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FIELD BINDWEED AND METHODS OF CONTROL

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A POWER SPRAYER SUITABLE FOR SPRAYING AREAS OF AN ACRE OR MORE

FIELD BINDWEED AND METHODS OF CONTROL[1]

J. W. ZAHNLEY and W. F. PICKETT

FIELD BINDWEED A SERIOUS WEED PEST

Field bindweed is by far the most dangerous and destructive weed found in Kansas. It is causing alarm not only in this state but over a large part of the United States, particularly in the West. It now occurs in every county in Kansas and is spreading at an alarming

FIG. 1.—A fertile area completely overrun by field bindweed.

rate. Some farms are so completely overrun with the weed (fig. 1) that crops can be produced only by the expenditure of much additional labor, without which greatly reduced yields are obtained. Such farms are regarded by many as nearly worthless in their present condition and would not sell for one-half the normal price if put on the market. Some loan companies refuse to accept mortgages on farms known to be infested with this weed.

Crop production on heavily infested land is rarely profitable. The bindweed roots explore the soil as deep as the roots of most crops and remove both plant nutrients and moisture. The twining vines of the weed bind the crop plants together, completely override the crop, reduce the yield, and make harvesting difficult.

1. Contribution No. 230 from the Department of Agronomy and No. 125 from the Department of Horticulture.

At the Fort Hays Branch Agricultural Experiment Station the yields of close-drilled sorghum on bindweed land have been compared with those of the same crop on clean land. For the normal date of seeding, in early June, the average yield of sorghum on clean land for four years, 1919 to 1922, was 3.92 tons, and on bindweed land 2.06 tons per acre. From late seeding, the first week in July, the average yield on clean land was 3.54 tons, and on bindweed land that had been intensively worked up to seeding time, 1.92 tons per acre. A comparison of Sudan grass was also made for the normal date of seeding for each of these years. On clean land the average yield of hay was 2.2 tons per acre, while on bindweed land it was 1.54 tons. The quality of the hay produced on the bindweed land was much poorer, as the weeds prevented the normal maturing of the crop. Barley produced an average yield of 7.5 bushels per acre for two years on infested land and 21.5 bushels on land free from bindweed.

Results of 15 tests of wheat located on 11 farms in three counties in central Kansas in 1934 showed an average yield of 13.7 bushels per acre on bindweed land and 20.9 bushels on adjacent land free from bindweed. On three farms in one county in the same year an average yield of 16.6 bushels of oats per acre was secured on bindweed-infested land and 30.9 bushels on adjacent land free from bindweed.

Fortunately bindweed now occurs only in small patches on most infested farms, and many farms are entirely free from it. Immediate action to put into effect preventive and control measures will in many cases prevent serious damage. It is the purpose of this bulletin to describe the methods of control that, in the majority of cases, have proved to be most satisfactory under various conditions common in Kansas.

DESCRIPTION AND HABITS OF GROWTH

Field bindweed *(Convolvulus arvensis)* is a long-lived perennial belonging to the morning glory family and is frequently referred to as "wild morning glory." It can be distinguished by its small bell-shaped flowers (fig. 2, B, right) which are scarcely half as large as those of the common morning glory or of the hedge bindweed (fig. 2. B. left) and which range in color from pure white or slightly tinged with pink to almost pure pink. The leaves vary in size and shape (fig. 2, A), but are usually small, somewhat arrow-shaped, and blunt or rounded at the tip. The plant produces a trailing or twining growth of vines which climb up any support, such as other weeds and stems of crop plants. (Fig. 3.) The seed is about one-eighth of an inch long, dark grayish-brown color, and covered with raised dots or pimples which can be easily seen with the aid of a small magnifying glass. (Fig. 4.) In shape, the seed somewhat resembles a quarter of a sphere, although this varies with the number of seeds in the pod. (Fig. 4, inset.) The size and shape of the seed are such that they are difficult to separate from wheat, oats, barley, sorghum, or Sudan grass seed.

