UNIVERSITY OF IDAHO
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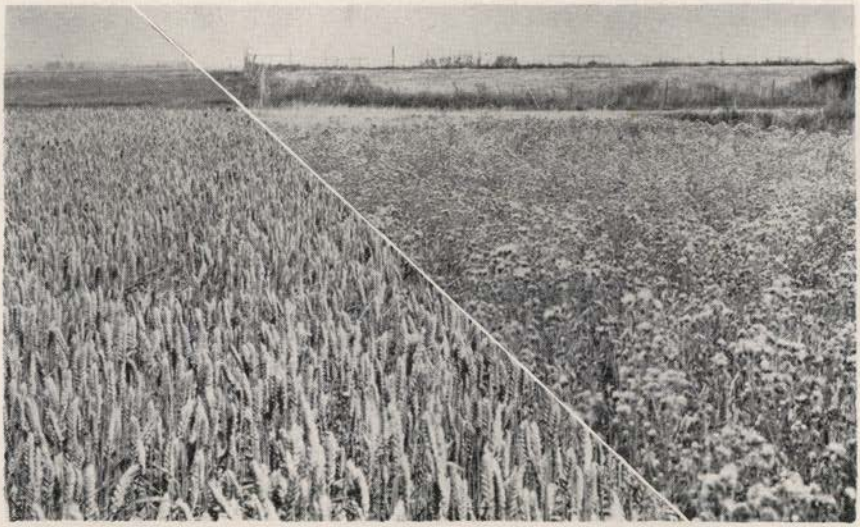

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Everyone is looking for an easier and more efficient way to control Canada thistle.

Results from thistle control trials near St. Anthony, Idaho, indicate that 2,4-D is more effective on thistles when used in crops grown on a highly fertile soil.

Both alfalfa and grasses, grown in dense stands for at least three years, are effective in controlling thistles.

Clean cultivation is the quickest and most effective control measure.

No control effort whatever actually is more expensive than adequate control.

The work reported here clearly demonstrates that chemicals, cultivation methods, and planned cropping systems can bring Canada thistle under control and, above all, provide greater profits.

Tetonia Branch Experiment Station

Department of Agronomy

U. S. Department of Agriculture

Control Canada Thistle For Greater Profits*

HUGH C. MCKAY, GERALD AMES, J. M. HODGSON, AND L. C. ERICKSON**

Canada thistle is the most important perennial weed on Idaho farms. Canada thistles reduce crop yields, increase operating costs, decrease land values, and present other community problems. They are aggressive on all Idaho farm lands, but are most troublesome in the cooler, irrigated or higher moisture areas, such as the upper Snake River Valley and the northern Panhandle.

Fifty years ago there were only two known infestations in the state, and both were small. One was at Sandpoint and the other at Boise. Now Canada thistles cover about 230,000 acres. About half, or 110,000 acres, is concentrated in the Upper Snake River Valley, mainly on irrigated ground. The bulk of the remainder is in the higher rainfall area of northern Idaho.

Idaho is not alone in its Canada thistle problem. Seven other western states have a total of 1,294,000 infested acres. In only two states is Canada thistle missing from the noxious weed seed list, although it is primarily a weed of only the northern half of the country.

The problem of control is intensified by the many sources of infestation. A large Canada thistle plant is capable of producing about 700 seeds per year. In Idaho, contaminated seed stocks, infested feeds, barnyard manure, irrigation water, and wind are the principal means of seed spread. Canada thistles are found at the headwaters of most the state's streams and along irrigation canals and many roadways. Wind is capable of carrying Canada thistle seed to adjacent areas.

This report presents the results of a 5-year study (1953-1957) conducted by the University of Idaho and the Crops Division of the Agricultural Research Service to evaluate the effectiveness of several cropping practices for control of Canada thistle.

Purpose and Methods

The experiment was designed to evaluate the effects of 11 cropping combinations including 2,4-D treatments, cultivation, and nitrogen fertilizer. These treatments were applied separately and in various combinations to test their effects on established stands of Canada thistle and to determine which treatment would give the greatest financial returns.

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* Cooperative investigations in weed control of the Idaho Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

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The work was started in 1953 on 5 acres of densely infested irrigated land near St. Anthony, Idaho. The upper right-hand section of the cover picture shows the density of the initial Canada thistle stand. The soil was a silt loam, typical of this area. The field chosen had been cropped almost exclusively to grain and potatoes for about 40 years. The land had been in grain the 4 years just previous to the initiation of the tests and consequently it was in a low state of fertility.

