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Bindweed Control in the Panhandle of Texas

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DIGEST

Results of bindweed control experiments at the Amarillo Experiment Station and in surrounding areas since 1949 are reported in this bulletin.

Seedling bindweeds have been controlled by cultivation at monthly intervals between crops of wheat or close-drilled sorghum.

Patches of bindweed up to one-half acre in size have been eradicated with applications of soil sterilants. Sodium chlorate, Concentrated Borascu, Atlacide, Polybor Chlorate and Karmex W proved satisfactory at 5, 16, 7, 12 and and ⅜ pounds per square rod, respectively. Good results with soil sterilants were obtained on dryland when heavy rains fell within a month after the application of the materials. If soil sterilants were not soon leached into the soil the wind frequently blew them away. Applications made in the late summer or early fall are most likelly to be successful since wind movement is low and rainfall is high at that time. Irrigation water was used to leach the soil sterilants into the soil in some tests. One application of the soil sterilants seldom completely eliminated the weeds; retreatments usually were necessary for complete eradication.

Large infestations of bindweed were controlled by intensive cultivation with sweep type plows at 3-week intervals under low soil moisture conditions; cultivations at 2-week intervals were required under good moisture conditions. Sweep-type plows severed all the bindweed tops from the roots and left crop residues on the soil surface to aid in the prevention of wind and water erosion. Two annual applications of 1 pound per acre of 2,4-D ester or amine controlled weeds on areas where cultivation was not feasible, such as roadsides, grass waterways, pastures and ranges.

The most satisfactory method of bindweed control on large acreages of cropland was through competitive cropping, intensive cultivation and the use of 2,4-D. Wheat was the best competitive crop used. Sorghum was not established easily during the summer when the weeds were growing vigorously. A fallow-wheat system, using intensive cultivation during the fallow periods, gave good control, eliminating 92 percent of the weeds in 3 years. Continuous cropping to wheat was a good practice for controlling bindweed when used with intensive summer cultivation and 2,4-D in the fall before wheat was planted, or in the spring when the wheat was fully tillered.

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Bindweed Control in the Panhandle of Texas

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FIELD BINDWEED *(Convolvulus arvensis)*, A NATIVE of Europe, was introduced into North America along the Atlantic seaboard and was reported in Virginia as early as 1739. It spread westward across the United States, and by 1900 was established in most of the Western States (5). At present, 32,000 acres of the weed occur in the Panhandle of Texas on 28 percent of the farms, threatening crop production on over a million and a half acres of cultivated land.

Control methods for bindweed were suggested as early as 1909 by Cox (2). The first research for bindweed control in Texas was conducted by S. E. Wolf at the Blackland Experiment Station at Temple over 25 years ago.

The research reported in this bulletin was started at the Amarillo Experiment Station and surrounding areas in 1949. The soil type on the station is Pullman silty clay loam, a reddish-chestnut soil. This soil has 45 percent clay in some layers. The organic matter content of the cropland is about 2 percent and the pH of the surface soil is approximately 6.5. The soil is highly calcareous and overlays caliche ($CaCo_3$) at a depth of 4 to 6 feet on level land (1).

Since 1938, the average annual rainfall on the Amarillo station has been 18.44 inches. During the experimental period reported here, the rainfall varied from 24.52 inches in 1949 to 14.77 inches in 1952. Monthly rainfall from 1949 through 1953 is shown in Table 1. Heavy greenbug infestations in 1950 and 1951, and the low rainfall in 1952 severely reduced dryland crop production during the investigations.

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TABLE 1. MONTHLY RAINFALL IN INCHES AT THE AMARILLO EXPERIMENT STATION, 1949-53

Month	1949	1950	1951	1952	1953
January	1.81	T	0.58	0.43	0.40
February	0.60	0.33	0.80	0.11	0.02
March	0.36	O	0.76	0.73	0.41
April	2.35	0.38	0.13	2.97	0.18
May	6.69	1.12	6.25	1.40	0.81
June	3.45	5.05	3.38	2.00	0.03
July	3.18	6.99	2.46	2.64	4.84
August	1.94	2.16	2.17	2.69	2.73
September	2.51	3.93	0.98	0.33	0.54
October	1.17	0.11	1.23	O	5.18
November	O	0.02	0.28	1.04	0.33
December	0.46	0.21	0.29	0.43	0.64
Total	24.52	20.30	19.31	14.77	16.11

Figure 1. Bindweed growing in a field near Bushland.