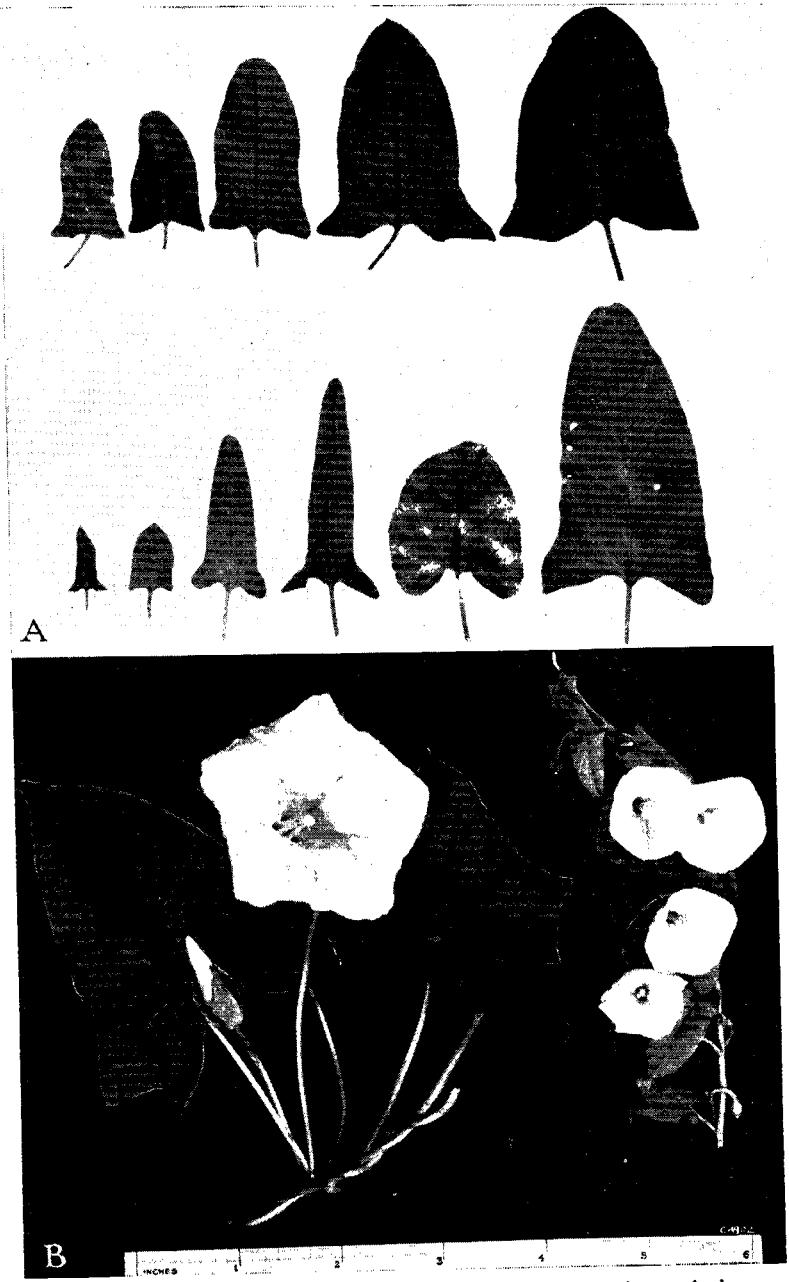

FIG. 2.—(A) Leaves of field bindweed. Note the variety of shapes. (B) The common species of bindweed. Left—Hedge bindweed. Right—Field bindweed. Note the large flower, two large leaflike bracts at base of flower bud, angular lobes, and pointed tip of the hedge bindweed leaf.

The root system of bindweed is very extensive. It penetrates the soil to a depth of 4 feet or more, and roots have been found to reach depths of 15 to 25 feet. The main roots are long, tortuous, whitish cords about one-tenth of an inch in diameter, with many branches. These roots scarcely diminish in size at a depth of 4 or 5 feet. In excavations where 6 feet or more of surface soil was removed a stand of bindweed was soon produced at the bottom of the excavation from the roots extending below that depth, showing that the fleshy roots may form buds and give rise to new plants anywhere along their length.

The seed of bindweed has great vitality and if plowed under will remain buried in the soil from one season to another without injury and will germinate when brought near the surface. The seed germinates any time from early spring until fall, when conditions become suitable. The seedlings thus produced make little top growth the first, season, but the roots grow rapidly and soon reach a depth of 2 feet or more. It has been found that in six weeks after seed sprout the seedlings become so thoroughly established that they will not be killed by cutting them off 2 or 3 inches below the surface of the ground.

WEEDS OFTEN MISTAKEN FOR FIELD BINDWEED

Hedge bindweed, wild buckwheat, and climbing milkweed are often mistaken for field bindweed. Each of these may be readily distinguished, however, by two or more prominent characters.

Hedge Bindweed. — The flower of the hedge bindweed *(Convolvulus sepium)* is fully twice as large as that of field bindweed, nearly always pure white, and has two large leaflike bracts at its base. The leaves are larger, more pointed. and have more angular lobes at, the base. (Fig. 2, 13, left.)

Wild Buckwheat.-Wild buckwheat *(Polygonum convolvulus* is an annual weed, with a relatively short, branching root, almost heart-shaped leaves with sharp tips and rounded lobes at the base. The flowers are in clusters in the axils of the leaves, scarcely one-eighth of an inch across and very inconspicuous. Several small three-cornered seeds are formed in the cluster after the flowers disappear. (Fig. 5: A.)

Climbing Milkweed. — Climbing milkweed *(Gonolobus laevis)* is most readily distinguished by the arrangement of the leaves in pairs directly opposite each other at the same joint or node of the stem. (Fig. 5, B.) The leaves are long and pointed, with rounded lobes at the base and with conspicuous light-colored veins. The seed is borne in a slender pod 2 to 4 inches long, characteristic of the milkweeds.

FIG. 3.—A typical plant of field bindweed.

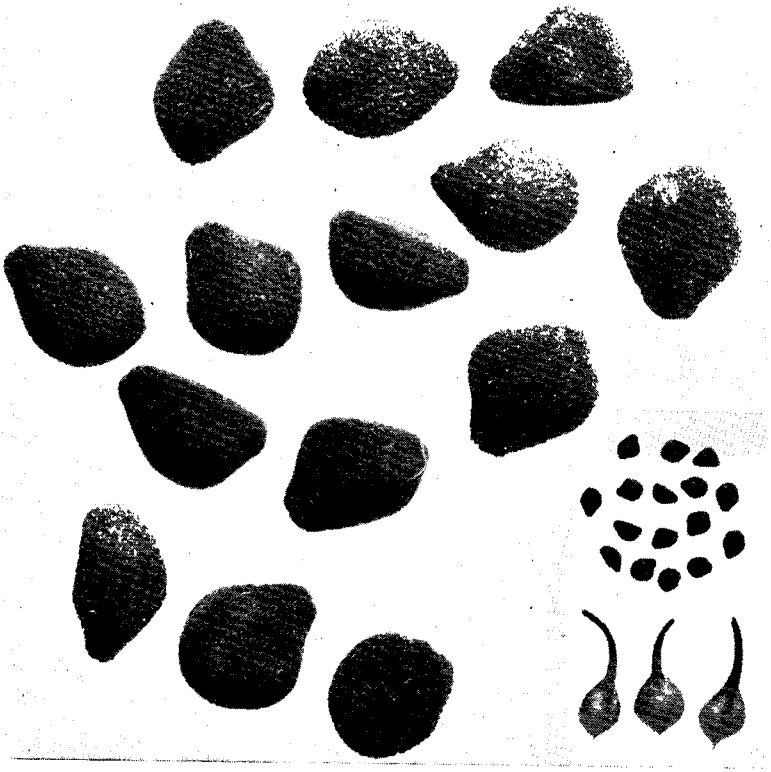

FIG. 4.—Field bindweed seed enlarged showing raised dots or pimples.