The 11 treatments used in this study are listed below by letter designation.

A. Spring wheat plus nitrogen fertilizer and 2,4-D spray each year.
B. Spring wheat plus nitrogen fertilizer and 2,4-D spray in the spring and fall of each year.
C. Check (continuous spring wheat).
D. Spring wheat plus 2,4-D spray in the spring of each year.
E. Spring wheat plus nitrogen fertilizer each year.
F. Cultivation in 1953, spring wheat plus nitrogen fertilizer and 2,4-D spray each year thereafter.
G. Alfalfa–grass mowed for hay.
H. Pasture–grass sprayed with 2,4-D and mowed for hay.
I. Spring wheat plus 2,4-D spray in 1953. Seeded to alfalfa and grass in 1954 and mowed for hay in 1954, 1955 and 1956.
J. Rotation, alfalfa–grass in 1953-55 and potatoes in 1956.
K. 2,4-D spray plus cultivation in 1953 and spring wheat plus nitrogen fertilizer and 2,4-D spray each year thereafter.

The treatments were randomized and replicated four times on plots 1/10 acre in size. An aerial view of the plot area is shown in Figure 1.

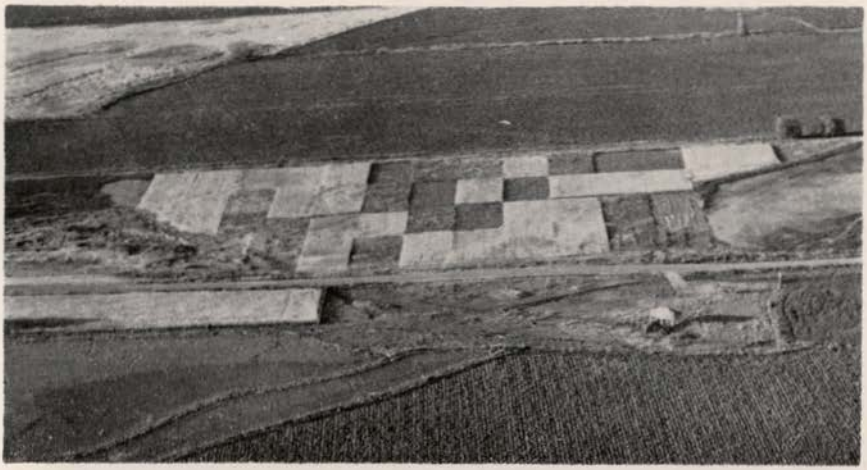

Figure 1.—Canada thistle control plot area located in the irrigated area near St. Anthony, Idaho

All farming operations such as plowing, seeding, cultivating and spraying were done with commercial tractor-mounted field equipment.

A duckfoot cultivator was used for the cultivation plots. All plots were plowed in the spring of the first year and in the fall of each year thereafter. All plots except the potato plots, which received three additional irrigations, were irrigated twice during each growing season.

The nitrogen fertilizer was applied broadcast each spring prior to seeding at a rate of 80 pounds per acre of actual nitrogen. The 2,4-D spray was applied at the rate of 2 pounds per acre of amine salt formation in 30 gallons of water the first year and at 3 pounds each year thereafter. The spray application was made about the third week of June when the grain was 8 to 10 inches high. At this time the Canada thistles were in three stages of growth: germinating seedlings, broad rosettes, and shoots up to 1 foot tall. The fall application of 2,4-D (treatment B) was made about the middle of September.

The clean-cultivation plots were cultivated three times during the 1953 season at 21-day intervals. They were irrigated between each cultivation.

The hay and pasture crops were seeded without a nurse crop for two reasons. There was an extremely heavy stand of Canada thistle, and it was advantageous to mow the Canada thistle as a partial control measure during the year of establishment of the forage crop. The alfalfa–grass and the grass–pasture plots were fertilized with 30 pounds of acutal nitrogen and 100 pounds of phosphate (P_2O_5 equivalent) per acre in the year of establishment. The pasture grass plots received 80 pounds of actual nitrogen each year thereafter. The pasture plots were sprayed with 2 pounds of 2,4-D the first year about 6 weeks after the grass emerged and 3 pounds of 2,4-D each year thereafter.

