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AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE
AND APPLIED SCIENCE

MANHATTAN, KANSAS

DEPARTMENT OF AGRONOMY

HYBRID CORN IN KANSAS[1, 2]

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The crop from this splendid field of hybrid corn will not be used for seed. (See Table II, page 18, for the reasons why.)

INTRODUCTION[4]

Hybrid corn is a comparatively recent development. Extensive breeding programs for the development of corn hybrids date only from about 1920. The Kansas program was begun in 1923 by A. M. Brunson and continued under his leadership

[1] Department of Agronomy, Kansas Agricultural Experiment Station and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture, cooperating. Contribution No. 291, Department of Agronomy.

[2] A considerable portion of the material in this bulletin was taken from Iowa Agricultural Experiment Station Bulletin 366 entitled "Hybrid Corn in Iowa" by A. A. Bryan and R. W. Jugenheimer.

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[4] Table of Contents on page 20.

through 1937. Despite the newness of hybrid corn, yield comparisons in many corn belt states have adequately demonstrated the superiority of *certain* hybrids over the best standard open-pollinated varieties. Results of these and other comparisons have awakened among growers a keen interest in the possibilities of hybrid corn.

Every grower is interested in obtaining large acre yields. The net profit from growing a bushel of corn is the difference between the cost of production and the selling price. Costs of producing an acre of corn are relatively constant, regardless of yield. The cost per bushel, therefore, is materially reduced with larger acre yields.

Comparisons in many states indicate that *certain* corn hybrids are more able to withstand drouth, wind, diseases, insects and other unfavorable conditions than the best standard varieties. These qualities reduce the hazards of corn production, with resultant benefits to the grower and the consumer.

This bulletin outlines what hybrid corn is; the methods followed in the development of corn hybrids by the Department of Agronomy, Kansas Agricultural Experiment Station in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture; how hybrid seed corn is produced commercially; and some precautions the grower should remember in its use.

MODERN CORN BREEDING

In 1905 G. H. Shull, working at Cold Spring Harbor, Long Island, and E. M. East, working first at the Illinois experiment station and later at the Connecticut Agricultural Experiment Station, started inbreeding corn independently. Publication of Shull's first results in 1908 and 1909 marks the beginning of modern corn breeding. Shull obtained large increases in yield from crosses between inbred lines. He outlined a method of breeding to utilize this increased vigor which involved (1) inbreeding for several generations to isolate desirable lines that breed true for the characters they possess, (2) determination of the lines which produce the best crosses and (3) utilization of the better crosses for the commercial production of corn.

GROWTH OF HYBRID CORN ACREAGE

The first commercial hybrid seed corn was produced in Connecticut about 17 years ago. Corn belt hybrids adapted to the corn belt have been available for only about 10 years but during that time their use has shown a phenomenal increase. In fact, the acreage of hybrid corn has doubled and trebled every year during the past three or four years, Almost unknown to the average corn grower four years ago about 17,000,000 acres were planted with hybrid seed corn in 1938. This is over one-seventh of the nation's total corn acreage. As shown in Table I about 62 percent of the corn acreage in Iowa, 55 percent in

Illinois, 50 percent in Indiana, 40 percent in Ohio, 25 percent in Wisconsin, 20 percent in Minnesota, 8 percent in South Dakota, 11 percent in Nebraska, 6 percent in Missouri, 5 percent in Michigan, and 3 percent in Kansas, was planted with hybrid seed corn in 1938.

TABLE I.—ESTIMATED ACREAGES OF HYBRID CORN IN THE UNITED STATES.

State	Year					
	1933	1934	1935	1936	1937	1938
			Acres			
Iowa	35,000	140,000	308,000	525,000	1,295,000	5,400,000
Illinois	....	5,000	35,000	250,000	1,225,000	4,950,000
Indiana	....	....	4,200	56,000	300,000	2,100,000
Ohio	1,000	6,000	15,000	60,000	250,000	1,400,000
Wisconsin	2,550	10,100	41,800	108,000	345,000	600,000
Minnesota	....	....	38,500	82,125	149,500	950,000
Nebraska	....	....	....	....	....	910,000
South Dakota	....	....	....	....	....	250,000
Missouri	....	....	....	....	....	250,000
Michigan	....	....	....	....	....	75,000
Kansas	....	....	....	....	....	75,000
United States	....	....	....	....	4,000,000	17,000,000
		Percentage of State Corn Acreage				
Iowa	0.4	1.4	3.1	5.3	13.0	52.0
Illinois	.....	0.06	0.4	3.1	12.8	55.0
Indiana	.....	.....	0.1	1.4	7.3	50.0
Ohio	0.03	0.2	0.4	1.8	7.4	40.0
Wisconsin	0.1	0.4	1.7	4.3	13.8	25.0
Minnesota	.....	.....	0.8	1.8	3.3	20.0
Nebraska	.....	.....	.....	.....	.....	11.0
South Dakota	.....	.....	.....	.....	.....	8.0
Missouri	.....	.....	.....	.....	.....	6.0
Michigan	.....	.....	.....	.....	.....	5.0
Kansas	.....	.....	.....	.....	.....	3.0
United States	.....	.....	.....	.....	4.0	17.0

Incorporated in the above estimates were data from surveys made independently by Dr. M. T. Jenkins, Bureau of Plant Industry, Washington, D. C., Professor A. A. Dowell, University of Minnesota, St. Paul, Minnesota, and Mr. J. A. Becker, Bureau of Agricultural Economics, Washington, D. C.

