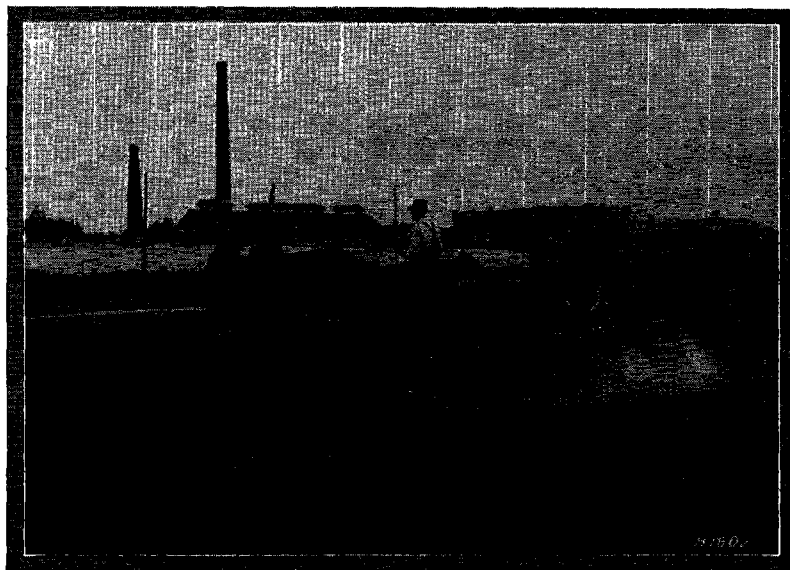


AGRICULTURAL EXPERIMENT STATION

KANSAS STATE AGRICULTURAL COLLEGE
MANHATTAN, KANSAS

DEPARTMENTS OF CHEMISTRY AND AGRONOMY



ORCHARD SPRAYER ADAPTED FOR USE IN SPRAYING BINDWEED

KILLING FIELD BINDWEED WITH SODIUM CHLORATE

W. L. LATSHAW AND J. W. ZAHNLEY

INTRODUCTION

Field bindweed is by far the most dangerous and destructive weed in Kansas. It is causing alarm not only in this state but over a large part of the United States, especially in the West. It now occurs in probably every county in Kansas. Some farms are so nearly over-run with the weed (fig. 1.) that they are practically worthless in their present condition and would not sell for half price if put on the market. In some instances loan companies refuse to carry mortgages on farms known to be infested with bindweed. Many fields and,

1. Contribution No. 140 from the Department of Chemistry and No. 174 from the Department of Agronomy.

Acknowledgment.—The authors are indebted to Prof. W. F. Pickett of the Department of Horticulture for valuable assistance in adapting spraying machinery and supervising field trials with sodium chlorate.

in some cases, entire farms have been abandoned because of this pest.

Crop production on heavily infested land is rarely profitable. The bindweed roots fill the soil as deeply as most crop roots and remove both plant food and moisture. The twining vines of the weed bind the crop plants together, completely over-riding the crop, reducing the yield, and make harvesting difficult.



FIG. 1.—An area completely over-run by field bindweed.

Fortunately the weed occurs in very small patches on many farms and some farms are entirely free from it. Immediate action to control this pest will in many cases prevent serious damage.

DESCRIPTION AND HABITS OF GROWTH

Field bindweed (*Convolvulus arvensis*) belongs to the morning glory family and is sometimes referred to as "wild morning glory." It can be distinguished from other morning glories by its small white or pinkish bell-shaped flowers which are scarcely half as large as those of the tame species. The leaves vary in size and shape (fig. 2) but are usually small, somewhat arrow-shaped but more blunt and rounded at the tip than those of other bindweed species. The seed are about one-eighth of an inch long, dark grayish brown in color, and covered with raised dots or pimples which can be

easily seen with the aid of a small magnifying glass. In shape the seed somewhat resemble the quarter of a sphere, although the shape varies with number of seeds borne in the pod.