HOW BINDWEED SPREADS

Bindweed is spread both by seed and roots. New patches in uninfested fields or localities are started from seed which in most instances is carried in impure crop seed or by threshing outfits. Thirty-one samples of crop seed tested in the Kansas Seed Laboratory in the spring of 1934 contained an average of 57 bindweed seeds to the pound. These 31 samples included twenty of oats, seven of Sudan grass, two of sweet clover, one of barley, and one of sorgo. Planting this oats at the rate of 70 pounds to the acre would distribute approximately 25 bindweed seeds to the square rod. This would be more than sufficient to produce a full stand of bindweed.

The seed may be scattered locally by feed grown on infested land, in the manure of animals grazed on infested land or consuming feed containing bindweed seed. Commercial feed, chicken feed, and screenings bought on the market frequently contain bindweed seed. The seed is carried on the feet of animals, on wheels of vehicles, or by road-maintaining machinery. Drainage water is an important means of 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 in plowed land to a distance of 7 feet in a period of 90 days. At distances of every foot or two new plants arise from these lateral roots. By this means, as well as by seed, the patches become larger and the stand of plants thicker from year to year. It can readily be seen that from a start of a few widely scattered plants an entire field or farm may become solidly infested within a few years.

IMPORTANT CONSIDERATIONS IN THE CONTROL OF BINDWEED

Prevention is the most important consideration where the land is free from the weed. Every possible precaution should be used to avoid bringing bindweed on the farm. It is easier to prevent the weed's getting a start than to eradicate it after it is started. All crop seed should be tested for purity before planting. Any seed purchased should bear the label of tested seed as prescribed by the Kansas Seed Lab, and the purchaser should insist upon a guarantee that the seed is free from bindweed seed. Care should also be taken to avoid bringing feed grain, roughage, or manure to the farm from areas that are infested and to prevent the introduction of the weed by any other means by which it may be spread. Eternal vigilance is the price of success in keeping the farm free from bindweed.

A second important consideration is keeping constantly on the lookout to detect the first plants that appear. Isolated plants or small patches are readily seen when in bloom. The main bloom period is usually from about May 15 to June 15, but flowers may appear over a much longer period. The flowers are most abundant

and conspicuous in the forenoon of a bright day following showers; hence patches are most easily found under these conditions. Plants usually do not bloom before they are about two years old, so it is often necessary to detect new patches by the appearance of their vegetative growth. The small patches should be killed first to reduce the number of sources of infestation.

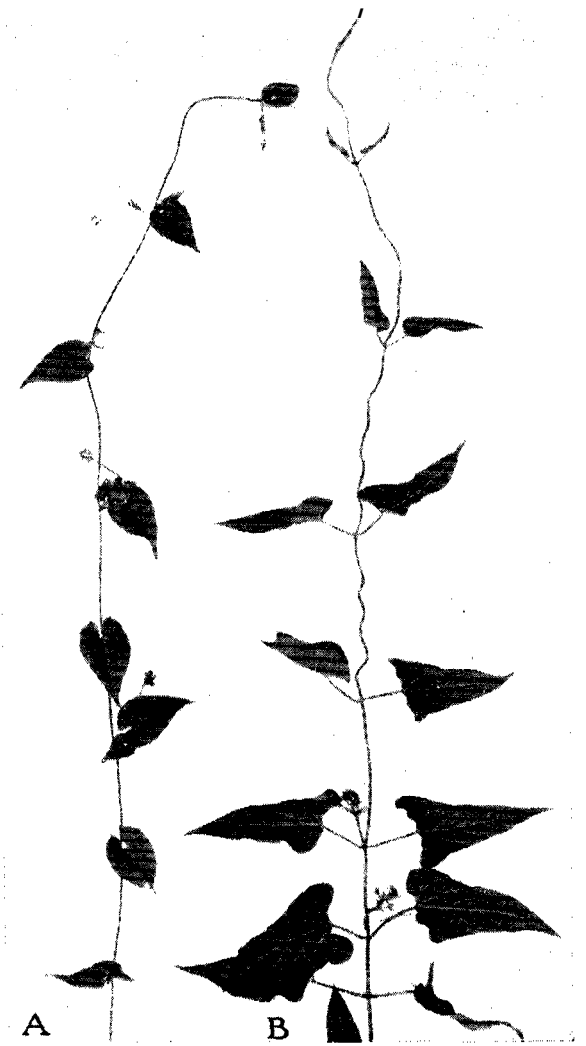

FIG. 5.—(A) Wild buckwheat. (B) Climbing milkweed. Note the pointed, heart-shaped leaves of (A) and the arrangement of leaves in pairs in (B).

As soon as a plant or patch is found, its location should be conspicuously marked by a stake or label and the infested area isolated. This area should not be cultivated with the remainder of the field on account of the danger of spreading the weed. Small patches can be killed with relatively little trouble and expense and should be given immediate attention. The sodium chlorate spray method and application of common salt are the most widely used and practical means of killing the weed when the infested area is small.

Attempts to eradicate large areas should ordinarily be delayed until the small patches are killed. A well-planned system of cultivation and cropping should be used that will reduce the danger of spreading the weed. Eradication by intensive cultivation combined with the growth of smother crops should ordinarily be started as soon as possible.

METHODS OF CONTROLLING BINDWEED

Although bindweed is difficult to eradicate, there are several methods by which this can be accomplished. The method that should be used will depend upon the location and size of the infested area. For small areas up to an acre or so in extent the most practical methods are (1) spraying with a solution of sodium chlorate, (2) salting, and (3) heavy pasturing with hogs. Large areas on land in regions of light rainfall and which can be cultivated can be more economically killed by a combination of intensive fallow and a smother crop. The various methods of killing the weed and the conditions to which each method is best suited are described on the following pages.

THE SODIUM CHLORATE SPRAY METHOD

Experiments carried on by the Kansas Agricultural Experiment Station at Manhattan during the nine-year period, 1925 to 1933, show that bindweed can be killed by spraying the plants with a solution of sodium chlorate with only temporary injury to the soil. In most cases this is the most practical method for getting rid of small patches of a few square feet to an acre or more. It is partiolarly useful along highways or right of ways where cultivation cannot be practiced and where leaving the land sterile by applying salt would be undesirable.