WHAT ISHYBRID CORN?

Hybrid corn is not a cross between standard varieties of corn. Hybrid corn may be thought of as corn "made to order." In the development of hybrid corn, the best standard varieties are literally taken to pieces and reassembled. The inferior heredity is discarded and new plants are created from the best inheritance which the regular varieties contained.

Hybrid seed corn is produced by crossing selected inbred lines. These inbred lines are the "building materials" of the corn breeder. They are of little value in themselves for they are inferior to open-pollinated varieties in vigor and yield. When two unrelated inbred lines are crossed, however, the vigor is restored. Some of these hybrids prove to be markedly superior to the original varieties. The development of hybrid corn, therefore, is a complicated process of continued self-pollination accompanied by selectionn of the most vigorous and otherwise desirable plants. These superior lines are then used in making hybrids.

PRODUCTION OF INBRED LINES

The best corn hybrids are produced by crossing selected inbred lines. The first requisite of a hybrid corn program, therefore, is to develop such lines. These lines are obtained by self

Fig. 1. Reduction in vigor as a result of seven generations of inbreeding. (Courtesy Connecticut Agricultural Experiment Station.)

pollinating or "selfing" the corn plant through several generations. Self pollination is the process of applying to the silks of a corn plant pollen from the same plant. Hand or artificial pollination will be described later.

Fig. 2. Good inbred lines differing in plant height, ear height and other characters. (Courtesy Iowa Agricultural Experiment Station.)

RESULTS OF INBREEDING

Inbreeding in corn results in a marked decrease in vigor and productivity. This reduction in vigor as a result of inbreeding is shown in figure 1. Theoretically, one-half of the total decrease in productivity from the open-pollinated plant to the pure line will occur in the first generation of selfing, one-half of the remainder in the second generation and so on until, finally, there is no further noticeable reduction. On the average, about 97 percent of this reduction in vigor occurs in the first five generations of selfing. Inbreeding results in a rapid approach toward plant uniformity within any progeny or line. Differences from line to line, however, often are extreme as illustrated in figure 2. Practically all of the plants in one line may be strong, erect, disease-resistant, or drouth-resistant while a neighboring line may have plants which are spindling, weak-rooted, badly infected with smut or the ear rots, or which are susceptible to heat and drouth.

REASONS FOR INBREEDING

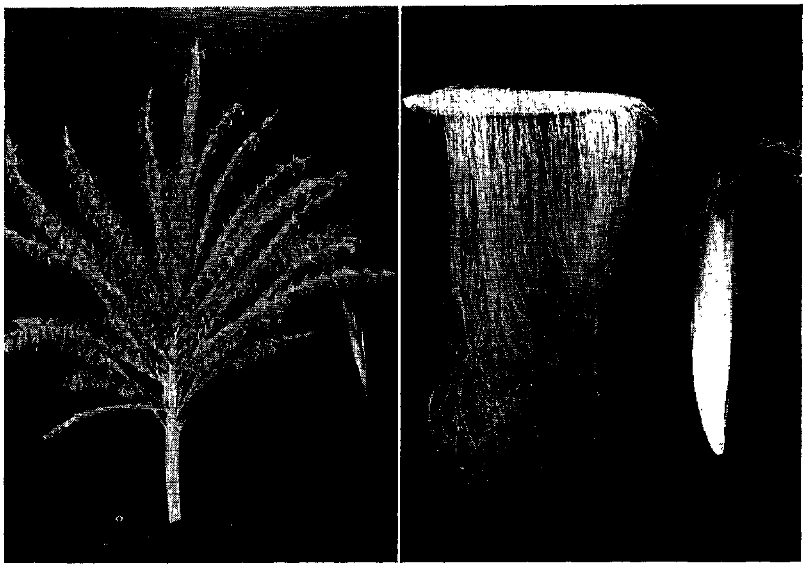
The chief reason for inbreeding is to obtain pure or true breeding lines. These are crossed for the production of corn hybrid's. Crossing inbred lines may produce *good* or *poor* hy-

Fig. 3. An extremely weak-stalked type of inbred line called "lazy." Notice contrast with strong stalks on left. (After Jenkins.)

brids. When a desirable combination is found, however, it may be remade year after year without change by the use of the same pure-breeding inbred lines. The high degree of uniformity attained among the plants of an inbred line after a few generations of self-pollination is present in the cross between two such lines. The crossed plants all will have the same heredity.

If the parents contribute many genes for high yield, every plant will have the same high yielding capacity. If they contribute few genes for vigor and yield, every plant will be lacking in vigor.

