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CHEMICAL CONTROL OF WEEDS IN CRIMSON CLOVER GROWN FOR SEED PRODUCTION

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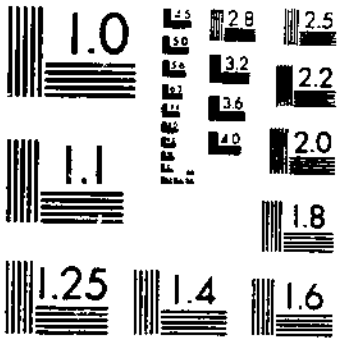

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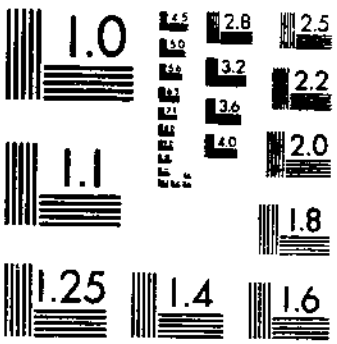

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Chemical Control of Weeds in CRIMSON CLOVER Grown for Seed Production

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Washington, D.C. Issued April 1964

Chemical Control of Weeds in CRIMSON CLOVER Grown for Seed Production

By William O. Lee, *research agronomist, Crops Research Division, Agricultural Research Service*

Crimson clover (*Trifolium incarnatum* L.) has become increasingly important economically as a seed crop in western Oregon. The average number of acres devoted to production of this crop in Oregon was 5,850 during 1949–58, 16,000 in 1959, 21,000 in 1960, and 15,500 in 1961. As a result of this acreage increase, Oregon now ranks first in the Nation for crimson clover seed production.

Since 1960 Oregon has produced almost half of the crimson clover seed grown in the United States. Tennessee, Alabama, and Georgia also produce large quantities. Unlike these areas, Oregon's crop is grown primarily for seed production. Although limited grazing is sometimes practiced during the early spring in this State, very little of the crimson clover crop is utilized for green manure, silage, or hay. In most other areas where this crop is grown, its main use is for grazing and soil improvement, and a seed crop is harvested as such only when conditions are favorable for seed production.

Many weed problems are encountered when crimson clover is grown for seed production. Since this crop is fall planted and develops very slowly during the cool, wet winter months, it is a poor competitor and is soon overtopped by more rapidly growing weed and crop species. Appearing in great abundance are the winter-germinating annual weeds, such as wild oats, fescues, wild bromes, and wild brassicas, and the volunteer crop plants, such as small grains, ryegrass, and vetches. Thus, at harvesttime it is frequently impossible to identify an untreated crimson clover seed field without inspecting it closely. Although this excessive weed growth may not be objectionable when crimson clover is grown for purposes other than seed production, it becomes very objectionable in seed fields. Research has shown that heavy weed or volunteer crop growth severely reduces seed yields and often results in contaminants in the seed that are difficult and costly to remove. In addition, profuse amounts of weed seeds are produced, which remain on the field to interfere with the production of succeeding crops in the rotation.

LITERATURE REVIEW

A review of the literature showed that practically no research has been reported on weed control in crimson clover, although considerable research has been conducted to develop methods of controlling weeds

in other forage legumes. This is undoubtedly because crimson clover has generally been grown as a multipurpose crop, and when utilized for purposes other than seed production, weeds caused no serious losses. However, in Oregon where crimson clover is grown almost exclusively for seed production, weeds are a major obstacle to the economic production of the crop.

Since 1950 numerous reports (*2, 4, 8, 10*)[1] have been published concerning the use of isopropyl *N*-phenylcarbamate [IPC] and isopropyl *N*-(3-chlorophenyl)carbamate [CIPC] for controlling grass weeds in legumes. These herbicides have been compared when applied as preplanting, preemergence, and postemergence treatments on seedling legumes and as dormant-season treatments on established legumes. Grass weed control has generally been effective with these herbicides, whereas injury to the legumes has been variable among the different species. In general, CIPC has been slightly more injurious than IPC to the legumes, especially when applied at early stages of development. More recently ethyl *N,N*-di-*n*-propylthiolcarbamate [EPTC] has been reported (*5, 9*) to give good control of grass weeds and certain broadleaved weeds in establishing new stands of legumes. This herbicide has given best results when applied as a preplanting soil-incorporated treatment.