The root system of bindweed is very extensive. It fills the soil to a depth of four feet or more and many roots extend to a much greater depth. The main roots are long, tortuous, whitish cords about one-tenth of an inch in diam-

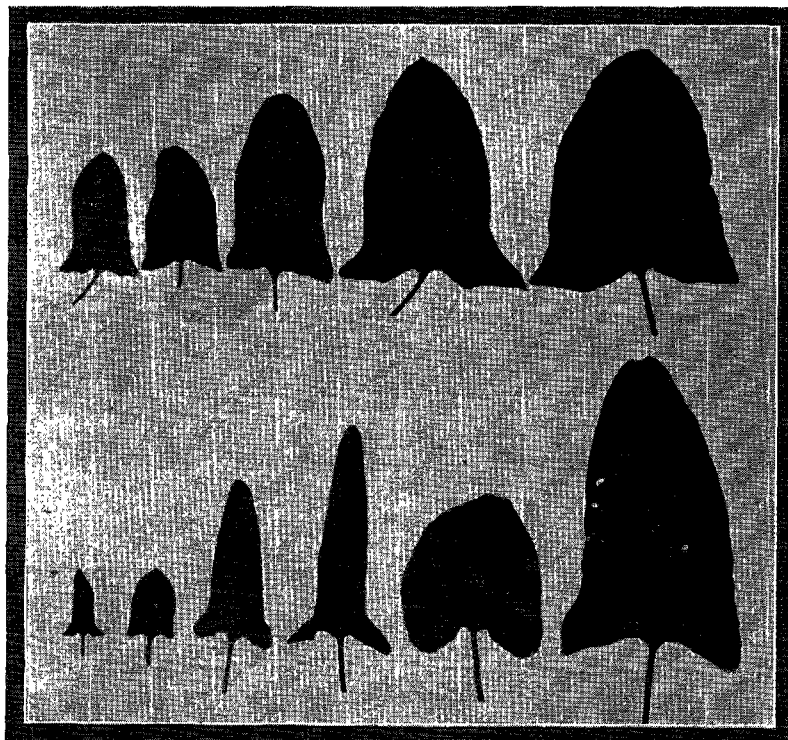


FIG. 2.—Leaves of field bindweed. Upper row: Typical shapes.
Lower row: variation in size and shape

eter and with many branches. These roots scarcely diminish in size at a depth of four or five feet, and if the soil is scraped off to that depth, a stand of bindweed will start from the roots extending below this depth, showing that the fleshy roots may form buds and give rise to new plants anywhere along their length.

The seed of bindweed have great vitality and if plowed under will remain buried deep in the soil from one season to another without injury, and will germinate when brought near the surface. The seed germinate any time from early

spring until fall whenever conditions become suitable. The seedlings thus produced make little top growth but the roots grow rapidly, extending deep in the soil. It has been found that in six weeks after the seed sprout the seedlings become so thoroughly established that they will not be killed by cutting off two or three inches below the surface of the ground.

Bindweed is spread both by seed and roots. The first foothold in a field or locality usually comes from seed scattered in seed grain or from threshing machines. Five lots of seed oats, representing several carloads, examined by the state seed laboratory in 1927, contained an average of over ten bindweed seeds per pound. The seed may be scattered locally by feed grown on bindweed land. It is also scattered in the manure of animals grazed on bindweed land or consuming feed containing bindweed seed. Commercial feed, chicken feed, and screenings bought on the market frequently contain bindweed seed. Drainage water is an important factor in spreading bindweed carrying the seed down slopes or ravines during torrential rains.

When a plant becomes established, horizontal roots are produced which have been found to grow to a distance of seven feet in a period of 90 days in cultivated land, producing several plants along their length. Thus the roots spread gradually a few feet each year, so that before long the infestation may cover a large area. It will readily be seen that from a start of a few widely scattered plants an entire field or farm may soon be over-run with the weed.

