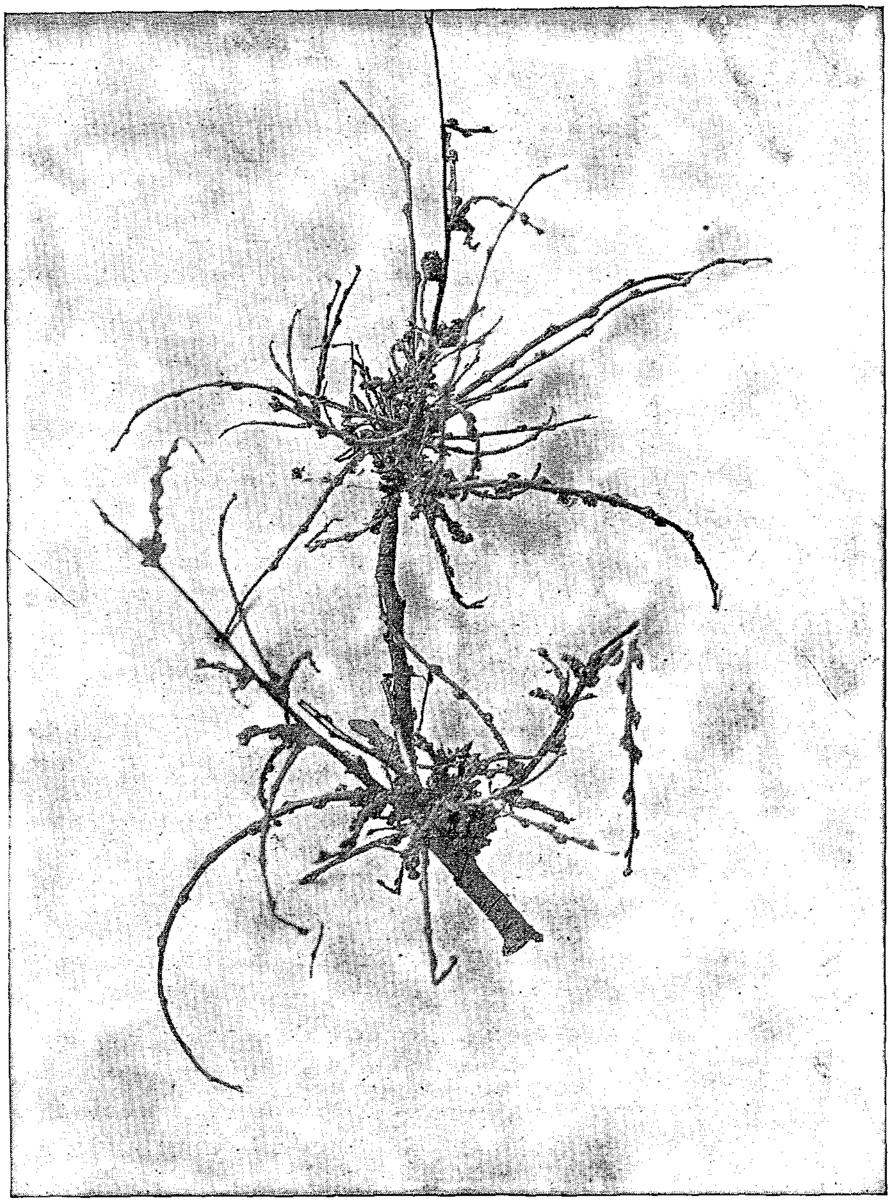


SORGHUM BLIGHT.

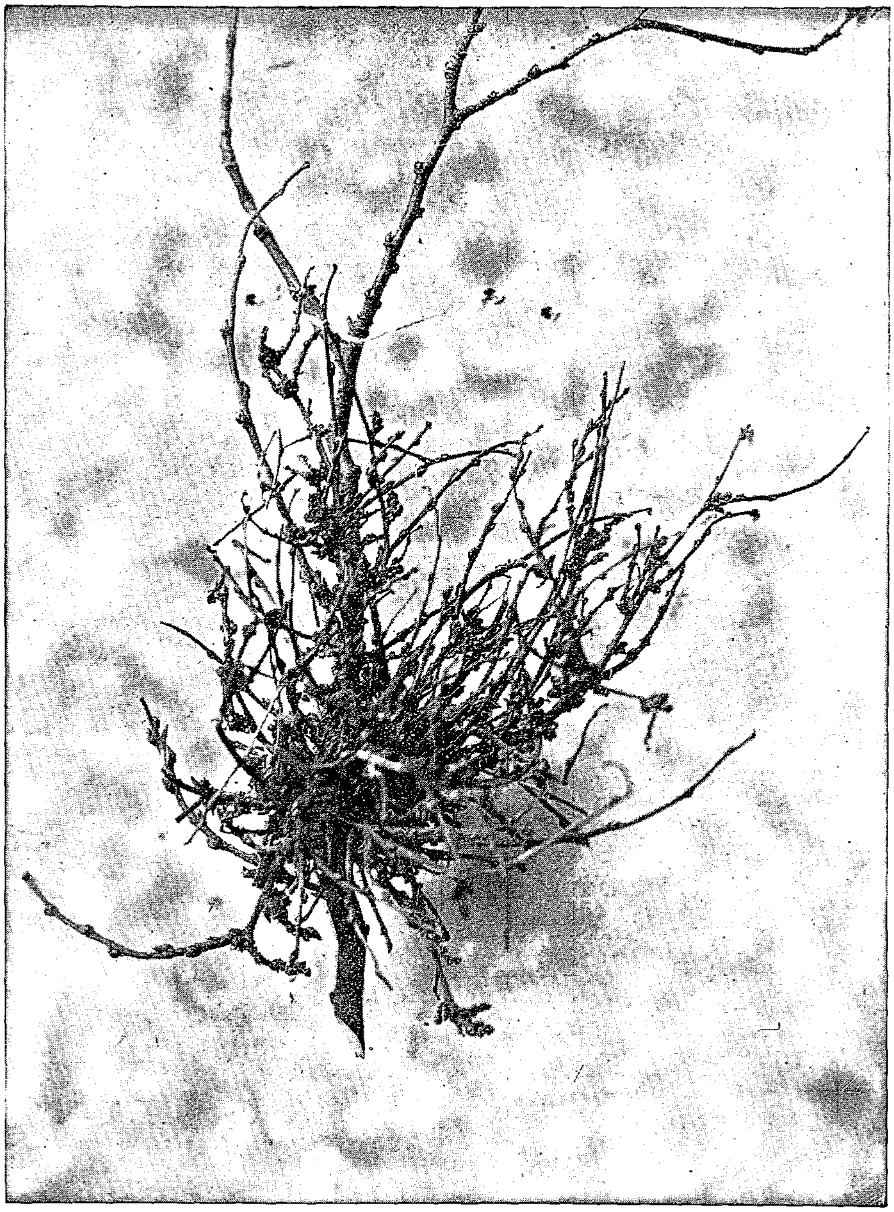
SORGHUM BLIGHT



SORGHUM BLIGHT (1 – 6), AND HACKBERRY KNOT (7 – 13).



[*From Photograph.*] **HACKBERRY KNOT.**



[*From Photograph.*] **HACKBERRY KNOT.**