The density of Canada thistle on each plot was determined by counting the stems on 16 permanent square-yard quadrats within each plot. In 1953, the original Canada thistle stands were counted before any spraying or cultivation operations began. In the following years stand counts were made in June in the same permanent quadrats just before the plots were sprayed.

Wheat yields were determined by sampling the same permanent quadrats as used for the Canada thistle counts. The forage yields were determined by random square-yard sampling.

Experimental Results and Discussion

CANADA THISTLE CONTROL

The data in Table 1 show the beneficial effects of combining two or more practices in one treatment as compared with using only one practice. The results show that 2,4-D was always more effective when it was combined with other practices. For example, 2,4-D alone gave only 80 percent control after 4 years of treatment, while the 2,4-D plus nitrogen treatment gave 98 percent control. Furthermore, the forage and forage-potato treatments reduced the Canada thistle stands more than 2,4-D alone.

Table 1.—Control* of Canada thistle by various chemical, cropping and cultural practices over a 5-year period.

TREATMENT	Percent Control			
	1954	1955	1956	1957
A. Spr Wh. + Nitrogen + 2,4-D	50	89	96	98
B. Spr. Wh. + Nitrogen + 2,4-D Spr. and Fall	75	84	93	96
C. Check – Spring Wheat	0	0	0	0
D. Spr. Wh. + 2,4-D	25	31	67	80
E. Spr. Wh. + Nitrogen	16	32	10	16
F. Cultivation 1953, Spr. Wh. and Nitrogen + 2,4-D thereafter	96	99	99	99
G. Rotation – Alf. and Grass mowed for hay	36	90	93	99
H. Seeded Pasture + 2,4-D spray and mowed for hay	89	96	98	98
I. Spr. Wh. + 2,4-D 1953, Alf. and Grass mowed for hay thereafter	24	10	70	96
J. Rotation – Alf. and Grass 1953-1955 Potatoes 1956	50	90	98	96
K. Cultivation + 2,4-D 1953, Spr. Wh. + Nitrogen and 2,4-D thereafter	99	99	99	99

* The Canada thistle regrowth was counted each year in June, and therefore the figures show the effect of the previous year's treatment.

Effect of Soil-Fertility Level on Canada Thistle Control

The benefits of a high soil-nitrogen level for Canada thistle control under continuous wheat cropping cannot be over-emphasized. The additional nitrogen benefits the crop growth and thereby increases competition against the Canada thistle. Figure 2 illustrates the nitrogen and 2,4-D relationships.

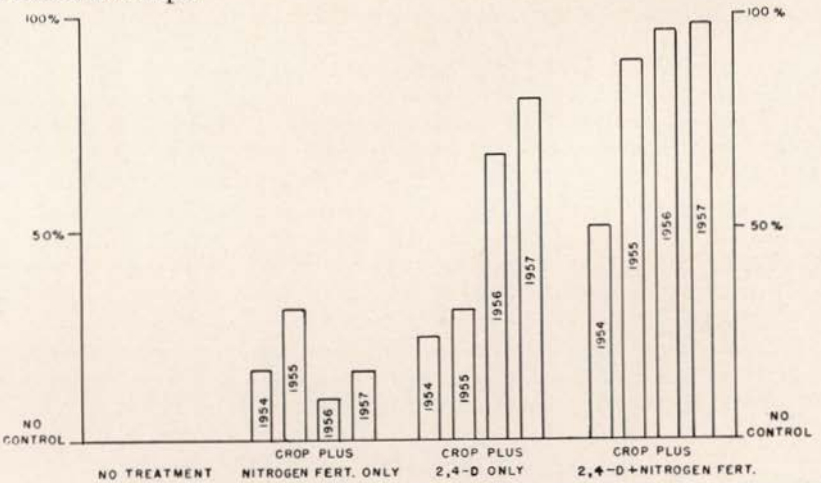

Figure 2.—Control of Canada thistle from spring wheat cropping with 2,4-D spray and nitrogen fertilizer treatments for years 1954-1957.

Although 100 percent control was not obtained from any of the treatments on spring wheat, the combination of 2,4-D spray and nitrogen fertilizer gave 98 percent control after 4 years of treatment. This combination treatment showed a 50 percent control after 1 year and increased to 89, 96 and 98 percent the following 3 years. While good control was obtained with this combination treatment, certain difficulties were encountered, mainly the build-up of wild oats when wheat follows wheat. Where no wild oat problem is present, it may be possible to grow wheat continuously for more than 3 successive years; also winter wheat might be used to help alleviate the wild oat problem.