KILLING FIELD BINDWEED WITH SODIUM CHLORATE

Experiments carried on at the Kansas Agricultural Experiment Station at Manhattan during the past three years show that field bindweed can be successfully and efficiently killed by the use of sodium chlorate. (Fig. 3.)

PREVENT SPREADING

Because of the rapid spread of bindweed by tillage implements, one of the first things to do when bindweed is discovered is to isolate the area upon which it occurs. This land should not be cultivated with the rest of the field. If it becomes necessary to cultivate an infested area, the implements used should be carefully cleaned to remove all vines and roots. If a crop is grown on an infested area, great care should be taken to avoid distribution of bindweed by seed removed with the crop.

SALT AND FALLOW

Up to the present time the best methods used in this state for the control of bindweed have been the use of salt, fallow, and a combination of fallow and smother crops. In many cases these methods have proved successful when properly



FIG. 3.—Bindweed eradication experimental plots.

applied, but they have certain disadvantages which under some conditions make their use impracticable.

Salt applied on infested areas at the rate of 20 tons per acre will destroy nearly all bindweed plants and if followed by a second application to the few remaining plants will completely eradicate the weed. Salt is too expensive to use over large areas and it ruins the land for crop production for an indefinite period. Salt is equally destructive to trees, shrubs, and other plants.



FIG. 4.—Bindweed in an orchard presents a very difficult problem.

Fallow is being used successfully for the control of bindweed and has the advantages over salt of a smaller cash outlay and leaving the land in good condition for immediate cropping. While this method has several advantages, it has a number of disadvantages. It is very expensive from the standpoint of time and labor involved. The work must be done thoroughly and prompt attention must be given at the right time or the work may not only fail to eradicate, but may even help to distribute the weeds. In rainy seasons it is frequently impossible to cultivate at the proper time because of the condition of the soil. Fallow results in the loss of the use of the land for crop production for one or two seasons. On sloping fields the soil washes badly when continuously cultivated and in the western part of the state wind erosion is likely to be serious.

Bindweed in orchards (fig. 4.) presents a peculiarly difficult problem where neither fallow nor salting can be used effectively.

SODIUM CHLORATE

Considering the seriousness of the bindweed situation and the facts that older methods now in use in Kansas are not wholly satisfactory, other methods have been tried during recent years by the Agricultural Experiment Station. From this experimental work it has been found that sodium chlorate applied as a spray will kill the weed quickly and efficiently and without injury to the soil or danger to live stock grazing on the area being treated.

Various methods of treatment have been tried including spraying with solutions of sodium arsenite, copper sulphate, zinc chlorilide, sodium hypochlorite, and a commercial preparation specifically made for the eradication of bindweed known as "K. M. G. weed killer." Fallow tests were also included, but no other method proved as successful as spraying with sodium chlorate.

HOW TO USE SODIUM CHLORATE

Commercial sodium chlorate is a white crystalline substance very similar in appearance to ground rock salt. It is readily soluble in water and the preparation of the spray solution consists only of dissolving the proper amount of sodium chlorate crystals in water. It has been determined that 100 pounds of the crystals dissolved in 100 gallons of water produces a solution of suitable strength to kill the weed and make sufficient material to treat an acre. Where there is a heavy growth of other vegetation or considerable rubbish, it will be necessary to use a larger quantity of the solution in order to thoroughly moisten all the leaves of the bindweed.

PRECAUTIONS IN USING SODIUM CHLORATE

Sodium chlorate is as injurious to other growing plants as it is to bindweed, therefore care should be taken not to allow the spray solution to come in contact with the leaves of trees, shrubs, or other vegetation not to be killed. Spray apparatus in which sodium chlorate has been used must be thoroughly cleansed by rinsing, using plenty of water to remove all traces of the chemical before being used to spray other vegetation. Sodium chlorate in contact with finely divided organic matter forms a combustible mixture. Clothing, fine straw, or chaff that has been moistened with a solution of this material and permitted to dry may be ignited by friction or a spark and become a fire menace. For these reasons sodium chlorate should be handled carefully. The spray solution should not be prepared inside barns or sheds, and if clothing becomes saturated, it should be thoroughly rinsed before being allowed to dry. It is advisable to wear rubber boots while spraying and to keep wagons and spray equipment well painted.