Considerable research has also been reported in which low rates of 2,4-dichlorophenoxyacetic acid [2,4-D], 2-methyl-4-chlorophenoxyacetic acid [MCPA], 4-(2,4-dichlorophenoxy)butyric acid [4-(2,4-DB)], 4-(2-methyl-4-chlorophenoxy)butyric acid [4-(MCPB)], and several other closely related chemical compounds have been compared for the control of broadleaved weeds in legumes.

The purpose of the investigations reported in this bulletin was to evaluate chemicals and methods of application for weed control in crimson clover, which have been effective for weed control in other legumes, and to develop new principles and practices of weed control in this crop.

MATERIALS AND METHODS

During 1957–61 these investigations were conducted in western Oregon on controlling weeds in crimson clover grown for seed production. Five experiments dealt primarily with herbicides that were effective in controlling grass weeds and four experiments with herbicides that were effective for broadleaved weed control.

Since crimson clover is grown in rotation with various other seed crops, ryegrass and volunteer cereal grains are the most common grass weeds encountered in crimson clover seed fields. However, other winter-germinating grasses, such as annual bluegrass (*Poa annua* L.), rattail fescue (*Festuca myuros* L.), wild oat (*Avena fatua* L.), and ripgut brome (*Bromus rigidus* Roth), are frequently abundant.

The broadleaved weed causing the greatest production difficulty in crimson clover seed fields is hairy vetch (*Vicia villosa* Roth). This plant with its rank, twining growth overtops crimson clover and causes it to lodge. The clover then fails to pollinate and may even rot prior to maturity. When heavy infestations of hairy vetch occur,

[1] Italic numbers in parentheses refer to References, p. 21.

crimson clover seed production may be completely eliminated, and the large amount of tangled vegetative growth makes cutting and windrowing very difficult. Also common in crimson clover seed fields of western Oregon are wild turnip (*Brassica campestris* L.), wild radish (*Raphanus raphanistrum* L.), cutleaved geranium (*Geranium dissectum* L.), dogfennel or mayweed (*Anthemis cotula* L.), chickweed (*Cerastium* sp.), groundsel (*Senecio vulgaris* L.), and cornflower or French pink (*Centaurea cyanus* L.). Seeds of wild turnip, radish, geranium, and cornflower are difficult and expensive to separate from crimson clover.

Control of Grass Weeds

In the five experiments conducted on the control of grass weeds in crimson clover, the clover was planted each year between September 16 and 26. Lime and phosphate fertilizers were applied according to recommendations for the area.

The crops produced and the methods of soil preparation prior to planting crimson clover varied from year to year. In the two 1957 experiments, crimson clover followed spring barley. A heavy disk was used for seedbed preparation. In the 1958 experiment, crimson clover followed crimson clover, and the area was irrigated several weeks before planting. A tractor rotary tiller was used for seedbed preparation. In the 1959 experiment, a small grain cover crop was plowed under in the spring, and the area was fallowed during the summer. In the 1960 experiment, hairy vetch was grown the previous year, and the area was plowed in the spring of 1960 and fallowed during the summer.

In the 1957, 1958, and 1959 experiments, soil-incorporated treatments were compared. In 1957, the herbicides were applied to the soil surface and incorporated by disking twice with a double disk. In 1958, the herbicides were sprayed on the soil surface and incorporated immediately with a hand-operated rotary tiller. In 1959, various methods of applying and incorporating herbicides as preplanting treatments were compared. In some treatments the herbicides were sprayed on the soil surface and incorporated with a rotary tiller as in 1958. In other treatments the herbicides were injected directly into the soil by means of a subsurface blade injector and either left undisturbed or worked with a rotary tiller to distribute them throughout the upper 4 inches of soil. After the chemicals were incorporated, the seedbed was worked with a harrow and roller.

Herbicides compared as preplanting treatments included IPC, CIPC, EPTC, 2-chloroallyldiethyldithiocarbamate [CDEC], and 2-chloro-*N*,*N*-diallylacetamide [CDAA]. In 1957 and 1959, they were applied on the same day as seeding. In 1958, they were applied on September 18 and the clover was seeded on September 24. The rates of application ranged from 2 to 8 pounds per acre.