Sodium chlorate is a white crystalline substance very similar in appearance to common salt. It is put on the market in three forms: vi., in coarse crystals which resemble ground rock salt, in fine crystals about like table salt, or in a powdered condition. The fine crystalline form is preferred, as it dissolves more readily than the coarse crystals. The powdered form is usually more expensive but has the advantage of going into solution more quickly than the other forms.

STRENGTH OF SOLUTION AND RATE OF APPLICATION

One pound of sodium chlorate to one gallon of water produces a solution of sufficient strength to kill bindweed. Increasing the concentration or strength of the solution adds to the danger from fire.

The solution should be applied at the rate of approximately 200 gallons per acre or 1 1/4 gallons to the square rod for the first application. The area of the patch to be treated should be measured and the proper amount of material used. It is unwise to try to guess the size of the area or to try to make the material cover more than it should. Many failures can be traced to using insufficient material. Sufficient solution must be used to wet all the vegetation thoroughly. If the bindweed is very vigorous or is mixed with other weeds, more material will be required for the first treatment. For the second and third applications of the season 100 to 150 gallons to the acre will usually be sufficient.

TREATMENT BEFORE SPRAYING

Disking in the spring of the year in which spraying is to be done will help hold other weeds in check and reduce the cost of spraying. Cultivating the ground two or three times will not interfere with the effectiveness of the chemical treatments, provided no cultivation is given after June 1. If the land cannot be cultivated, or if a heavy growth of other weeds is produced after early cultivation, it may be mowed during June in order that the spraying may be more conveniently done and with less material. However, the growth of bindweed on the area to be treated should not be disturbed in any way for at least a month, and preferably two months, before the first application of the spray.

TIME OF APPLYING SODIUM CHLORATE

For areas that have not been sprayed the preceding year the first application should not be made before the middle of July. The middle of August is usually a better time than earlier. Beginning as late as the middle of September has given good results. The condition of the plants during the period between July 15 and September 15 will determine when to start spraying. If the bindweed plants have ceased making good vegetative growth on account of dry weather it is best to wait until growth is resumed, even though the work must be delayed until September. This will usually be within one to three weeks after a good rain. If this delays the work until September, two applications, one of about 250 gallons per acre and the other of 100 to 150 gallons, should be used, making the last one about the time of the first frost or as soon as some of the plants appear to be recovering from the previous treatment. Frequent light showers during the period of spraying are of value in that they make the spray more effective.

FIG. 6.—A field of field bindweed in full bloom. Protographed June 6, 1927.

FIG. 7.—The field shown in figure 6 photographed May 17, 1928. Three applications of sodium chlorate killed the bindweed.

NUMBER OF APPLICATIONS

It is best to make at least three applications the first season, keeping up the work until after the first frost, provided there is any growth of bindweed left on the treated areas at that time. (Figs. 6 and 7.) One treatment in August, another in September. and a third one in October will usually be about the right distribution of treatments. This will vary according to the growth of the bindweed. The application of the second spray should be delayed until the plants have made good recovery from the first. A late treatment just after the first frost should not be neglected if there is any growth left. When only two treatments are given, the rate of application should be heavier. A single very heavy application has not proved satisfactory, mainly because of the difficulty of obtaining even distribution of the material. It is usually necessary to spray once or twice the second season where the stand was very vigorous or conditions were unfavorable for obtaining a successful kill the first year.

SUITABLE SPRAY EQUIPMENT

The type of sprayer best suited to individual needs will depend mainly upon the size of the area to be treated. Any compressed air sprayer that will disperse the material in a fine mist may be used. For small patches of only a few square rods a 2- to 5-gallon knapsack sprayer is suitable. (Fig. 8.) This sprayer with a galvanized tank can usually be purchased for $3 to $4.50 and with the brass tank and fittings cornplete for $7 to $9. A pressure of about 40 pounds, which is the minimum for effective work, can be maintained with this type. Since sodium chlorate is corrosive, the brass is much more durable. Any sprayer should be thoroughly washed out and rinsed several times with fresh water after it has been used to apply sodium chlorate, and should not be used in spraying crop plants for pest control.

For a single area up to as large as an acre, or for several small patches aggregating not more than an acre, a barrel sprayer can be used. One of this type with double-action hand pump which will maintain a pressure of 100 pounds can be purchased for $35 to $40. A metal oil drum which can be secured at low cost may be used as a supply tank. (Fig. 9, A.)

Where a number of patches comprising a larger area are to be treated, a power sprayer should be used. One with 100- to 200-gallon metal tank with pump operated by a small motor will cost from $200 to $400. This type of sprayer can be mounted on a light truck, wagon, or trailer and operated by two men. (Frontispiece and fig. 9, B.) Mr. E. O. Graper, county agricultural agent in Smith county, has a sprayer of this type mounted on a truck and so connected that the pump is operated by a take-off from the motor of the truck.

THOROUGH WORK IS ESSENTIAL

Even distribution of the spray material and thorough wetting of all plants and keeping up the applications as often as needed until after frost are essential to success. Spray equipment, which will maintain a pressure of 100 pounds or more is desirable. The majority of failures can be traced to neglect of some important detail in the method, such as insufficient material used, beginning the treatment too early in the season, failure to put on a third or fourth application when needed, and uneven distribution of the material. Missing a few plants around the border of the treated area is the most common cause of patches becoming reestablished after they were regarded as eradicated. A careful search for a rod or two beyond what is believed to be the last plant on the border of the patch is important.