The increased vigor and growth of wheat resulting from the use of nitrogen fertilizer are shown in Figure 3.

Figure 3.—Plot in foreground had a combined treatment of nitrogen fertilizer and 2,4-D spray. Plot on right was treated only with 2,4-D.

While the Canada thistle stems were killed by using 2,4-D spray only, as shown in Figure 4, the plants recovered more rapidly because the shorter grain crop offered very little competition.

Figure 4.—Spring wheat treated with 2,4-D on the right and not treated on left.

In the first year, only 25 percent Canada thistle control was obtained by use of 2,4-D alone, as compared with 50 percent when the wheat was fertilized and sprayed with 2,4-D. In the second year, only 31 percent control was obtained as compared with 89 percent for these two treatments. Not until the third year, when 67 percent control was obtained, did there appear to be much improvement in the "2,4-D only" plots. The fourth year was considerably better with 80 percent control, but still 2,4-D alone was not equal to the 98 percent obtained when fertilizer and 2,4-D were used.

When nitrogen fertilizer was used alone, Canada thistle control varied from 10 to 32 percent for the 4 years, apparently depending upon the vigor and growth of the spring wheat crop.

Canada Thistle Control from Spring and Fall Applications of 2,4-D

Plots of spring wheat sprayed with 2,4-D in the spring and again after harvest showed no improvement in Canada thistle control over plots given the single spring treatment for the 4-year period (Figure 5). In the

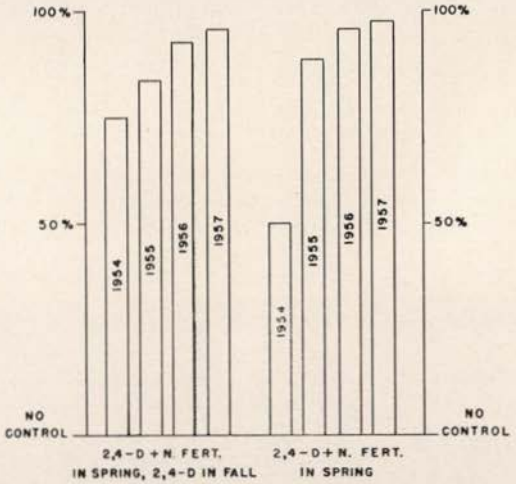

Figure 5.—Effect of spring vs. spring and fall applications of 2,4-D on Canada thistle control.

first year of treatment, however, the double application of 2,4-D, which gave 75 percent Canada thistle control as compared with 50 percent for the single spring application, showed a definite advantage. The lack of fall growth resulting from the spring treatment and short growing season in the Upper Snake River area apparently contributed to the lack of effectiveness by the additional fall application.

Treatments Giving the Greatest Canada Thistle Control

It is evident from Figure 6 that clean cultivation gave the greatest Canada thistle control in the shortest time. The obvious disadvantage of this is that no crop or income is produced the first year. Clean cultiva-

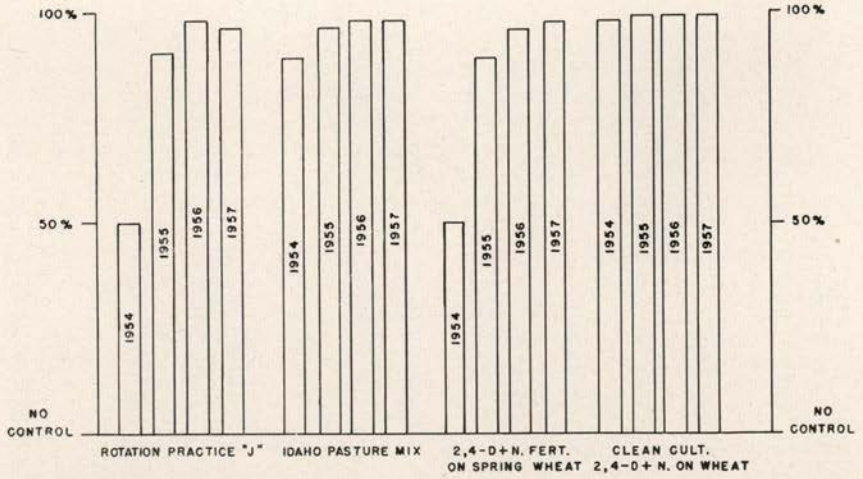

Figure 6.—Effect of cultivation, rotations, pasture, fertilizer and 2,4-D upon Canada thistle control.