METHOD OF APPLICATION

Thorough distribution of the spray solution is essential for best results. All leaves of the weed should be well moistened. This implies that spray applied in the form of a mist is more effective and economical of material than if applied in droplets. Any compressed air sprayer, which will disperse the material as a fine mist, may be used. For small patches of a square rod or two in extent, a two- to five-gallon knapsack compressed air sprayer is suitable. (Fig. 5.)

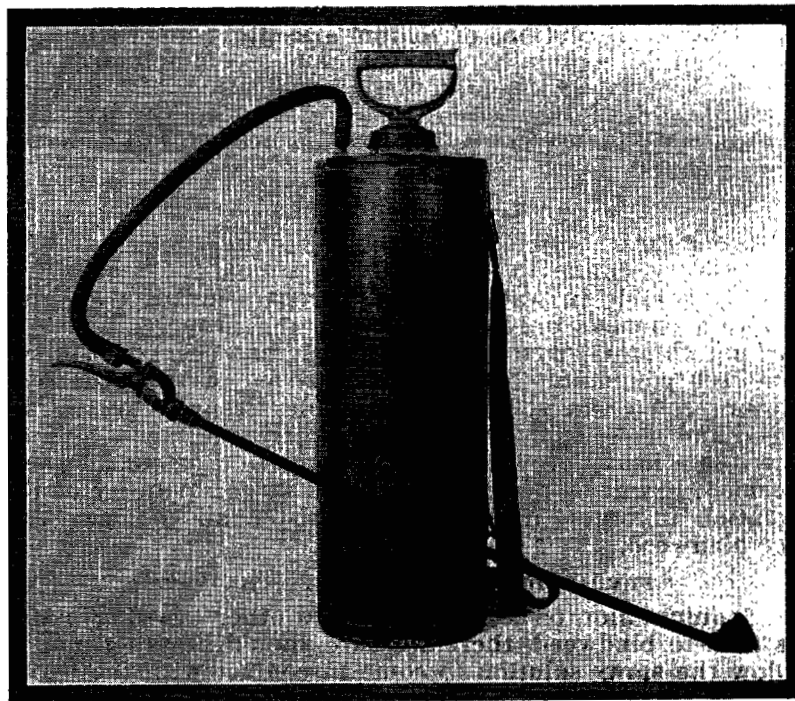


FIG. 5.—A suitable sprayer for small patches.

For larger areas a barrel sprayer mounted on a wagon or truck can be used conveniently. For areas of several acres in extent a power sprayer such as is used by commercial potato growers is more efficient. A sprayer such as is used in commercial orchards can readily be converted into a suitable type for use on large areas of bindweed by attaching a $\frac{3}{4}$ inch pipe of desired length to the sprayer outlet, so that it will hang horizontally about $2\frac{1}{2}$ feet from the ground. This pipe is fitted with spray nozzles about 2 feet apart so that the spray will overlap as it reaches the tops of the weeds. The cut on the cover page shows an orchard sprayer that has been equipped in this way.

It is suggested that in communities where bindweed is prevalent, several individuals cooperate in buying a suitable power sprayer to be used cooperatively. The township or county unit may own and operate a spray outfit to good advantage. By such means more expensive and efficient machinery may be provided and a saving effected by buying the material in quantity.