PRECAUTIONS IN USING SODIUM CHLORATE

Clothing, hay, or straw, unpainted boards and similar materials that have been wet with a solution of sodium chlorate and allowed to dry may be ignited by friction, sparks, or a hot sun and cause serious damage from fire. The chemical itself will not burn and if handled carefully there is little danger. The spray solution should not be prepared inside a barn or shed or where there is litter that would burn. Such litter may be easily ignited when dry if any of the solution or crystals are spilled on it. Rubber boots should be worn while spraying and wagons and spray equipment kept well painted. Sprayers with wooden tanks should not be used. If any part of the clothing becomes wet it should be washed out thoroughly before being allowed to dry. Wearing clothing that has been wet with the solution is extremely hazardous and may result in a painful and serious accident. Remember that inflammable material, when saturated with sodium chlorate solution and dried, burns violently and with intense heat when ignited.

There is danger during hot, dry weather in spraying along the foundation of wooden buildings where there is an accumulation of dry grass or other inflammable material. Under these conditions spraying should be done during damp weather or in the evening and followed the next morning with a light spraying of water to reduce the concentration of chlorate.

Live stock which does not have access to plenty of salt will graze heavily on sprayed areas because of the salty taste of sodium chlorate. This will reduce the effectiveness of the treatment by consuming the material that is on the plants. Sodium chlorate will not injure the animals, unless they consume large quantities of it because of their hunger for salt. It is therefore safe to allow live stock to graze in pastures where there are treated areas, provided they are kept well supplied with salt.

Sodium chlorate is as injurious to most other growing plants as it is to bindweed, therefore care should be taken not to allow the spray to come in contact with the leaves of trees, shrubs, or other vegeta-

tion not to be killed. The grasses are more resistant to the killing action of this chemical than most broad-leaved plants.

TREATMENT THE SECOND SEASON

Killing a patch of bindweed should be looked upon as at least a two-year job and the work the second season regarded as equal in importance to that of the first. The land should in no way be disturbed after spraying is started until May of the year following the first treatment. If a good kill was obtained and only a few old plants are left and these are yellow and sickly, thorough summer

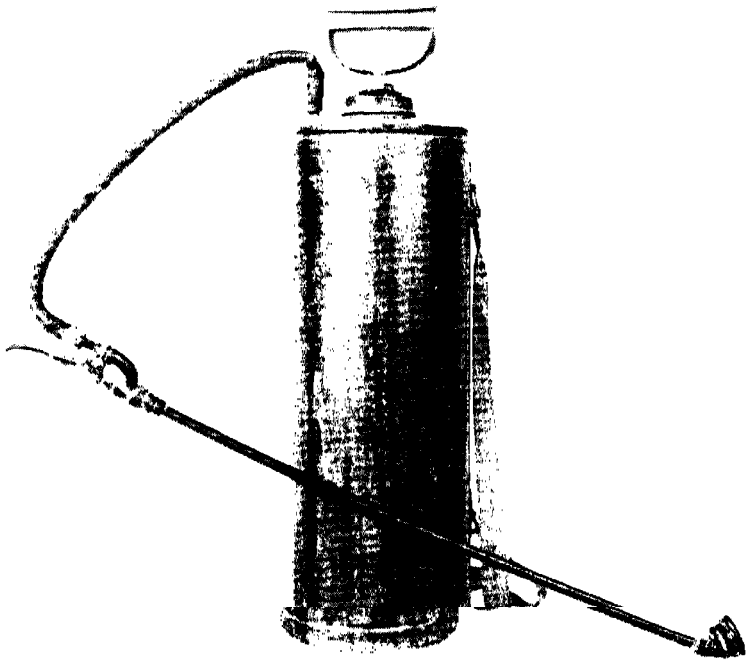

FIG. 8. A knapsack sprayer suitable for spraying small patches of field bindweed.

fallowing the second year, beginning about May 20, should kill the remaining old plants and should germinate some seed and kill the seedlings Leaving the land undisturbed until after the middle of May allows the sodium chlorate in the surface soil to destroy the seedlings which start from seed that has been covered. Disking a few times after May 20 will sprout additional seed and kill more seedlings. Plowing early in the spring of the second year is not good practice, as it covers the seed so deep as to prevent germination. Any disturbance of the soil before May 20 interferes with the action of the chemical that is left in the surface soil on seedlings and weakened old plants.

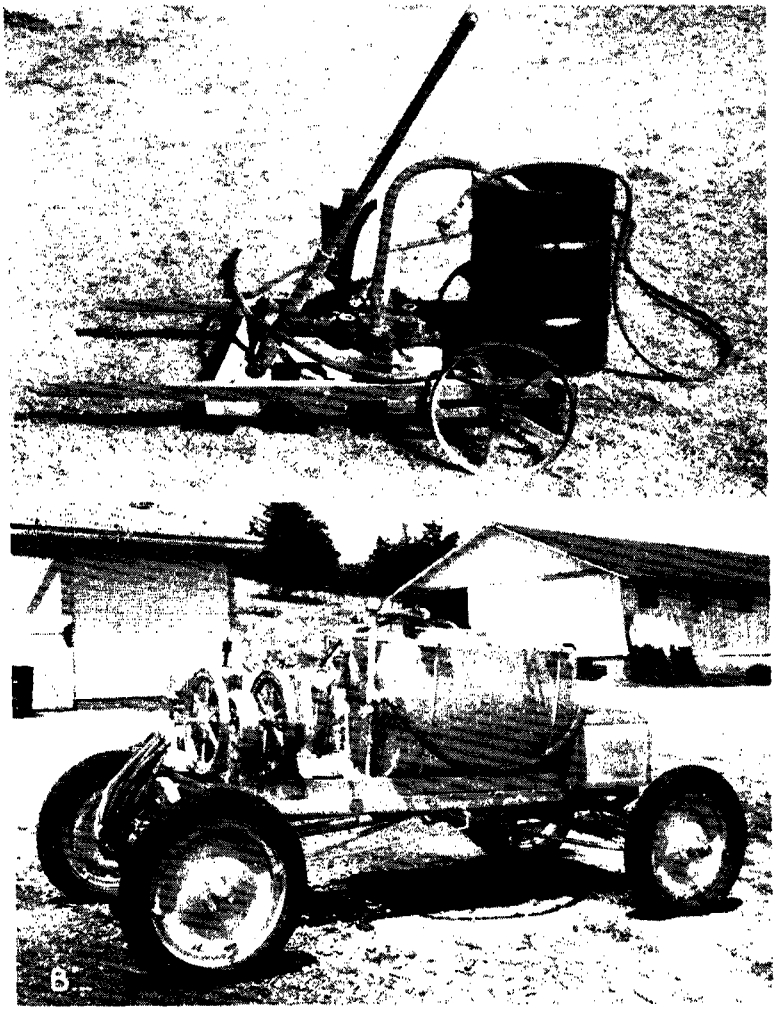

FIG. 9.—(A) A barrel sprayer suitable for spraying areas no larger than an acre. (B) A power sprayer mounted on an auto chassis which is transported as a trailer. This is an all-metal outfit adapted to spraying either small or large areas of bindweed.