Inbreeding brings to light and makes possible the elimination of deleterious or inferior recessive characters, such as white or yellow seedlings which die as soon as the food material stored in the seed is used up, barren plants, dwarf plants, striped plants and many other less extreme defects. Under natural conditions these characters are suppressed by the constant crossing of corn. As these weaknesses are brought to light by selfing, the lines which possess them are discarded and only the stronger lines are continued. Figure 3 shows an inbred line with extremely weak stalks. This type has been called "lazy" and acts in this way almost regardless of environmental conditions. Experimental results indicate that the more vigorous lines tend to produce the outstanding crosses and, from the standpoint of practical production, they certainly are much more desirable. By careful selection among large numbers of progenies it is possible to get reasonably vigorous lines, yielding perhaps one-half as much as the original variety.



A B

Fig. 4. Flowers of the corn plant. (A) Tassel or male inflorescence. (B) Ear or female inflorescence.

TECHNIC OF INBREEDING

Corn is a naturally cross-pollinated plant. It is necessary, therefore, to control pollination artificially to obtain a self-fertilized ear.

The tassel usually appears shortly before the silks on the same plant and soon starts shedding pollen. It sheds pollen for three or four days, or even longer. Figure 4 shows a tassel or male inflorescence and a young ear or female inflorescence of the corn plant.

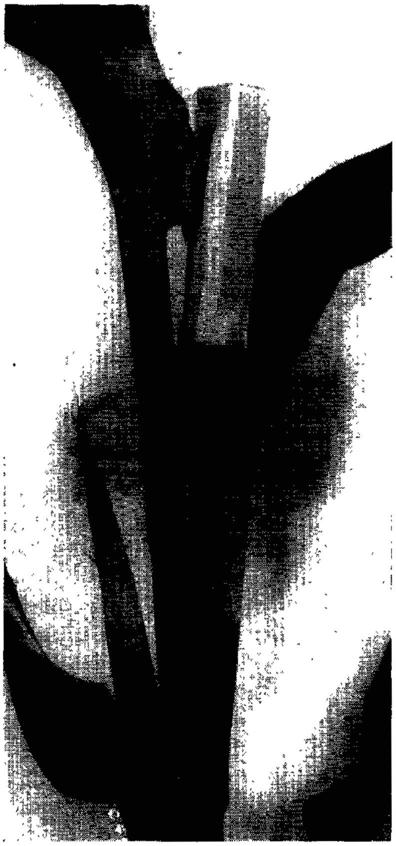


Fig. 5. A shoot bag when pinched securely between the shoot and silk protects the silks from undesired pollination. (Courtesy Iowa Agricultural Experiment Station.)

To obtain a self-fertilized ear it is necessary to cover the ear shoot before any silks appear, collect pollen from the tassel and artificially apply it to the silks. A bag, 2½ x 6 inches, made of glassine or semi-transparent paper, is convenient to cover the ear shoot, as illustrated in figure 5. Such a bag permits observation of the silks as they grow.

The sides of the silks are receptive to pollen along their entire length, and they must not be exposed nor should pollen be allowed to sift down among them.

The tassel is covered with a large paper bag when the silks are an inch or two in length and the tassel has started to shed pollen. A 12-pound bag made of heavy Kraft paper, having the seams joined with waterproof glue, is satisfactory. Two types of such bags are made, the flat or satchel bottom type and the pointed or square bottom. The square bottom type has proved to be the most satisfactory. A tassel bag in place is shown in figure 6. It should be left on for about 24 hours and the pollen then collected. Corrugated paper clips may be used conveniently to fasten the tassel bags on the tassel. Edges should be placed together and corners folded over and fastened around the neck of the tassel as tightly as possible. When the tassel bag is removed, care must be taken to avoid spilling the pollen.

Pollen should be applied to the silks in some manner that will not expose them to contamination from pollen of another plant during the operation. A convenient method is as follows:

Fold the tassel bag about one-third of the distance from the bottom, holding it so that the pollen will remain in the bottom of the bag. Slip the tassel bag over the shoot to be pollinated, reach up inside the bag and carefully remove the glassine shoot bag without touching or exposing the silks. Pull the tassel bag down carefully with one edge of the bag between the shoot and the stalk.

Fig. 6. Tassel bagged for collecting pollen. (Courtesy Iowa Agricultural Experiment Station.)

Either break down the leaf and let the outer edge of the bag remain outside the leaf and shoot, or pull the outside edge of the bag between the shoot and the leaf sheath. Then flip the bottom of the bag upwards, spreading it open as it is lifted, and shake vigorously; this causes the pollen grains to fall upon the silks. Pull the two front edges of the bag around the stalk, fold them twice and fasten with a paper clip, or pull three edges of the bag together and fasten with a clip without folding. This completes the pollination process. A completed pollination is shown in figure 7.

It is necessary to inspect the bags occasionally to make sure that the ear shoots do not grow through them and expose the silks while they are still receptive. The bag may be left on the ear until harvest.

This same method may be used for crossing inbred lines or sister plants within lines. In crossing different inbred lines the pollen (or tassel) is taken from one line and used on the silks of another line.