TIME AND NUMBER OF APPLICATIONS

The first application of spray should not be made before the plants come into full bloom (fig. 6), which in central

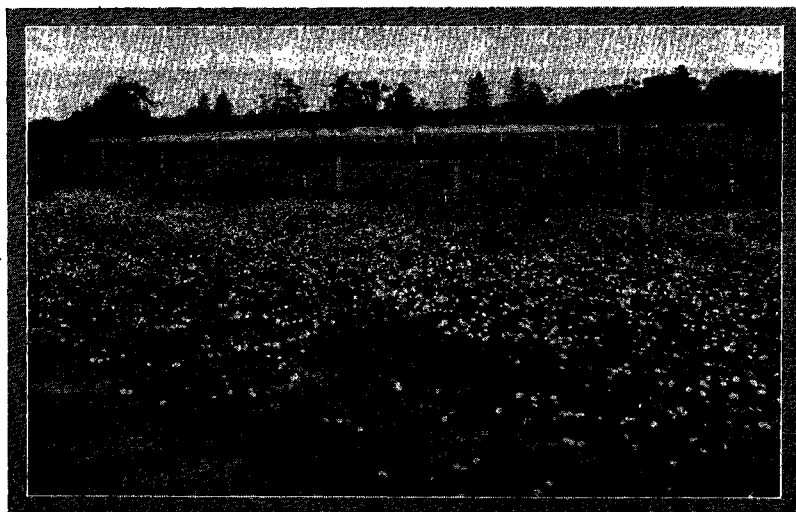


FIG. 6.—A field of bindweed in full bloom—in ideal condition for the first application of sodium chlorate. (Figure 9 shows this same area 100 days later.)

Kansas is about the first of June. The bloom period is somewhat later where the land has been cultivated. Experimental results in some cases have indicated that the first application may be made several weeks after bloom, even as late as the middle of August, with equally good results. This practice has the disadvantage of allowing seed to mature.

The time of the second application will depend upon the recurrence of normal growth. Usually in from four to six weeks the surviving plants will have become green and bloom will appear. At this time a second application of spray should be made. The time required for this resumption of growth will depend upon the vigor of the plants, the thoroughness with which the first spray was applied and its effectiveness, and the growing conditions as influenced by soil moisture.

Usually three applications will completely kill all growing plants. If the plants are exceptionally vigorous, additional treatments may be required. As high as 95 per cent of the plants on experiment plots have been killed by two applications of spray. Eradication of the growing plants should not be considered complete until 100 per cent of the weeds have been killed, hence it is usually necessary to spray a third time and sometimes a fourth in order to kill the few remaining plants.

The method of procedure may be varied to fit in with the cropping system; for example, infested wheat land may receive two treatments following harvest and a third treatment early the next summer when the remaining plants are

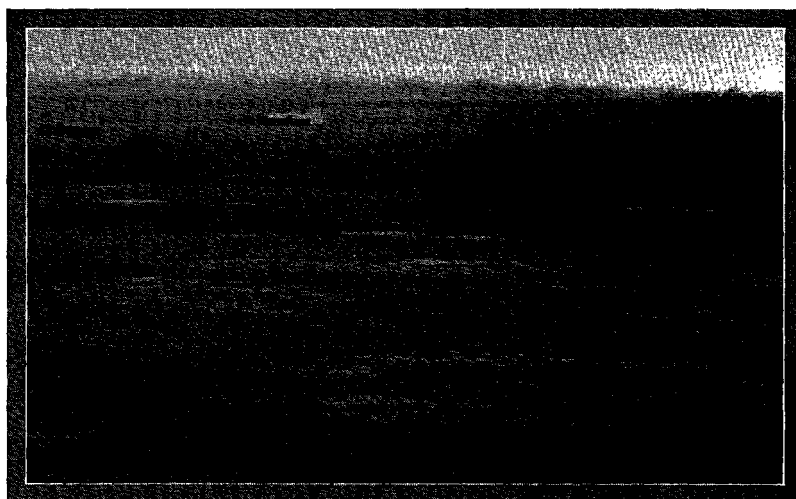


FIG. 7.—Bindweed patches killed with sodium chlorate in a Sudan grass pasture.

in bloom, then the land planted to a smother crop such as sorghum drilled or broadcast for hay. This practice does not involve any loss of the use of the land.