tion treatments gave 96 percent control of Canada thistle the first year. There was very little difference between treatment K when 2,4-D was applied before cultivation and F (not shown on chart) when no 2,4-D was applied. Because of the necessity of allowing the Canada thistle to grow the first year to obtain a stand count of the established stand of Canada thistle, it was necessary to delay the first cultivation. With one more earlier cultivation it might have been possible to obtain 100 percent control.

Thick stands of forage crops were highly effective in the control of Canada thistles in this experiment. The grass-pasture seeding, with a 2,4-D treatment 6 weeks after the grass emerged and annually thereafter, gave 89 percent control the first year and increased to 98 percent the fourth year of treatment. The grass-pasture seeding was mowed annually. The alfalfa-grass treatment was not as effective in controlling Canada thistles the first year, giving only 36 percent control. However, in the second and third years the alfalfa-grass, which was mowed twice each year, showed 90 and 93 percent control and in the fourth year 99 percent. This indicates that a good stand of alfalfa and grass, as shown in Figure 7, when mowed for hay is highly effective in controlling Canada thistles. Dense stands of alfalfa-grass should be maintained at least 4 years to yield the greatest benefit. A wilt-resistant variety of alfalfa, such as Ranger, should be used.

The advantages of the growth habits of alfalfa and grass over the growth habits of Canada thistle were shown in these treatments. Alfalfa and grass start growth earlier in the spring and form a highly competitive plant cover; they also recover rapidly after mowing. Mowing is in itself detrimental to Canada thistle. Several cuttings of hay combined with vigorous competitive plant growth are an important control practice in connection with the use of forage crops.

Figure 7.—A dense and vigorous growth of alfalfa such as this is highly effective in controlling Canada thistle.

In the first 3 years of treatment the alfalfa-grass and potato rotation gave results similar to the alfalfa-grass rotation. In the fall of 1956 the alfalfa-grass was treated with 4 pounds of 2,4-D per acre and plowed. This was done, first, to weaken any remaining Canada thistle; and second, to kill the alfalfa so that the alfalfa roots would not interfere with the potato production equipment the following year. The plots of potatoes following the alfalfa-grass showed that 98 percent control of Canada thistles had been obtained. But the following year (the second crop of potatoes), control dropped to 96 percent, giving an increase of 2 percent in the number of Canada thistles. This indicates that cropping to potatoes will limit but not control Canada thistles.

Spring wheat plus 2,4-D spray in 1953 and alfalfa-grass mowed for hay in 1954-55-56 were included to determine whether alfalfa and grass could be established more effectively if a grain crop were grown the preceding year and treated with 2,4-D spray to aid in reducing the vigor of the Canada thistles. The results show that lack of effective control in one year from the use of 2,4-D alone gave no advantage to raising one grain crop prior to the alfalfa-grass seeding. Better results might have been obtained if nitrogen fertilizer had been applied to the grain, but at the time the experiment was started, the important part that fertilizer in combination with 2,4-D would play in the control of Canada thistles was not anticipated. When forage crops are seeded without a nurse crop

in dense Canada thistle infestations, the Canada thistles should be mowed at regular intervals to aid in the forage establishment. This practice will also weaken the Canada thistles and prevent seed production.

In comparing the various methods of control, spring wheat plus nitrogen fertilizer and 2,4-D gave almost identical results with alfalfa-grass for the 4-year period. However, other factors besides Canada thistle control have to be considered. Wild oats is a common field weed, and in this trial, the increasing wild oat population limited the growing of wheat following wheat to 2 or at the longest 3 years.

In general, any rotation with the objective of controlling Canada thistles should include at least 4 years of alfalfa-grass, not more than 2 years of potatoes, and not more than 2 or 3 years of continuous grain. Beans or sugar beets could be substituted for potatoes in some areas of the Snake River Valley.

Controlling Canada Thistle Seedlings

All cropping practices for Canada thistle-infested land must be planned not only to kill the established plants, but to eliminate new seedlings which are certain to come from seeds left in the soil after the parent plants have been killed. About 10 seedlings per square yard each spring were found in the plot area even after over 90 percent of the old Canada thistle plants had been killed.