DESCRIPTION OF BINDWEED

Field bindweed, sometimes called possession vine, is a hardy, climbing perennial with arrow-shaped leaves and trumpet-shaped flowers (Figure 1). The plant is a trailing vine that grows along the ground, but climbs readily if supported. The stems may be as long as 3 feet (5). The leaves are pointed at the tip and have large pointed basal lobes; however, their shape and size may vary considerably (Figure 2).

The flowers are about three-fourths to 1 inch in diameter, varying from white to pink. In Northwest, Texas, the plant usually starts blooming in late May or early June and continues to

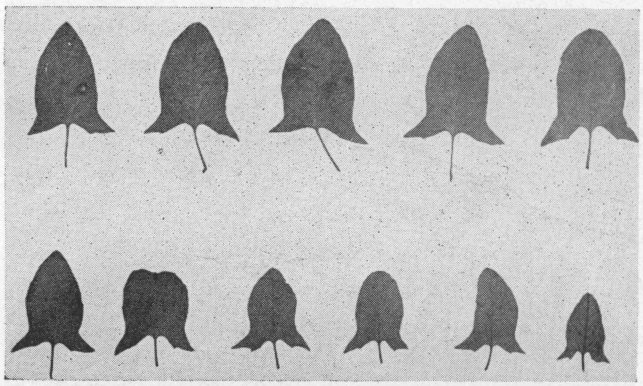

Figure 2. Bindweed leaves showing variations in size and shape.

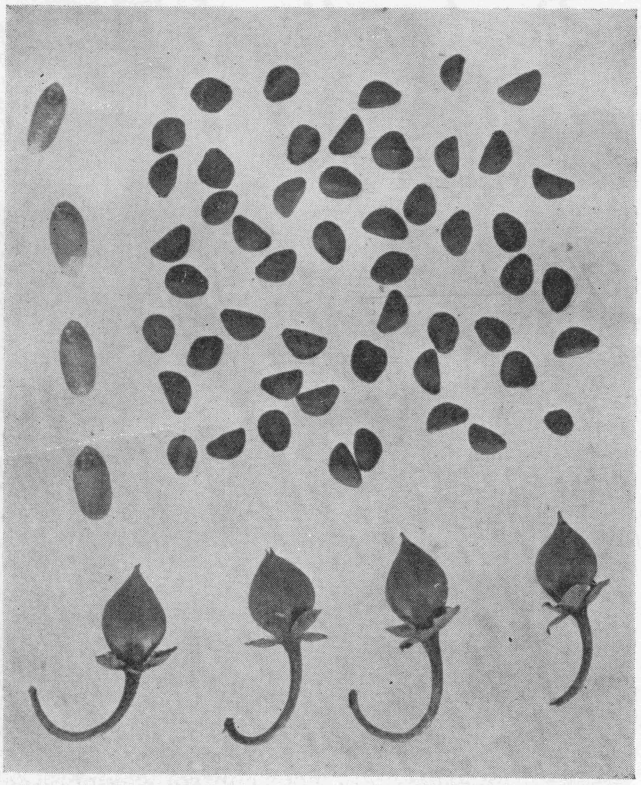

Figure 3. Bindweed seed and pods in relation to wheat seeds.

flower and set seed throughout the summer as long as moisture is available. One to four seed are formed in each pod. The seed are about the size of a wheat kernel and have a pebbled, black seed coat (Figure 3). Water cannot enter the coat readily to start growth and many of the seed remain dormant for long periods of time. Seed production is favored by warm, dry weather (5); consequently, seed set is usually very high in the Texas Panhandle. Seed samplings taken near Bushland in 1954 showed over one-half million bindweed seeds per acre were produced in wheat, and up to four and one-half million seeds per acre were formed in bindweed-infested road ditches.

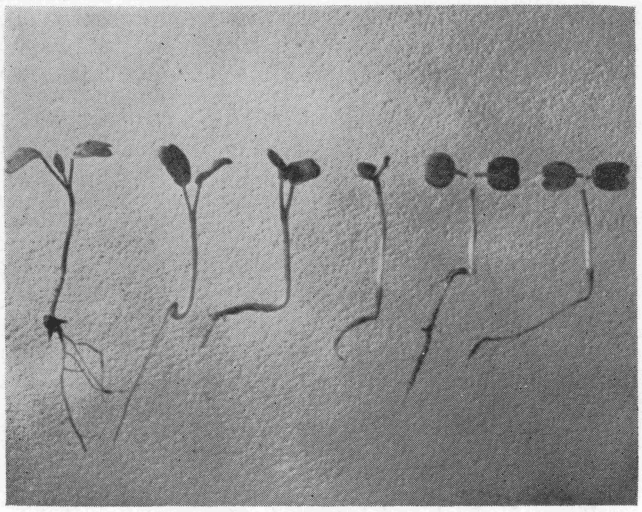

Figure 4. Bindweed seedlings.