Herbicides applied as preemergence treatments were IPC, EPTC, CDEC, CDAA, and 1-*n*-butyl-3-(3,4-dichlorophenyl)-1-methylurea [neburon]. Seeding and treating were completed on the same day. At the time of treatment the seedbed was fine, firm, and favorable for herbicidal activity.

Herbicides used as postemergence sprays were IPC, EPTC, and MCPA. They were applied at various stages of development from the time of emergence until March when upright crimson clover growth was beginning. Also, several combination treatments were compared in which herbicides were applied at more than one stage of development.

In 1957, 1959, and 1960, a standard 8-foot grain drill equipped with a legume seed attachment was used to plant the crimson clover. In 1958, a Brillion grass seeder [2] was used.

Since volunteer ryegrass is the major grass problem in crimson clover seed fields, ryegrass seed was planted on the experimental field along with the crimson clover. The plot size was 8 by 28 feet and included three 8-foot drill widths planted perpendicular to the plot. In all experiments a randomized block design was used with either three or four replications. Because of the difficulty in removing wild turnip seed from the crimson clover seed, the experimental area was given a uniform application of MCPA at one-fourth pound per acre each year during December to control the turnip. Where MCPA was included as a specific treatment in the experiment, such plots did not receive the uniform MCPA application.

In the experiments started in 1958, 1959, and 1960, crimson clover yield determinations were made. A strip 2½ by 24 feet was cut from the center of each plot for seed yield determinations. An experimental harvester cut the vegetation, dropped it on a draper, and elevated it into a large pan. The samples were then placed in large burlap hop bags and dried. After drying, the seed was thrashed with a machine designed for small samples of legumes. The seed was then cleaned by means of conventional seed-cleaning equipment.

All herbicides as surface treatments, using water as a carrier, were applied with an experimental sprayer mounted on bicycle wheels. This sprayer was equipped with air supply tanks and a pressure regulator valve for maintaining a constant pressure while spraying. Nozzles with 8004 openings and a spraying pressure of 35 pounds per square inch were utilized to apply 40 gallons of liquid per acre. An experimental positive-feed fertilizer spreader was used to apply granular materials. The blade injector used was a tractor-mounted V-shaped blade 5 feet wide controlled hydraulically from the tractor. Nozzles were fixed at the trailing edge of the blade, and the liquid was sprayed into the soil as the soil was lifted by the blade.

Control of Hairy Vetch and Other Broadleaved Weeds

In the four experiments conducted on the control of hairy vetch and other broadleaved weeds in crimson clover, the cultural methods, equipment, and procedures were similar to those described for grass weed control. In some of the experiments hairy vetch was seeded over the entire plot area as a test species. However, because of the rank, twining growth habit of hairy vetch, it became impossible to take satisfactory crimson clover yield samples where vetch had been planted in the plots. Thus, instead of planting the entire plot area

[2] Mention of a trade product does not imply its endorsement by the U.S. Department of Agriculture over similar products not named.

to hairy vetch, this weed was planted in only one of the three drill widths and control observations were made on this portion of the plot.

Yield determinations were made from the two drill widths where vetch was not seeded. Thus, yield data do not reflect the competitive effect of the hairy vetch. Instead, they measure the effect of the herbicide on the crimson clover and the release from competition of other volunteer broadleaved weeds that are controlled by the herbicides. If vetch is present in the portion of the plot from which clover yield determinations are made, the yields would probably be affected much more by the various degrees of vetch control. Where vetch is not controlled, yields would be much lower.

All herbicides for vetch control were applied as postemergence treatments. Various dates, rates, and herbicides were compared in the four experiments conducted during 1957–60. Applications were made between December 15 and May 1 and included the seedling through the upright growth stages. The herbicides compared in these experiments were MCPA, 4-(2,4-DB), 4-(MCPB), and 2-(2,4-dichlorophenoxy)propionic acid [2-(2,4-DP)].

In the two experiments started in the winter of 1957–58, a randomized block design was used. One experiment had three replications and the other four. In the experiments started in the winter of 1958–59 and of 1959–60, a split-plot design with four replications was used.

No herbicides were applied to control grass weeds in these experiments on the control of broadleaved weeds.

RESULTS

Control of Grass Weeds

Preplanting Treatments

Tables 1 and 2 show the effects of several herbicides, applied as preplanting soil-incorporated treatments, on grass weed control and on crimson clover.