In the alfalfa-grass plots and in the wheat plots where 2,4-D sprays were used, the seedlings failed to survive. Therefore, if the wheat had not been sprayed each spring or if there had not been a good stand of alfalfa-grass, the infestations would have been re-established by these seedlings. This shows the necessity of continuing control practices over many years, even after the old established stand has been eliminated.

Crop Yields

The yields of wheat obtained indicate the low level of fertility for the plot area at the beginning of the experiment. Plots receiving nitrogen fertilizer gave large increases in yield as shown in Table 2.

Table 2.—Yield in bushels per acre of wheat and tons per acre of forage for each Canada thistle control treatment, 1953-1955.

TREATMENT	1953	1954	1955	Ave.
		Bushels Per Acre		
A. Spr. Wh. + Nitrogen + 2,4-D	76.6	77.1	47.7	67.9
B. Spr. Wh. + Nitrogen + 2,4-D twice	71.7	78.0	50.8	66.8
C. Check	30.3	23.3	19.2	24.2
D. Spr. Wh. + 2,4-D	29.9	34.8	20.3	26.2
E. Spr. Wh. + N Fertilizer	72.5	53.9	27.5	51.2
F. Cultivation 1953, Spr. Wh. + Nitrogen and 2,4-D thereafter		80.2	48.4	64.3
K. Cultivation + 2,4-D 1953, Spr. Wh. + Nitrogen + 2,4-D thereafter		90.4	55.5	72.9
I. Spr. Wh. + 2,4-D 1953, Alf. and Grass Mowed for Hay thereafter	30.3			
		Tons Per Acre		
G. Alfalfa and Grass Mowed for Hay		5.5	4.9	5.2
H. Pasture Seeding + 2,4-D Spray and Mowed for Hay		3.6	4.0	3.8
I. Spr. Wh. + 2,4-D 1953, Alf. and Grass Mowed for Hay thereafter			4.0	4.0
J. Rotation Alf. and Grass 1953-55 and Potatoes 1956		4.6	4.0	4.3

The high yields of wheat depended largely upon whether or not nitrogen was applied. Where no nitrogen was applied, as in the check, the average yield of wheat for the 3-year period was only 24.2 bushels per acre. When 2,4-D only was used, the average was 26.2 bushels per

acre, an increase of 2 bushels, possibly due to reduced Canada thistle competition. Where nitrogen fertilizer only was applied, the average yield was 51.2 bushels, an increase of 27 bushels per acre from the application of nitrogen. When the combination of 2,4-D and nitrogen was used, the wheat averaged 67.9 bushels per acre, an increase of 43.7 bushels over the check. This was an increase of 41.7 bushels over the 2,4-D treatment only and an increase of 16.7 bushels over the nitrogen only. A most important result of this experiment was the increase in yield obtained from the combination of nitrogen and 2,4-D. This combination treatment gave yield increases greater than just the single benefits of 2 bushels for 2,4-D only and 27 bushels for nitrogen only. These two increments equal 29 bushels, but the increment from the combined treatment averaged 43 bushels, an increase of 14 bushels.

No diffferences in yield were obtained whether 1 or 2 applications of 2,4-D were made each year on continuous spring wheat plots.

The application of 2,4-D and fertilizer had conspicuous effects upon the growth of the wheat as shown in Figure 8. The figure shows the typical stunting effects of 2,4-D, the combined inhibiting and growth response when 2,4-D and nitrogen were applied, and the growth response derived from nitrogen alone.

Figure 8.—Effect of 2,4-D and nitrogen upon straw growth and yield in the 1953 crop.

The nitrogen fertilizer gave a tremendous increase in straw length and growth while the application of 2,4-D tended to shorten the straw, but did not decrease the grain yield as compared with non-treated check plots. In 1953, the nitrogen treatment yielded 72.5 bushels per acre as

compared with the nitrogen plus 2,4-D treatment, which yielded 76.6 bushels per acre. No lodging, brittle or broken straw was observed even in the following years when 3 pounds of 2,4-D were applied.

Profits from Various Treatments

Farmers are not only interested in how to control Canada thistles; they also want and need to know how their income will be affected. Figure 9 shows that doing nothing is more expensive than adopting a complete weed control program which includes the better cropping practices.