SOURCE OF THE INBRED LINES

Source of the inbred lines may be either high-yielding, open-pollinated varieties or hybrids. In the Kansas program, developed by A.M. Brunson, the most satisfactory lines have been obtained from the white varieties, Pride of Saline, Cassel, and Freed; and from the yellow varieties, Midland, Hays Golden, Kansas Sunflower, Yellow Selection No. 1, Illinois High-Yield, Illinois Low-Ear, Illinois Two-Ear, and Dawson County Yellow.

Fig. 7. The completed pollination. (Courtesy Iowa Agricultural Experiment Station.)

IMPORTANCE OF SELECTION IN THE DEVELOPMENT OF INBRED LINES

The quality ears from the more desirable plants are selected each year for continuation of the inbred lines. Plants are selected on the basis of yield, heat and drouth-resistance, erectness, maturity, low ears, dark green chlorophyll, good tassels, and freedom from suckering, smut, rust, rots, molds, barren plants, broken shanks and abnormalities. Selection is effective only for those characters which are inherited and which may be definitely classified in the line. Selection of lines prepotent for high yield must be based very largely on their performance in crosses.

Experience has shown that the isolation of good inbred lines requires the production and testing of a large number of lines. About 20,000 self and cross pollinations were made at Manhattan this year. A large proportion of the inbred lines obtained through the inbreeding process are only average or mediocre. It is necessary to test many lines, therefore, to find the occasional desirable one.

UTILIZATION OF INBRED LINES IN HYBRIDS

All inbred lines of field corn so far developed are inferior to open-pollinated varieties in vigor and yield. Until such time as decidedly more productive lines are developed, the ultimate use of inbred lines in commercial corn growing is in the productionn of hybrids. The better hybrid combinations among selected lines also give substantial increases in yield over the better open-pollinated varieties now grown. Other desirable characteristics, such as strength of stalks and of roots and freedom from specific diseases, are advantages which *some* of these hybrids possess. Not all hybrids are worth while; some hybrids are much less desirable than the average open-pollinated corn. In order to produce a satisfactory hybrid the corn breeder must make and test a large number of crosses among his outstanding inbred lines. When a desirable combination is found, however, it can be expected to perform in the same way each time it is produced.

KINDS OF HYBRIDS

Several kinds of hybrids are possible, depending upon the number of inbred lines involved. The simplest hybrid, known as a single cross, is made by crossing two inbred lines. A cross between a single cross and a third inbred line is known as a three-way cross. A cross between two single crosses is called

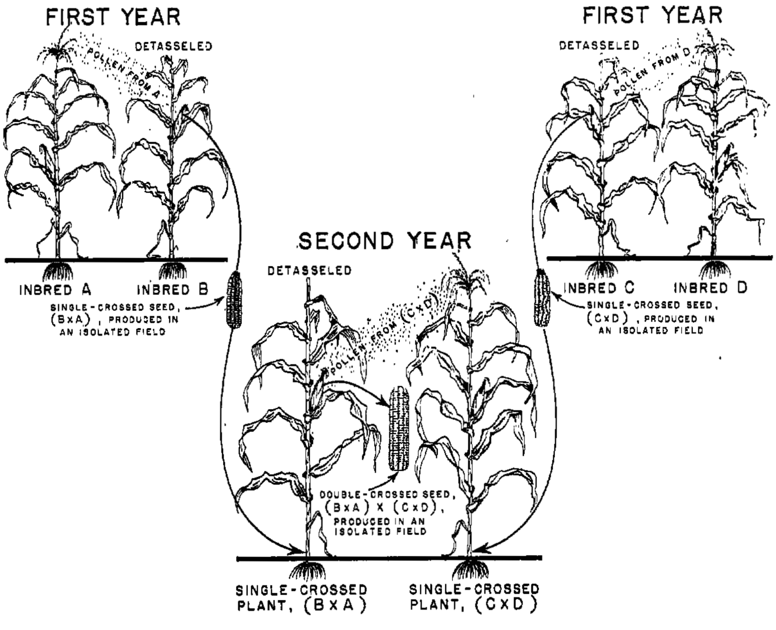


Fig. 8. Method of producing seed of single and double crosses.

a double cross, while two double crosses combined may be termed a double-double or a multiple cross. The product resulting from combining many inbred lines may be referred to as a synthetic variety. A top cross is a cross between an inbred line and an open-pollinated strain.

Each of these various types of hybrids has its use. The method of producing single and double crosses is illustrated diagrammatically in figure 8. Most investigators in corn breeding agree that, with present inbred lines, the double cross is the most economically produced field corn hybrid.

The single cross, used extensively for sweet corn production where uniformity is of extreme importance, has been suggested frequently for commercial planting. High cost of seed is the principal objection to single crosses for field corn production. Single-crossed seed, of necessity, is produced on inbred plants, which are relatively poor producers, both of seed and pollen. This makes the cost of producing single-crossed seed relatively great, because the acre yield of seed is small. When the single-crossed seed is used only as a parent stock for making double-crossed seed, however, the quantity needed is small, and its high cost is relatively unimportant.

Seed of three-way crosses is less expensive to produce than that of single crosses but more expensive than that of double crosses. In most cases they are produced where three lines are available which combine well, but a suitable fourth line is lacking. As the supply of desirable lines increases, three-way crosses may be entirely replaced by double crosses.