If only a partial kill was obtained from the first season's work and a considerable number of old plants remain alive after May 1, the area should be sprayed again about May 15, taking particular care to wet all the remaining plants thoroughly. These should be killed readily because of their weakened condition as a result of the previous year's treatments. They should be watched, however, and sprayed again if necessary. The work should be carried to completion when once started.

CROPPING TREATED LAND

Sodium chlorate leaves the soil partially sterile for several months. Where 300 to 400 pounds to the acre have been applied from August to October, it is best not to attempt to grow a crop on this land the following year. The better practice is to let it be idle and devote that season to making a complete job of killing the bindweed by additional spraying in case of a poor kill the first year or cultivation to kill seedlings if the old plants were all killed. Where very good results were obtained the first year the land may be disked about May 20 and again in early June, then plowed and sown to sorghum for hay. Following a dry winter and spring, however, the chemical may remain in the soil in sufficient quantity to interfere with obtaining a stand of the crop.

All areas that were infested should be watched carefully for several years after treating. It is advisable to grow smother crops, such as sorgo or Sudan grass for hay, or an intertilled crop in which thorough cultivation is practiced for at least the first two seasons of cropping.

COST OF ERADICATION WITH SODIUM CHLORATE

The price of sodium chlorate this season (1934) ranges from 8 cents a pound in ton lots to 9 cents in single drums of 100 pounds, f. o. b. Kansas City. At this rate the average cost of eradication will amount to from $30 to $40 an acre for material alone. Including labor, the cost may amount to as much as the infested land is worth. However, where only a few small patches or a few acres are infested they are a menace to the entire farm and should be eradicated to prevent further spread. Small patches can be killed at a cost of 20 to 30 cents a square rod for material. On many farms the few scattered patches that occur could be killed now with comparatively little expense, but if the work is delayed a few years the cost mill be many times as great.

CALCIUM CHLORATE AND sodium CHLORATE COMPARED

A weed-killing preparation consisting largely of calcium chlorate is available and is being used to some extent. It can be substituted for sodium chlorate with good results, but is not so effective pound for pound. Carefully conducted tests at the Kansas Agricultural Experiment Station at Manhattan show that it requires from $1\frac{1}{2}$ to $1\frac{3}{4}$ pounds of this preparation to equal 1 pound of sodium chlorate for killing bindweed. It tends to draw moisture fromt the

air and does not become dry so readily as sodium chlorate, hence there is somewhat less danger from fire in using it. It is not entirely free from this danger, however, as there is at least one authenticated report of spraying with a solution of 2 pounds of this material to 1 gallon of water to the square rod at 11 o'clock a.m., and fire starting spontaneously at 12:30 p.m. when the sun came out hot.

THE FALLOW-SMOTHER-CROP METHOD ON LARGE AREAS[2]

A combination of intensive summer fallow and smother crops has proved to be the most successful and practical method of eradicating bindweed on large areas of land. This weed can be entirely destroyed by repeated and careful clean cultivation from early in the spring of one year to about July 1 of the next year, followed by a smother crop of drilled sorghum.

The method consists of plowing the land soon after the plants start growth in the spring and cultivating at intervals of a week to 10 days thereafter or as often as the leaves appear above the ground. The most satisfactory implements for this purpose are the duckfoot or blade weeders that cut the weeds about 3 inches below the surface of the soil. (Fig. 10.) Other implements (fig. 11), such as the disk or oneway, may be used for this purpose but are distinctly less satisfactory than the blade type of weeders. Objections to the disk and oneway are that they often fail to cut all of the weeds or to cut them deep enough, require more operations to keep the weeds under control, and leave the land in a loose condition subject to severe wind and water erosion.

Occasionally during seasons of heavy rainfall it is impossible to cultivate at the right time and heavy top growth results. When this occurs the field should be plowed again and the blade weeders used repeatedly thereafter. When the bindweed is allowed to produce surface growth, it recovers from the effect of previous cultivation, which prolongs the period required for eradication. Careless or delayed cultivation may tend to encourage the growth and spread of bindweed. Care should be observed to remove the roots and vines from the implements before leaving infested areas. Otherwise the plants will be scattered on clean land, renew growth, and establish new sources of infestation. Unless a farmer is firmly resolved to cultivate often enough to keep the bindweed from showing above the surface of the ground, he cannot expect permanent, success in the eradication of the pest by the fallow system.

At the Fort Hays station this method has involved from 15 to 27 tillage operations with an average of about 20 during the first year and about 12 the second year. It is obvious, therefore, that the work should be limited to an area no larger than one is sure of being able to handle.

2. The discussion on the fallow-smother-crop method was prepared by D. A. Savage, of the Division of Forage Crops and Diseases, United States Department of Agriculture, in charge of forage crop investigations at the Fort Hays Branch Agricultural Experiment Station (Hays, Kan.), and L. C. Aicher, superintendent of that station.