The root system of bindweed is very extensive and contains food material which can support the plant for a long period. In the Panhandle area, the roots extend to the caliche, which varies from 4 to 6 feet deep. In deep soils, roots have been found at depths of more than 20 feet (4).

Bindweed seedlings can be distinguished by their heart-shaped cotyledonary leaves (Figure 4). The young seedling develops a deep taproot and in about 11 weeks spreads radially by producing lateral roots. New plants are produced from buds on the lateral roots and, within one season, a plant may spread up to 10 feet in diameter (3).

EXPERIMENTAL METHODS

The experiment was planned to study bindweed seedling infestation and control, to determine the best method for eradication of bindweed patches up to one-half acre in size and to find practical methods for the control of larger infestations of the weed. Studies with soil sterilants for eradication of small patches under dryland conditions were carried out near Bushland, Claude and Dumas. Similar work under irrigated conditions was conducted near Summerfield and Bushland.

Methods of control for large infestations were tested on 40 acres of land near the Amarillo Experiment Station at Bushland. Control methods tested were intensive cultivation, 2,4-D applications and cropping systems using wheat and sorghum as competitive crops.

RESULTS

Bindweed Seedling Infestation and Control

Most bindweed patches on cropland are started from seed carried to the land in infested grain seed, dirty combines or by cattle eating contaminated feed. Because of this hazard, only clean seed should be used in planting grain seed and combines should be cleaned carefully after working in bindweed-infested fields. Grain containing bindweed seed should be ground before it is fed. These simple practices would prevent much of the spread of bindweed to clean fields.

Dormant bindweed seed remaining in the soil on areas where the weed has been eradicated can germinate and become established if the seedlings are not controlled. An average of 162 seed per square yard of soil 6 inches deep was found in plots at Bushland after the bindweed had been controlled by 4 years of intensive cultivation. The following spring, 2 seedlings per square yard grew on the same plots and had to be controlled to prevent reinfestation. In Kansas, bindweed seedlings emerged on land 30 years after the original infestation of the weed was controlled. Seedlings were controlled by using monthly cultivations between crops of winter wheat or closely-drilled sor-

ghums. Sorghum planted in 40-inch rows with monthly cultivations between crops showed slow bindweed reinfestation. Normal cropping practices without monthly cultivations in either wheat or closely-drilled sorghum did not control the seedlings. Return of previously-infested areas to perennial grasses also showed bindweed would reinfest the land (9).

Eradication of Small Patches of Bindweed

Since small infestations of bindweed should be eradicated before they spread, investigations with soil-sterilizing herbicides have been made since 1949 at Claude, Dumas, Bushland and Summerfield. Experiments were conducted under both dryland and irrigated farming conditions with sodium chlorate, Concentrated Borascu, Atlacide, Polybor Chlorate and Karmex W.

Sodium chlorate has been used for bindweed control since 1927, when Latshaw and Zahnley (6) first tested the material. It is very soluble in water and can be applied either as a spray or dry with a mechanical spreader. The chlorate ion is the toxic agent in this material. Organic matter sprayed with sodium chlorate is highly inflammable upon drying and should be handled with the same precautions as gasoline. Clothing impregnated with sodium chlorate ignites easily. Because of this hazard, all applications of the material should be made dry with a mechanical spreader. Animals may eat enough soduim chlorate to poison themselves; consequently, cattle should not have access to chlorate-treated areas until the material has been leached into the soil (7).

Concentrated Borascu is an insoluble form of borate and must be applied dry with a mechanical spreader. Although small quantities of boron are required for plant growth, high concentrations will kill most vegetation. The material is noninflammable and nonpoisonous and can be used where cattle are grazing.

Atlacide is a chlorate type soil sterilant that may be applied dry or as a spray. It is less hazardous than pure sodium chlorate, but the same precautions should be used as for sodium chlorate.

Polybor Chlorate is a mixture of sodium pentaborate and sodium chlorate. It is soluble and can be applied as a spray or in dry form. The material is very fine and, when applied dry, is easily blown away.