Double-crossed seed is produced on single-crossed plants, which are highly productive of quality seed. Single-crossed plants, likewise, produce pollen abundantly. This makes possible a greater proportion of seed-producing rows to pollen rows in the crossing plot. Furthermore, single-crossed plants withstand adverse conditions much better than inbred plants, reducing the risk in seed production. All of these factors have an important bearing on the cost of producing seed and favor the use of double crosses.

In Kansas where periods of extreme heat and drouth are frequent, the most desirable varieties over a period of years have been those in which the individual plants varied considerably in date of pollination. Experimental evidence has shown that double-cross hybrids pollinate over a shorter period than do the adapted varieties. It appears, therefore, that the most desirable hybrids for use in Kansas might be those with considerable variation in date of pollination. This may be accomplished by the use of (1) top crosses of desirable lines on adapted varieties, (2) double crosses or multiple hybrids involving early and late maturing lines, or (3) a mechanical mixture of two or more adapted hybrids differing in maturity.

NEW HYBRIDS MUST BE TESTED

The hundreds of crosses made by the experiment station must be compared carefully before any can be recommended for general growing. Experience has shown that some hybrids may yield twice as much as others grown under the same conditions.

Under the system of testing used at the Kansas station new

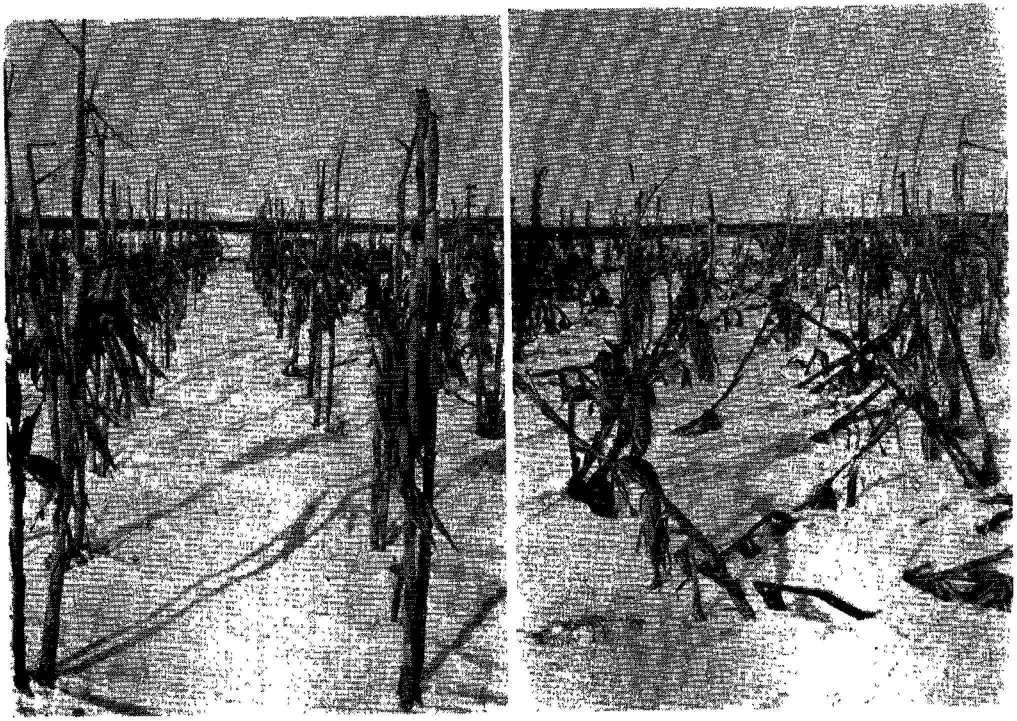


Fig. 9. Hybrids differ markedly in strength of stalks and roots. These pictures of two hybrids growing in the same field were taken on the same day. (Courtesy Iowa Agricultural Experiment Station.)

inbred lines are tested first intop crosses with an open-pollinated variety. This is an inexpensive way of obtaining reliable results on a large number of lines and permits each line to be tested annually, through several years, thus providing for a determination of the seasonal effect. The crossed seed is produced in a detasseled crossing plot in which the variety is used as the pollinating parent. Yellow inbred lines have been crossed with Hays Golden, and white lines have been crossed with Pride of Saline. Fifty percent or more of the inbred lines may be discarded on the basis of two or three years' results from this preliminary test. Remaining lines are given a more careful test in combination with each other. Essentially, the first comparisons in top crosses are to find the inbred lines which possess the most promising heredity, and the later comparisons in double crosses are to discover the particular combinations giving the best results in field planting.

Double crosses between the lines which have proved the most promising in the tests of top crosses are compared first at the experiment station. Outstanding combinations then are to be entered in the Kansas Corn Performance Test and finally compared by farmers. In these comparisons the characters given consideration are yield, lodging, drouth-resistance, disease, ear drop, maturity, ear size, shelling percentage and quality.