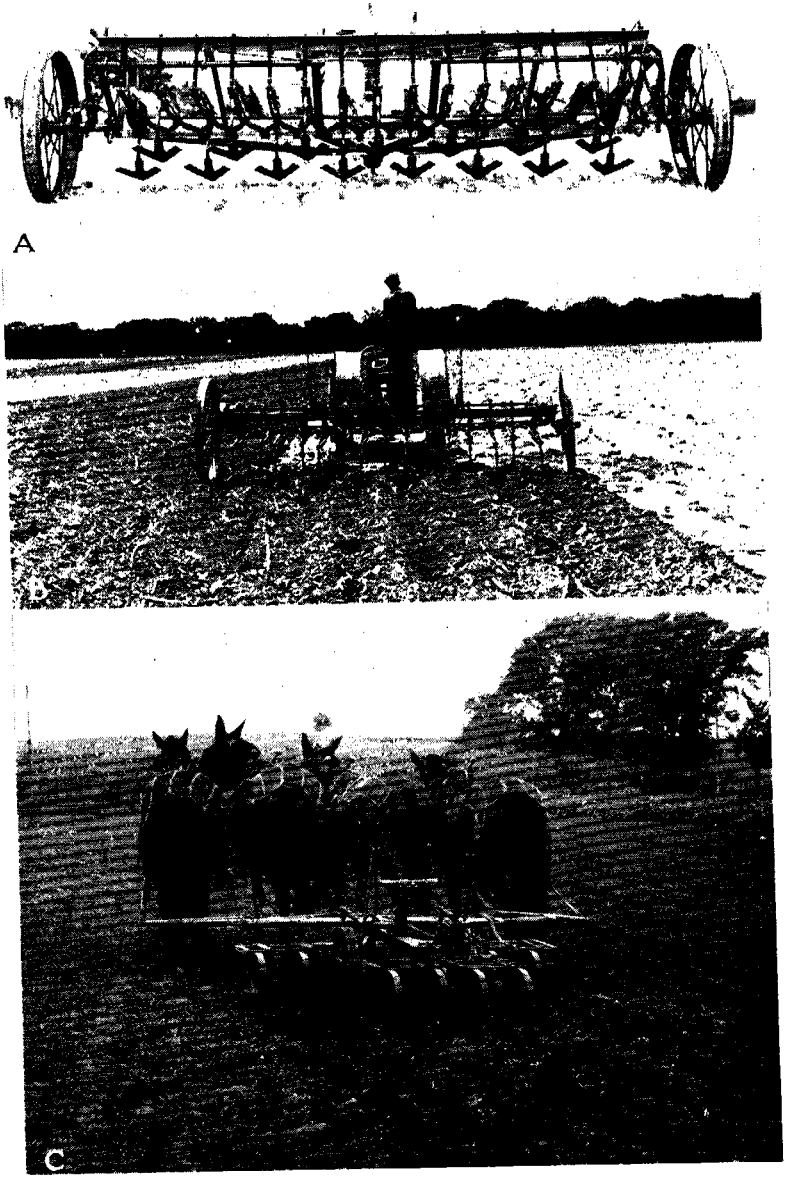

FIG. 10.—Cultivators adapted to killing field bindweed in summer fallow operations. (A) A beet cultivator with duckfoot shovels. (B) The duckfoot cultivator in operation. (C) A spring-tooth cultivator equipped with 10-inch sweeps, or duckfoot shovels, used to destroy bindweed.

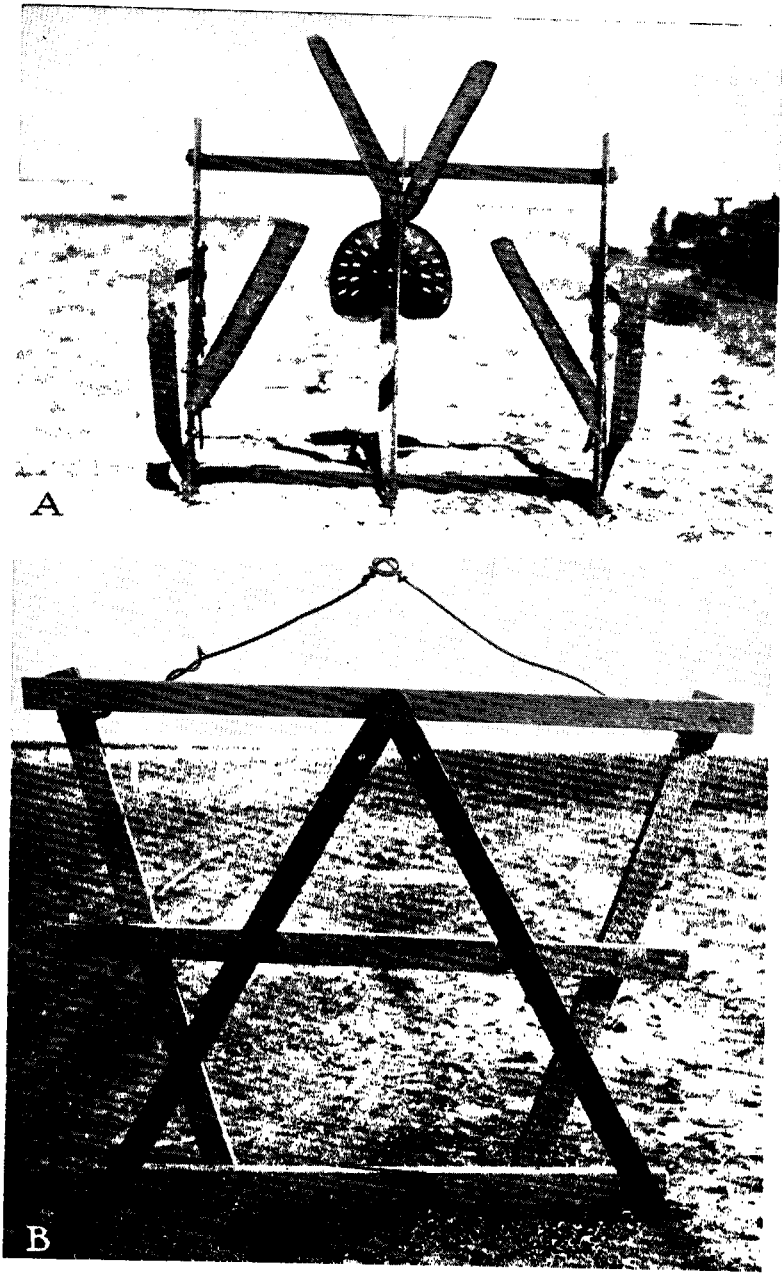

FIG. 11.—Two satisfactory home-made knife weeders. (A) A weeder made by the Fort Hays Branch Agricultural Experiment Station. (B) A weeder designed by Alex J. Rupp, of Ellis county, Kansas.