In table 1 are the results of a preliminary experiment started in 1957 in which five herbicides were compared at three rates each. CIPC at 6 pounds per acre gave good weed control. It caused rather pronounced temporary injury to the crimson clover early in the fall, but this injury did not persist. EPTC and IPC at 6 pounds per acre also showed fair to good weed control without any serious injury to the crimson clover. CDEC and CDAA failed to give promising weed control and resulted in rather severe injury to the crimson clover. On May 1 the crimson clover on the untreated check and on treated plots where weed control was ineffective showed severe stand reduction and retarding due to weed competition. Thus, the better chemical treatments were used as a standard in evaluating the treatments, and as a result injury decreased as the rate of application increased in several instances. Actually the higher rate of application produced better weed control and reduced the weed competition.

Results of the second experiment started in 1958 are shown in table 2. CIPC, IPC, and EPTC were compared at four rates each. CIPC at

TABLE 1.—*Effect of various herbicides, as preplanting soil-incorporated treatments, on grass weed control and on crimson clover growth in experiment started in 1957 near Corvallis, Oreg.*

Herbicide (pounds per acre)	Grass weed control [1]		Crimson clover injury [1]	
	Oct. 24, 1957	May 1, 1958	Oct. 24, 1957	May 1, 1958
CIPC:				
2	6	5	5	3
4	7	4	5	3
6	9	8	6	1
CDEC:				
2	2	0	3	8
4	3	0	1	5
6	4	1	3	7
CDAA:				
2	3	1	2	6
4	3	0	2	8
6	3	1	3	7
EPTC:				
2	4	1	2	5
4	6	2	2	4
6	6	5	3	1
IPC:				
2	6	3	3	1
4	6	5	2	0
6	7	5	3	0
Untreated check	0	0	0	7

[1] 0=no visible effect; 10=all plants killed.

TABLE 2.—*Effect of herbicides, as preplanting soil-incorporated treatments, on grass weed control and on crimson clover growth and seed production in experiments started on Sept. 18, 1958, and on Sept. 24, 1959, near Corvallis, Oreg.*

Herbicide and rate (pounds per acre)	Grass weed control [1]	Crimson clover injury [1]		Crimson clover seed per acre
	June 15, 1959	Feb. 3, 1959	June 15, 1959	
1958 experiment				*Pounds*
CIPC:				
2	5	3	0	359
4	6	3	0	418
6	8	4	0	461
8	8	4	0	463
IPC:				
2	2	1	0	342
4	4	3	0	364
6	8	3	0	425
8	8	3	0	382

See footnotes at end of table.

TABLE 2.—*Effect of herbicides, as preplanting soil-incorporated treatments, on grass weed control and on crimson clover growth and seed production in experiments started on Sept. 18, 1958, and on Sept. 24, 1959, near Corvallis, Oreg.*—Continued

Herbicide and rate (pounds per acre)	Grass weed control [1]	Crimson clover injury [1]		Crimson clover seed per acre
	June 15, 1959	Feb. 3, 1959	June 15, 1959	
1958 experiment—Con.				*Pounds*
EPTC:				
2	2	3	0	373
4	4	3	0	386
6	6	4	0	380
8	8	4	0	455
Untreated check				344
L.S.D. at 5-percent level				80
Method and rate of herbicide application (pounds per acre)	**Apr. 22, 1960**	**Oct. 22, 1959**		
1959 experiment				
CIPC:				
Blade incorporated:				
2	4	2		328
4	5	1		309
6	6	3		377
Emulsifiable; surface applied and rotary tilled after treatment:				
4	9	3		829
6	9	5		653
Granular; rotary tiller incorporated:				
4	6	2		517
6	9	5		581
EPTC:				
Blade incorporated:				
2	4	4		460
4	6	2		369
6	7	3		355
Blade incorporated and rotary tilled after treatment:				
2	1	3		350
4	6	3		483
6	7	3		340
Emulsifiable; surface applied and rotary tilled after treatment:				
4	8	2		400
6	8	2		308
Granular; rotary tiller incorporated:				
4	9	2		259
6	10	5		163
Untreated check				416
L.S.D. at 5-percent level				208

[1] 0 = no visible effect; 10 = all plants killed.