Hybrids differ markedly in their ability to withstand storms

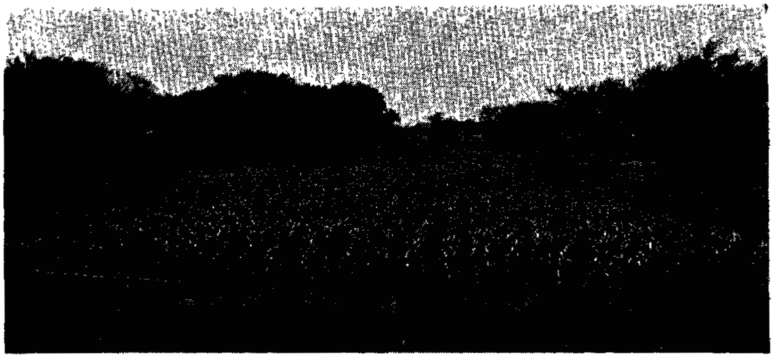


Fig. 10. Increasing the seed of an inbred line by open-pollination in an isolated field. The plants were grown from hand-pollinated seed. A distance of 70 to 80 rods from other corn is highly desirable. (Courtesy Iowa Agricultural Experiment Station.)

(figure 9). Some hybrids lodge badly in a severe windstorm, while others in neighboring rows continue to stand almost perfectly. Some hybrids lodge because of weak stalks and others because of weak roots. Little lodging occurs in some seasons, and under such conditions it is not possible to recognize lodge-resistant strains. Devices have been developed and used at some experiment stations for testing the breaking strength of the stalks and the pulling resistance of the roots. These devices furnish a means of testing the hybrids independently of storms, thus materially speeding up the process of selection.

COMMERCIAL PRODUCTION OF HYBRID CORN

When a hybrid has been thoroughly tested and its desirability ascertained, seed of the parent inbred lines must first be increased. Each inbred line may be increased by hand-pollination or by open-pollination in an isolated field (figure 10). These isolated increase fields should be located at least 70 to 80 rods from other corn.

TECHNIC OF CROSSING

The second phase in the commercial production of hybrid corn is that of crossing the inbred lines. Crosses may be made by hand pollination or by growing the strains to be crossed in alternate blocks in an isolated plot and detasseling, before they have shed any pollen, all of the plants of the strain on which

Fig. 11 (A). Producing single-crossed seed on detasseled plants in two-row blocks. The plants were grown from inbred seed produced by open-pollination in isolated plots such as are shown in fig. 10. (Courtesy Iowa Agricultural Experiment Station.)

seed is to be produced. Experimental hybrids requiring only small quantities of seed are best made by hand-pollination. The production of large quantities of hybrid seed is accomplished less expensively in isolated crossing plots than by hand pollination. In these crossing plots the parent which furnishes the pollen is called the male or pollen parent and the one detasseled is called the female or seed parent.

The ratio of male to female rows depends upon the kind of cross to be made and the abundance of pollen produced by the male parent (figures 11A and 11B). Inbred lines lack vigor and pollen producing ability. When they are used to supply the pollen, it is safest to plant one row of male parent to every two rows of female parent (figure 11A).

When single-crossed plants supply the pollen, one row of male parent to three or four rows of female parent is satisfactory (figure 11B).

For the production of good hybrid seed, the crossing field

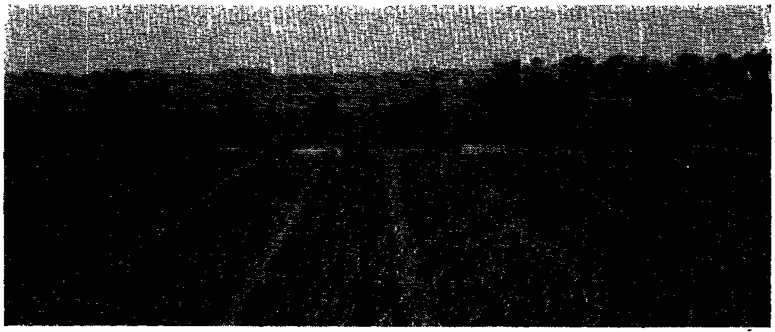


Fig. 11 (B). Producing double-crossed seed on detasseled plants in four-row blocks. The plants were grown from single-crossed seed produced on detasseled plants in isolated plots like those shown in fig. 11 (A). Note the difference in the ratio of male and female rows in fig. 11 (A) and fig. 11 (B). (Courtesy Iowa Agricultural Experiment Station.)

must be isolated from other corn to avoid contamination from foreign pollen. Fields in which single crosses are being produced should be at least 40 rods from other corn. Fields to produce double crosses also should be isolated from other corn. This distance however may be modified somewhat by the size of the crossing field and by the planting of border rows of male parent adjacent to the crossing field.

All tassels must be removed from the female rows before they have shed any pollen. This is necessary in order that the resulting ears on these plants will be a cross between the ear producing parent and the desired pollen parent. Every seed field should be carefully gone over every day until detasseling is completed. This usually requires about two weeks. Hybrid seed corn from fields where the detasseling has been carelessly done is almost sure to perform poorly.