Karmex W (3-p-chlorophenyl 1, 1-dimethyl urea) is an organic chemical and is extremely toxic to plant growth. It must be applied as a spray, using about 1 gallon of water per square rod. Plots of soil treated with Karmex W in 1951 still are free of vegetation. Because vegetative growth may be prevented for a long time, Karmex W should be applied only to areas where a long period of soil sterility would not be objectionable.

TABLE 2. AVERAGE RAINFALL AND CONTROL OF FIELD BINDWEED AT DUMAS AND CLAUDE IN 1950 USING 3 POUNDS OF SODIUM CHLORATE PER SQUARE ROD

Month	Rainfall, inches	Percent control
April	2.00	79
May	0.77	38
June	3.94	90
August	3.13	97
September	3.99	86
October	0.36	59
November	0.20	79

Application to Dryland

Investigations to determine the most effective rate and time of application of the soil sterilants to dryland areas were conducted during 1949, 1950 and 1951. The most economical rates in pounds per square rod were: sodium chlorate, 5; Concentrated Borascu, 16; Atlacide, 7; Polybor Chlorate, 12; and Karmex W ⅜. The most satisfactory time of application varied with the amount of rainfall that followed the application of the herbicides. If heavy rains fell within a few months after the application, satisfactory results were obtained. As can be seen in Table 2, using sodium chlorate as an example, the best control was obtained in June, August and September 1950 when at least 3 inches of rain fell during each month. Very poor control was obtained when the rainfall was low during the month of application. If rainfall did not leach the soil sterilants into the soil, the wind frequently blew them away. This is particularly true of fine materials such as Polybor Chlorate and Atlacide. Because applications of soil sterilant are more successful during periods of low wind movement and high rainfall, late summer or early fall treatment are most likely to give satisfactory bindweed eradication. This can be seen in Table 3, which shows the average wind movement and rainfall at the Amarillo Station since 1939.

One application of soil sterilants usually does not completely eliminate the bindweed. The remaining plants should be spot-treated about 2 years after the first treatment. If more than 50 plants per square rod remain, spot retreatment will be impractical and the entire area should be treated again with the soil sterilant (8). The soil sterilant should be spread at least 10 feet beyond the edge of the patch in order to kill all of the roots. After sterilants have been applied, the land should not be disturbed for at least 1 year. This will allow the sterilants enough time to leach

TABLE 3. AVERAGE WIND MOVEMENT AND RAINFALL AT THE AMARILLO EXPERIMENT STATION, 1939-53

Month	Wind, mph.	Rainfall, inches
January	6.99	0.55
February	7.88	0.38
March	8.76	0.41
April	8.54	1.30
May	7.69	2.91
June	7.58	2.53
July	6.30	2.51
August	5.99	2.57
September	6.63	1.68
October	6.14	2.14
November	6.31	0.75
December	6.54	0.71

Figure 5. Bindweed in this spot was eradicated by bordering, applying a soil sterilant and 4 inches of irrigation water.

uniformly into the soil. Lister cultivation should not be used for 2 or 3 years following the application because the lister blades may go deeper than the sterilants have penetrated, allowing the weeds to grow in the bottom of the lister furrows.

Application to Irrigated Land

Irrigation water can be used to leach the soil sterilants down to the plant roots. If the patch covers 10 or more square rods, the area should be bordered and then flooded with 3 or 4 inches of water (Figure 5). If it does not rain within a month following the first application of water, a second application will speed up the results. Even on clay soils, the sterilants will be leached too deeply for maximum results if more than 4 inches of water are used. The land should not be disturbed after flooding. The remaining plants should be retreated and the area reflooded 1 year after application.

If the infested spots are less than 10 square rods, bordering the area is inconvenient. The best method is to apply the soil sterilants just before a regular irrigation (Figure 6). When using this method to leach the sterilants into the soil, cultivations after application of the sterilants may reduce the effectiveness of the soil sterilants. As a result, several retreatments may be necessary to eliminate the weeds. Sodium chlorate, Polybor Chlorate and Atlacide, the more soluble materials, will not be distrubed as much by cultivation as other soil sterilants because they are easily leached into the soil.

Caution: Do not use Karmex W on irrigated land unless it is applied in a bordered area because it may move with irrigation water and kill annual crops in other parts of the field. This hazard does not exist with other soil sterilants which leach into the soil where they are applied.

Control of Large Infestations

Because it is too expensive to eradicate large infestations of bindweeds with soil sterilants, cheaper methods of control have been tested. These were intensive cultivation, the use of 2,4-D and cropping systems with competitive crops.