A method which has proved practical where the bindweed is in scattered patches is to fall plow, fallow in the spring until about June 1, and sow Sudan grass. The bindweed patches can be located easily before the Sudan grass has made much growth. Mark these patches and spray them with sodium chlorate after the weeds have produced vines several inches to a foot long. In this case it is not advisable to wait until the bindweed comes into full bloom on account of the heavier growth of Sudan grass which interferes with spraying. Figure 7 shows a field that has been treated in this manner. The light spots show bindweed areas which have been sprayed twice. This field of Sudan grass has been

KILLING FIELD BINDWEED WITH SODIUM CHLORATE 11

heavily pastured and the only loss of crop from this method has been on the areas treated. On some of the treated areas the bindweed has been completely killed, while on others some weeds remain which will require additional treatment.

CROPPING PRACTICES FOLLOWING ERADICATION OF BINDWEED

Following the killing of the weeds with sodium chlorate there is still the danger of new growth of bindweed becoming established from seed left in the soil. Bindweed seed have great vitality and may lie in the soil for several years without losing their ability to germinate. For this reason it is desirable to follow practices of tillage which will germinate the seed as rapidly as possible and destroy all seedlings before they become established. This may be accomplished by following the sodium chlorate treatments with thorough cultivation and the growing of smother crops such as sorgo or Sudan grass broadcast for hay, or growing an intertilled crop in which thorough cultivation is practiced. These methods should be followed for at least two seasons, or until the seed are destroyed.

EFFECTS OF SODIUM CHLORATE

The effect of sodium chlorate on bindweed is different from that of most other weed killers. There are numerous chemicals which readily kill the tops of the weeds and their killing action is more rapid than sodium chlorate, but in such cases the weeds soon recover and resume normal growth.

The fundamental difference between the action of sodium chlorate and other chemicals used is that it not only kills the tops, but seems to interfere with the manufacture of food in the leaves of the new growth. This new growth comes from the food reserve stored in the roots. As a result the roots become exhausted and the entire plant dies.

The action of sodium chlorate is slow, comparatively little effect being noticed at first, but gradually the plant becomes pale green or yellow, the leaves begin to curl, and finally the entire plant withers and dies. Each succeeding day shows more dead and dying plants. The older leaves die first, the reaction progressing toward the tip of the vines. After the second application the new growth of vines is slender and assumes an upright position and the leaves are yellow and unhealthy in appearance. The immediate effect upon the plants depends somewhat upon weather conditions, especially with regard to humidity or moisture in the air. The most favorable time for rapid killing is when the air is moist. For this reason spraying late in the afternoon or on damp days is desirable although not necessary. Rain fol-

lowing a short time after spraying does not hinder the action of the spray. In some instances the killing has been more complete when rain followed within a few hours after spraying.

Sodium chlorate applied in the amounts necessary to kill bindweed does not have an injurious effect on the soil. Experiments have been conducted and it has been found that this material has little, if any, influence on the beneficial bacteria in the soil.

A slightly injurious effect upon plant growth may be observed on crops seeded very soon after applying sodium chlorate, but this is only temporary. Figure 8 shows a crop



FIG. 8.—A good growth of wheat on land from which bindweed has been eradicated with sodium chlorate.

of wheat grown on plots from which bindweed had been killed by three treatments the year preceding seeding. This wheat yielded at the rate of 27 bushels per acre. Figure 9 shows a crop of sorghum produced from broadcast seeding on plots sprayed from two to four times the preceding season. The bare area in the foreground is the same area as is shown in figure 6 but photographed 100 days after the first treatment with sodium chlorate. The bindweed on this area has been sprayed three times.

USE OF DRY SODIUM CHLORATE

On small patches of a few feet or a rod or two in extent it may not be practicable to provide spraying equipment. In such cases it may be more economical to apply the sodium chlorate by spreading the dry crystals by hand to the individual plants or over the infested area. If spread broadcast, one pound to the square rod is sufficient for each application.