Pulling the tassels, usually as soon as they are well out of the "boot," is the most satisfactory method of removal. This probably will be one or two days after they are first visible. If the pulling is done too soon, one or two leaves may be removed with the tassel, or the tassel may break off and not be completely removed. This should be avoided—loss of leaves will reduce the seed yield, and incomplete removal of the tassel necessitates additional labor. When 90 to 95 percent of the tassels have been pulled, it probably is more economical to remove all of those from the remaining plants at one time even though it is necessary to pull several leaves. The loss in yield from pulling leaves on such a small percentage of plants would be more than balanced by the time saved.

Tassels on tillers or suckers should not be overlooked. Tops may be pulled out, regardless of the loss of one or two leaves. The yield will be reduced somewhat if the tillers are removed completely, but it is questionable whether the reduction in yield is of greater value than the additional time required for more careful detasseling.

KANSAS CORN PERFORMANCE TESTS

Not all corn hybrids are desirable for use in Kansas, although a few hybrids appear to be promising. Many others, however, are much inferior to the local varieties. The rather remarkable records made by some hybrids in yield tests have created a considerable demand for hybrid seed corn. Consequently, seed has been offered as hybrid which either is not hybrid at all or not of *proven superiority.* The average corn grower also has been confused by the large number of corn hybrids offered for sale. As a result corn growers, county agents, vocational agriculture teachers and others have realized the need of impartially and carefully conducted field trials which would furnish more information as to the suitability of particular corn hybrids to local conditions.

In order to determine the local adaptation, vegetative characteristics, and yielding capacity of specific hybrids the Kansas Corn Performance Tests are being established. These official tests are cooperative between the Department of Agronomy, Kansas Agricultural Experiment Station, the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture, and a number of farmers who supply the necessary land and tillage. In these tests the more promising corn hybrids released by federal, state, and commercial agencies will be compared with the best locally adapted varieties.

Although subject to some change as conditions warrant, the general plan of the tests is outlined by the following announcement of the 1939 Kansas Corn Performance Tests:

"The Department of Agronomy of Kansas State College, in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture, announces the following plans for a system of corn performance tests to be conducted in Kansas in 1939.

"1. The following committee is in charge of the Kansas Corn Performance Tests: A. L. Clapp, chairman, R. I. Throckmorton, H. H. Laude, and H. D. Hollembeak, members of the Department of Agronomy of Kansas State College; and R. W. Jugenheimer, Bureau of Plant Industry, United States Department of Agriculture, Manhattan, Kansas.

"2. The state will be divided into five districts to be known as No. 1

(northeastern), No. 2 (central eastern), No. 3 (southeastern), No. 4 (northcentral), and No. 5 (southcentral). Two tests will be established in each district, The division of the state into districts for the Kansas Corn Performance Tests is shown in figure 12.

"3. The tests will include Kansas standard open-pollinated varieties, and hybrids produced and distributed by federal, state and commercial agencies.

"4. Each company producing and distributing hybrids may enter from one to five hybrids in any one test, provided that no subsidiary company

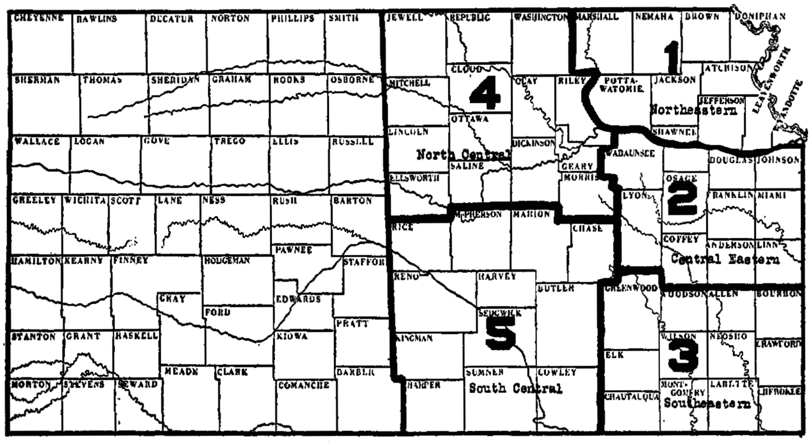


Fig. 12. The division of the state into districts for the Kansas Corn Performance Test.

may enter the same hybrid that is entered by the parent company who produces the seed stock or by another subsidiary of the same company. No test shall include more than sixty samples. If entries in any test amount to more than sixty, the number allowed each company shall be prorated. If less than twenty commercial hybrids are entered in any one section, the tests in that section may or may not be conducted at the discretion of the committee.

"5. An entry in any district must be included in both tests within the district. Each hybrid entered must be included in two or more districts. The company making an entry must agree to continue the same entry for at least three consecutive years if requested to do so by the Kansas Corn Performance Test Committee. Such request will not be made for any entry which yields below the average of the test.

"6. Any company making entry must furnish the names of five or more distributors or producers where seed of the hybrid may be secured. from the market stock for planting in these tests. Seed for the Kansas. Corn Performance Tests may be purchased by those in charge of the tests, from any of those distributors named by the company or from other recog–nized distributors of the hybrid.