Intensive Cultivation

Perennial weeds, such as bindweed, are killed with cultivation by gradually depleting the food supply in the root system. Each time the weed grows after it has been cut off by cultivation, food material must be transported from the roots to the growing area near the soil surface. As a result, repeated cultivations cause a depletion of food reserves. A sweep-type cultivator should be used to be certain that the plant tops are severed from the roots. With repeated sweep cultivations, crop residues are conserved and left on the soil surface, greatly reducing the hazard of wind and water erosion. Figure 7 shows the sweep plow used for bindweed cultivations during these tests. One-way plows, disk harrows, lister plows and rod weeders tend to cover weeds instead of cutting them off, and the root reserves of the plants are not reduced. Bindweed also escapes cultivation with a sweep plow if the shovels do not have enough overlap.

Figure 6. Bindweed in this spot was eradicated by applying a soil sterilant just before a regular irrigation.

All cultivations in the experiment at Bushland were made at 4 inches, the most economical depth of cultivation (8). Weeds were cultivated every 9 and 15 days after emergence throughout the growing season. Both treatments gave 89 percent control in 3 years (Table 4). The first cultivation in the spring was given between April 15 and May 1, when the bindweed runners were about 4 to 6 inches long. The last cultivation in the fall depended on moisture conditions and varied from September 24, 1952 (a dry year) to November 10, 1949 (a wet year). The average number of annual cultivations for the 9 and 15-day cultivation intervals was 6.3 and 5.5, respectively. The average time between the cultivations was 23 and 29 days, respectively. The number of days between cultivations varied with moisture conditions. During wet periods, the weeds emerged in about 4 days after cultivation; during very dry times, the weeds required 30 or more days to reach the soil surface.

A practical approach for using an intensive cultivation control program would be to cultivate every 3 weeks. If growing conditions are favorable, cultivations at intervals of 2 weeks are required. However, if it is dry and the bindweed has not emerged in 3 weeks, cultivation should be delayed until after the weeds have emerged.

2,4-D and Related Compounds

Successful control of bindweed with 2,4-D (derivatives of 2,4-dichlorophenoxyacetic acid such as the ester and amine salts) depends on the size and rate of growth of the plant at the time of treatment. Experimental work conducted in 1953 indicates that bindweed runners must be at least 6 to 10 inches long and growing vigorously before good root kill can be obtained with 2,4-D. Top kills will not control the weeds for long periods.

Various formulations of 2,4-D, MCP and 2,4,5-T were tested for bindweed control at one-half and 1 pound per acre. 2,4-D gave better control than MCP and 2,4,5-T. During wet periods, the one-half-pound rate of 2,4-D acid gave as much control as the 1-pound rate, but during dry periods when growth was somewhat restricted, the 1-pound rate was more effective. The ester formulation of 2,4-D usually resulted in greater stand reduction than the amine formulation the first time the chemicals were applied. Both formulations gave the same degree of control when several applications were used. Table 5 shows that two annual applications of 2,4-D ester or amine at 1 pound per acre for 3 years, timed in accordance to the growth of the bindweed, gave 80 and 73 percent control respectively. This was about the same amount of control that was obtained with intensive cultivation. Repeated 2,4-D treatments at 1 pound per acre are a practical method of controlling bindweed in areas that cannot be cultivated, such as pastures, ranges, grass waterways and road ditches. 2,4-D also can be used effectively with intensive cultivations on cropland when growing conditions are good.

TABLE 4. PERCENT BINDWEED CONTROL, NUMBER OF ANNUAL CULTIVATIONS AND DAYS BETWEEN CULTIVATIONS ACHIEVED WITH INTENSIVE CULTIVATIONS AT 9 AND 15 DAYS AFTER WEED EMERGENCE

Period of cultivation	Percent control after 3 years	Annual cultivations	Days between cultivations
9 days after emergence	89	6.3	23
15 days after emergence	89	5.5	29

TABLE 5. BINDWEED CONTROL AFTER 3 YEARS OF TREATMENT ON NONCROPPED LAND USING 1 POUND PER ACRE OF 2,4-D ESTER AND AMINE

Herbicide	Percent control after 3 years	Annual treatments[1]
2,4-D amine	73	2
2,4-D ester	80	2

[1] 2,4-D was applied to the plots when sufficient weed growth made spraying feasible.

Cropping Systems with Competitive Crops

Using a competitive crop in a bindweed control program is the economical method of controlling this weed. The crop produces an income from the land while the weeds are being controlled and the crop residues produced help control wind and water erosion.