FIG. 9.—A good growth of sorgo on bindweed-infested land. The bindweed was killed with sodium chlorate. (This is the area shown in figure 6, photographed 100 days later.)

For best results this should be done when the soil is moist and when plants are wet with dew. For isolated plants a tablespoonful to each plant will be found effective.

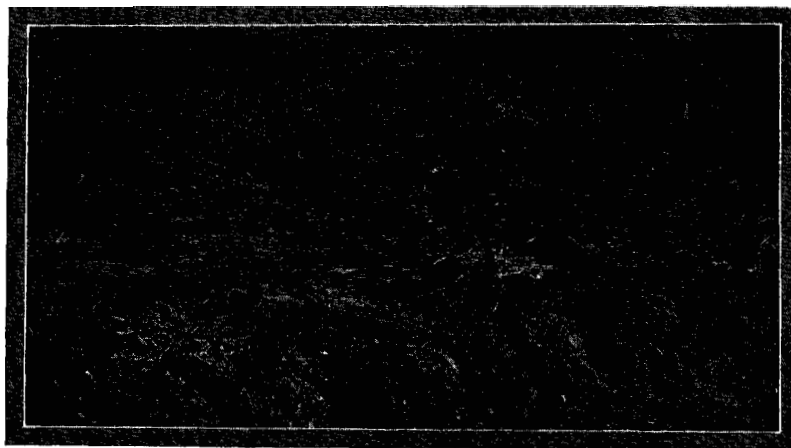


FIG. 10.—Bindweed after treatment with dry sodium chlorate. Most of the vines are dead or dying.

Figure 10 represents a number of plots treated with three applications of dry sodium chlorate at the rate of 100 to 200 pounds per acre for each application. Note the dead vegeta-

tion in the foreground. Nearly all of the bindweed was killed on these plots. The action of dry salt is slower than the same material applied as a spray.

COST OF TREATMENT

Sodium chlorate was quoted at 6¼ cents a pound in 100 pound lots on January 1, 1928. Transportation charges to points in Kansas will increase this cost to approximately 8½ cents a pound when purchased in small lots. By purchasing in carload lots this cost may be somewhat reduced.

An application of 100 pounds per acre would cost approximately \$8.50 for material alone. The cost of killing the weed will depend upon the number of applications necessary. Frequently the second and third applications require somewhat less material due to the smaller amount of vegetation to be treated. The first spraying usually kills all annual weeds and reduces the number and vigor of the bindweed plants. Labor and equipment costs will vary with the individual requirement.

FACTS ABOUT KILLING BINDWEED WITH SODIUM CHLORATE

Bindweed should be killed when first discovered. Delay only makes control more difficult and expensive. If this menace is permitted to grow undisturbed, it soon takes possession of the land making it worthless for crop production.

Small patches should be isolated and killed first.

In a campaign against bindweed the work demands first attention and should take precedence over other farm operations. Careless or listless attention will result in a loss of labor and material. There is no halfway point in the destruction of bindweed.

In the killing of bindweed with sodium chlorate the work should be confined to an area of such size as can be thoroughly handled. Undertaking too much means a waste of effort. A small area properly handled each year will lead to better results than a larger area neglected.

SUMMARY

1. Sodium chlorate applied as a spray is recommended for killing field bindweed.
2. Spraying with sodium chlorate has been found to be more effective and economical for killing bindweed in this state than any other method known at the present time.
3. Sodium chlorate is not poisonous to live stock and will not injure the soil.
4. A solution of suitable strength for killing bindweed may be made by dissolving 100 pounds of sodium chlorate crystals in 100 gallons of water.
5. One hundred gallons of this solution is sufficient for one treatment of one acre of bindweed.
6. Two or more applications are necessary. Usually three applications will kill the weed.
7. The number of applications necessary depends upon the vigor of the plants and the thoroughness of the work.
8. Sodium chlorate can be safely used to kill bindweed around trees and shrubs.
9. Sodium chlorate is dangerous to work with owing to the possibility of starting fire by careless handling and failure to follow directions.