In the fall of the first, year the fallow land should be blank listed or otherwise left in a roughened surface condition so as to control soil blowing and conserve the maximum amount of winter and early spring precipitation. The lister furrows should be "thrown in" as soon as the bindweed renews growth in the spring of the second year and cultivating practiced again at weekly intervals until about July 1. At this time a smother crop of rank-growing sorghum, such as Atlas sorgo should be drilled on the land at the rate of about 2 bushels of seed per acre. This crop, well supplied with subsoil moisture, may be depended upon to produce an exceedingly heavy growth of forage which serves to smother and completely check further growth of the bindweed. The heavy yield of hay thus obtained compensates for a considerable part of the cost of the tillage operations. This is shown by results at the Fort Hays station where bindweed land planted continuously to sorghum for four years, 1919 to 1922, yielded a total of 8.23 tons of feed per acre, and none of the bindweed was eradicated. Other bindweed land that was intensively fallowed in 1919 yielded 11.55 tons per acre for the total of the three years, and there was no bindweed left.

Bindweed produces a large amount of hard seeds, many of which remain in the ground and germinate several years later. These seedlings may be killed with ease if cultivated soon after they emerge. For this reason the field should be devoted to cultivated crops, alternate fallow and drilled sorghum, or alternate fallow and wheat for several years after growing the first smother crop.

Rigid adherence to the plan described above has resulted in complete eradication of bindweed at the Fort Hays Branch Agricultural Experiment Station.

SALTING SMALL AREAS

RATE AND TIME OF APPLICATION

Bindweed can be killed by applying salt at the rate of 20 to 25 tons to the acre. This amounts to approximately one pound to the square foot, or a layer about one-fifth of an inch thick. A few plants will usually come up after this heavy application, and these should be treated again the next season with a handful or two of salt to each plant. Great care should be taken to allow no plants to escape attention around the border of the treated area. It is advisable to apply salt the first year several feet beyond the last plant, since there will always be some horizontal roots within this marginal area, and these may give rise to new plants beyond where there is sufficient salt to kill them.

Salt may be applied at any time during the year, but it is probably best to apply it in the spring as soon as the plants have made sufficient growth to be located. If the extreme limits of the patches can be marked in late summer by a plowed furrow or by stakes. the salt can be applied early the following spring before growth starts. Salting when there is little or no top growth makes even

distribution of the salt easier and the weed seems to be unable to come UP through the salt as easily as it can survive if already up The soil should be loose enough that when rain comes the salt will be washed into the soil and not carried away by surface run-off. The land should not be worked after salting.

OBJECTIONS TO THE USE OF SALT

Salt leaves the soil barren for an indefinite period, gives it a whitish color, and makes it sticky. Its use should, therefore be limited to the smallest areas, such as along fence rows or such scattered areas in the fields as one is willing to sacrifice to prevent bindweed from spreading. An area of about 2 acres in Ford county that was salted in 1912 was still barren after 17 years, with little indication that it would grow crops for a long time to come. Treated areas will return to production in a shorter time if cultivated with the rest of the field and manured. Small patches a rod or two across can be brought back into production within a few years by such treatment.

Salt will kill trees, shrubs, and other valuable plants some distance away from where it was applied; hence it should not be used near the farmstead windbreak, orchard, garden, or lawn. Killing field bindweed with salt is usually as expensive as with sodium chlorate, but, there is the advantage of avoiding danger from fire.

PASTURING WITH HOGS

Hogs will destroy bindweed, if a sufficient number are placed on the infested area to keep down all top growth. They eat the roots of the weed readily and will root after them if their noses are not rung or slit. The patch should be plowed several times during the season to enable the hogs to get at the roots more readily. In fencing the infested area the inclosure should include a margin of at least a rod beyond the last plants. If this is not done it is almost certain that the plants will spread by long horizontal roots, and some bindweed will appear outside the fence.

Pasturing with sheep has not been a successful method fo destroying bindweed. Sheep will not eat the weed close enough to kill it and if starved to induce them to pasture it more closely the loss on the sheep will be greater than the value of the effect on the weed.

Chickens will destroy bindweed, provided a large number are confined on a small area.

ERADICATION OF FIELD BINDWEED REQUIRES PROMPT, STRENUOUS, AND DETERMINED EFFORT

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

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

Small patches should be isolated and killed first.

In the killing of bindweed by any method, 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

Field bindweed, the most noxious weed known in Kansas, is spreading at an alarming rate, and prompt action should be taken to prevent further spread.

Field bindweed can be distinguished by its small white or pink, bell-shaped flowers and somewhat arrow-shaped leaves with blunt or rounded tips.

Propagation is by both roots and seed. The seed is carried by impure crop seed, manure, threshing outfits, running water, road-maintaining machinery, and on the feet of animals and the wheels of vehicles.

Bindweed can be killed by spraying with a solution of sodium chlorate, by intensive cultivation in combination with the growth of a smother crop, or by salting.

The small patches should be killed first to reduce the number of sources of infestation. Such patches can be killed at comparatively little cost.

Spraying with a solution of sodium chlorate and salting are the most economical and practical methods of eradicating small patches of bindweed.

One pound of sodium chlorate to one gallon of water makes a solution of proper strength for killing bindweed. An application of 200 gallons per acre in August and 100 to 150 gallons in September and again in October is usually the best rate and distribution of treatments.

Salt applied at the rate of 1 pound per square foot, or 20 to 25 tons to the acre, will usually give almost complete control with one treatment, but will destroy the productivity of the land for many years.

Large infested areas can be killed most economically by intensive cultivation accompanied by the growth of a smother crop.