Several cropping systems using wheat as a competitive crop have been satisfactory for bindweed control (Table 6). Alternate fallow and wheat was the most successful method, giving 92 percent control after 3 years of treatment. During the fallow period, cultivations were made every 9 days after weed emergence. The first year of cultivation usually controlled the weeds well enough to prevent a yield reduction in the next wheat crop. This yield increase usually paid for the extra tillage in the intensive cultivation program. Continuous wheat production with intensive cultivations 9 days after the bindweed emerged between crops was not satisfactory, giving only 68 percent control in 3 years. 2,4-D applied in the spring at one-half pound per acre to wheat at the full tiller stage, preceded by inten-

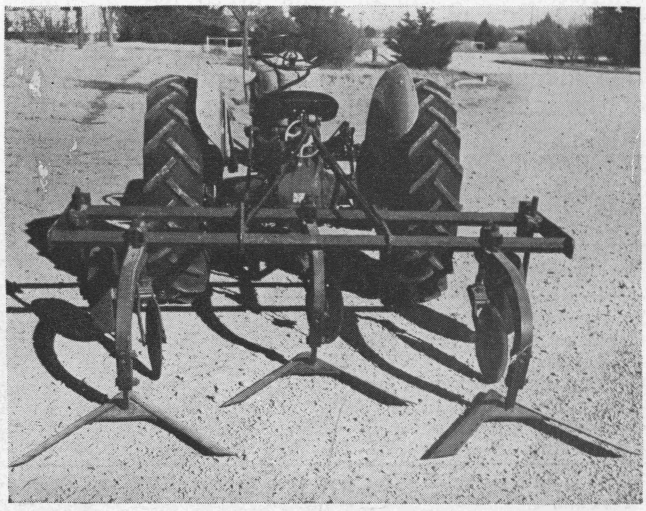

Figure 7. One type of sweep plow suitable for intensive cultivation in a bindweed control program.

Figure 8. Sorghum plot (left) infested with bindweed, and a wheat plot (right) relatively free of bindweed. Both areas have had cultivations for 5 years every 9 days after weed emergence when the land was not in crop.

sive cultivation, increased the control from 68 to 85 percent. A 2,4-D treatment at 1 pound per acre, applied in August to land used for annual wheat crops after intensive cultivations in July, increased the control to 88 percent. This treatment was not very effective during years when it was too dry for good weed growth; it was very effective during years with a wet August. The 2,4-D should be applied at least 3 weeks before wheat is seeded, since the chemical may cause injury to the germinating wheat. This also allows the 2,4-D enough time to move into the weed roots.

Wheat is a better competitive crop than sorghum. Wheat becomes established in the fall and winter while the weeds are dormant, and can compete for moisture in the spring. Sorghum planted in June while the bindweed is growing vigorously is unable to compete for the limited supply of water (Figure 8).

A practical method to control large areas of bindweed on Pullman soils is to use alternate wheat and fallow with sweep-type tillage during the fallow periods. A wheat, fallow, wheat rotation gives the best bindweed control, and is one of the most economical cropping systems for the area (10). During the fallow periods, cultivations should be made at 3-week intervals unless moisture conditions induce rapid weed growth. If this happens, the bindweed should be allowed to grow until the runners are 6 to 10 inches long and then be treated with 1 pound of 2,4-D acid per acre. After the 2,4-D treatment, cultivations will not have to be resumed until after the weeds reemerge. Treatments of 2,4-D during wet periods reduce the number of cultivations necessary and save crop residues. If the bindweed threatens to produce seeds in the wheat during the spring, one-half pound of 2,4-D acid per acre should be appled to the wheat before it reaches the boot stage.

TABLE 6. BINDWEED CONTROL IN WHEAT USING INTENSIVE CULTIVATION 9 DAYS AFTER BINDWEED EMERGENCE, WITH AND WITHOUT 2,4-D APPLICATIONS

Treatments	Percent control after 3 years	Cultivations annually	Sprays annually
Fallow-wheat-fallow	92	6	0
Continuous wheat, cult. July, 2,4-D Aug.[1]	88	3	1
Continuous wheat, cult. July, Aug., Sept., 2,4-D tiller[2]	85	4	1
Continuous wheat, cult. July, Aug., Sept.	68	5	0

[1] One pound of 2,4-D ester per acre to the bindweed during August.

[2] One-half pound of 2,4-D ester per acre when the wheat was fully tillered in the spring.

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