"7. Each commercial hybrid seed producer shall pay $6.00 per sample per location. Payment shall accompany entry and shall be made to the Department of Agronomy, Kansas State College, Manhattan, Kansas.

"8. Entries shall close February 1, 1939.

"9. The entry of each hybrid must be accompanied by the pedigree. Such pedigree may be coded if desired, provided the same code is used each time the same combination is entered. The name or number of a specific hybrid must be changed if a change is made in the pedigree.

"10. Each entry will be replicated five times in each test field. Entries will be distributed at random within each replication. Each entry will be planted in plots two rows wide and twelve hills long. The hills will be located three and one-half feet apart each way. The corn will be hand planted on the surface or in lister furrows at the discretion of the committee in charge. Three kernels per hill will be planted in districts Nos. 1, 2, and 3, and two kernels per hill in districts Nos. 4 and 6.

"11. A printed or mimeographed report giving data on yield, stand, moisture, lodging, dropped ears and damaged seed will be made and distributed by the committee. All entries will be included in the report unless unavoidable or unforeseen circumstances make it impossible to secure comparable data on a suffcient number of replications to insure reliable information in which case the committee shall not be required to include such data in the published summary.

These reports may be obtained by writing to the Department of Agronomy, Kansas State College, Manhattan, Kansas.

One or two years' results do not prove the superiority of any hybrid. Until the local adaptation and consistent superiority of any specific hybrids have been established by careful trial through several years, it is recommended that farmers plant

TABLE II.—COMPARISONS BETWEEN F_1 (FIRST GENERATION) HYBRID SEED AND F_2 (SECOND GENERATION) HYBRID SEED.

Double Cross	No. of days planting to silking		Unmarketable ears per 100 plants		Acre Yield			
					Bushels		Decrease	
	F_1	F_2	F_1	F_2	F_1	F_2	Bu.	%
A	69	73	3.1	10.3	87.9	68.4	19.5	22
B	69	73	4.9	12.7	82.2	68.1	14.1	17
C	71	73	2.6	6.3	82.2	62.3	19.9	24
D	69	74	2.1	8.0	82.0	66.7	15.3	19
E	72	73	5.5	6.2	78.3	69.9	8.4	11
F	70	69	3.1	3.6	76.6	65.7	10.9	14
G	73	73	5.3	7.3	76.0	72.0	4.0	5
H	72	73	3.1	8.7	73.8	66.3	7.5	10
I	70	73	4.4	11.5	73.2	63.3	9.9	14
J	73	74	6.8	10.1	73.0	61.4	11.6	16
Average	70.8	72.8	4.1	8.5	78.5	66.4	12.1	15.2

Richey, F. D., G. H. Stringfield, and G. F. Sprague. The loss in yield that may be expected from planting second generation double-crossed seed corn. Jour. Amer. Soc. Agron. 26:196-199. 1934.

standard adapted varieties in their main fields and that they plant only a few acres of any definite hybrid. In fact, they might try several different hybrids on a small scale. These should all be planted on the same field under similar conditions, and the best standard or locally adapted variety should be included as a check. A farmer should insist on knowing what specific hybrid or combination he is obtaining in order that he may demand the same combination in the future in case it proves satisfactory.

SAVING SEED FROM A FIELD OF HYBRID CORN

The crop grown from commercial hybrid seed corn should not be used as seed the following year. Numerous tests in many places have shown that seed from this advanced generation is likely to yield from 10 to 20 percent less corn than that from newly crossed hybrid seed. Some Ohio data on the F1, and F2, generations of 10 double crosses are given in Table II. These data show that the decreased yield varies from 5 to 24 percent depending upon the specific hybrid. On the average, however, the second generation seed yielded 15 percent less than from the newly crossed seed. This is usually about the same as, or a little poorer than, the yield of an open-pollinated variety. This second generation seed may look fine, germinate well, and produce a field of fine looking plants but the yield will be disappointing. The original hybrid seed was a cross between specific parents. Seed from a hybrid field is to a greater or less extent inbred. This tends to reduce the yield of the resultant crop.

PLACE OF PRODUCTION DOES NOT INDICATE ADAPTATION OF A HYBRID

The adaptation of a hybrid does not depend upon the place where the seed was produced. Unadapted open-pollinated varieties can be brought to Kansas and by selection over a period of years may be acclimated to local conditions. This is not true of hybrids. A hybrid is a combination of certain inbred lines. It is the same combination regardless of where produced. The important thing is to know whether the combination is suited to the location and conditions where the crop is to be grown. Therefore, the adaptation of a specific hybrid can be known only after several years of actual test in the farmers' own community. There is some evidence that certain hybrids have a narrower range of adaptation than some standard varieties.

The Department of Agronomy of the Kansas Agricultural Experiment Station in cooperation with the Division of Cereal Crops and Diseases, U. S. Department of Agriculture, has been working for a number of years on the production of hybrids suitable for Kansas conditions. Preliminary results indicate that some of these hybrids may be far superior to the varieties commonly grown and the hybrids now available from other sources. As soon as the localities of adaptation and superiority of some of these hybrids have been established through careful trial, such hybrids will be released to Kansas corn producers.

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