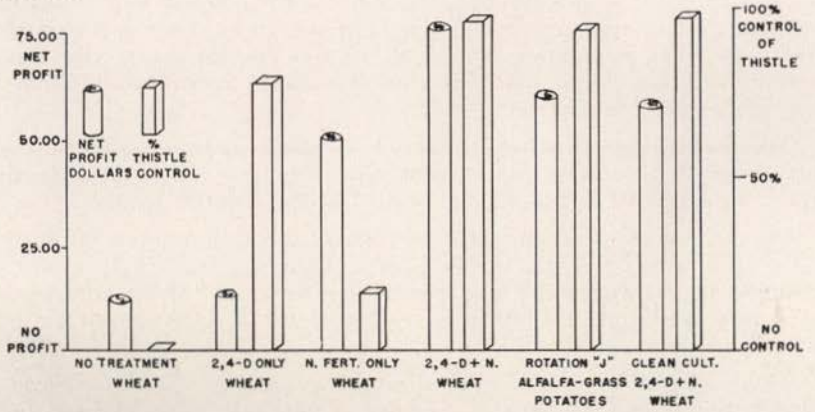

Figure 9.—Net dollars returned per acre above fixed costs, and percent control of Canada thistles.

The highest net average annual profit, $76 per acre and 98 percent Canada thistle control, were obtained from a combination of 2,4-D and nitrogen fertilizer. However, this practice is limited in duration by various associated problems, such as the usual rapid increase of wild oats and other weedy grasses.

When nitrogen fertilizer only was used, a net profit of $49 was realized per acre, but did not control the Canada thistles. An annual net profit of only $13 per acre, and after 4 years only 80 percent Canada thistle control resulted when 2,4-D was used alone. When no control measures were employed, the wheat yields were so low that a net profit of only $12 per acre was realized and there was an actual increase in even the dense original Canada thistle population.

The cultivation plots gave the quickest and highest percent control of Canada thistles and produced the greatest yields, but because of the necessity of the land being out of production for one year, the net average returns were reduced to $56 per acre for the 4-year period. The alfalfa-grass, potato rotation plots not only gave good Canada thistle control, but returned an average yearly net profit of $61 per acre. This entire experiment revealed, as can be seen, that a well-planned and carried-out weed program will control Canada thistles and add substantially to the possible net profits.

Summary and Conclusions

Eleven different cropping systems were tested for the control of Canada thistle during a 5-year period 1953 to 1957, in the irrigated area near St. Anthony, Idaho.

The purpose of the work was to evaluate the effect of several crops, 2,4-D spray, nitrogen fertilizer, and clean cultivation used alone and in various combinations for the control of Canada thistle. The treatments were also evaluated on the basis of net returns.

The data presented show that when wheat is grown on a low fertility soil, 2,4-D gives more effective Canada thistle control when nitrogen fertilizer also is applied. When the land was previously infested with wild oats, their population increased in the continuous spring wheat plots to such an extent that this combination treatment should not be used more than 2 or 3 years.

The use of close-growing crops such as alfalfa-grass or 2,4-D sprayed pasture grasses, mowed twice each year also proved to be effective, giving 99 percent Canada thistle control at the end of 4 years.

One season of clean cultivation every 21 days eliminated 99 percent of the established Canada thistle plants. However, no single treatment or single year's work will give permanent Canada thistle control, because new seedlings develop from seed in the soil. Only long-term control will eliminate this problem.

Yields of spring wheat were directly influenced by the degree of Canada thistle control and the fertility of the soil. The highest yields were obtained when both nitrogen fertilizer and 2,4-D spray were used.

The most expensive "control-measure" for Canada thistle was doing nothing. Nitrogen and 2,4-D applied to spring wheat gave the highest immediate returns per acre, but the increasing presence of wild oats limited the number of years this practice could be followed.

The data presented are from a soil low in fertility and heavily infested with Canada thistle and the same response from nitrogen might not be obtained from a soil of higher fertility.

The data obtained indicate that the best Canada thistle control program to adopt would depend upon the farming area, soil fertility, and the crop rotations available for use. If spring wheat is to be raised, it should be grown for 2 consecutive years, treated with 2,4-D, and fertilized both years, then followed by 4 years of alfalfa, alfalfa-grass, or grass only. Thereafter, potatoes or other row crops should follow for not more than 2 years.

Knowledge and application of the practices now known, combined with persistence and vigilance, are the keys to Canada thistle control and to greater profits.

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