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all rates showed fair to good weed control. Crimson clover seed yields were higher than the untreated check at all rates of application. The 6- and 8-pound rates were significantly higher than the check. As in the 1957 experiment, initial injury to the crimson clover was rather severe. However, by harvest the injury symptoms had disappeared and there was no reduction in seed yields. IPC and EPTC gave good weed control at 6 and 8 pounds, but failed to give satisfactory control at 2 and 4 pounds per acre. IPC at 4 pounds and above and EPTC at all rates gave crimson clover seed yields higher than the check. Seed yields were significantly higher than the check when IPC was applied at 6 pounds per acre or EPTC at 8 pounds.

The results of the experiment started in 1959 are also in table 2. Various rates and methods of applying CIPC and EPTC were compared. CIPC applied to the soil surface as either the emulsifiable or granular form and incorporated with a rotary tiller gave a high degree of weed control. The granular form resulted in seed yields slightly above those of the untreated check. The emulsifiable form gave yields significantly higher than the check.

EPTC applied on the surface and tiller incorporated resulted in good to excellent weed control, but seed yields were lower than the check. A significant reduction occurred when the granular form was applied at 6 pounds per acre.

None of the applications with the blade injector were promising. Although weed control was fair to good with these applications, it was not as good as when the herbicides were surface applied and incorporated. Also, the seed yields were generally lower than those of the untreated check. Probably the low temperatures at the time of and following treatment and the depth at which the herbicides were placed in the soil were responsible for the poor results.

In the 1959 experiment, crimson clover treated with EPTC showed rather severe symptoms of northern anthracnose as the plants approached maturity. As reported by Gentner (*3*), EPTC inhibits wax production in certain plants. Since this disease symptom was not noted on plots treated with other herbicides, it is theorized that perhaps the EPTC inhibited wax formation and may have made the clover plants more susceptible to the infection by the northern anthracnose organisms. The reduced seed yields on the EPTC-treated clover plots may have been at least partially due to the severe disease infection.

Preemergence Treatments

Tables 3 and 4 show the effects of herbicides, applied as preemergence treatments, on grass weed control and on crimson clover in experiments started in 1957, 1958, and 1959.

In table 3 are the results when five herbicides were applied in 1957 at three rates each. None of them were satisfactory. EPTC and IPC gave fair weed control, but resulted in moderate injury to the crimson clover. Neburon, CDAA, and CDEC were less effective than EPTC or IPC in controlling weeds and resulted in more injury to the crimson clover.

Table 4 shows the results when IPC and EPTC were applied in 1958 at four rates. Both herbicides showed fair to good weed con-

trol at 4 to 8 pounds per acre without serious injury to the crimson clover. Crimson clover seed yields were higher than the untreated check in all treatments and significantly higher than the check when EPTC was applied at 4 or 6 pounds per acre.

Table 4 also shows the results when IPC and EPTC were applied in 1959 at two rates. IPC showed excellent weed control without noticeable injury to the crimson clover. Seed yields were slightly higher than the check, but not significantly so. EPTC showed fair to good weed control and little visible injury when observations were made on April 22. Seed yields were higher than the check when EPTC was applied at 4 pounds per acre, but lower at 6 pounds. As in the preplanting treatments, the EPTC-treated crimson clover showed rather severe northern anthracnose symptoms as the plants approached maturity.

The results of these preemergence treatments seem to be largely dependent on the weather folowing the application. Where rainfall and cool temperatures followed the treatments, the results were good. When warm, dry conditions followed the treatments, the results were not satisfactory. Since warm, dry conditions frequently occur during late September and early October in western Oregon, probably these treatments would not be effective in some years.

TABLE 3.—*Effect of various herbicides, as preemergence treatments, on grass weed control and on crimson clover growth in experiment started on Sept. 27, 1957, near Corvallis, Oreg.*

Herbicide and rate (pounds per acre)	Grass weed control [1]		Crimson clover injury [1]	
	Oct. 24, 1957	May 1, 1958	Oct. 24, 1957	May 1, 1958
Neburon:				
1	5	3	8	8
2	7	5	10	10
4	7	5	10	10
CDAA:				
2	4	1	2	7
4	5	1	3	6
6	5	4	4	7
CDEC:				
2	5	3	3	7
4	6	3	3	6
6	6	4	3	7
EPTC:				
2	3	0	2	6
4	6	3	3	6
6	6	5	2	6
IPC:				
2	6	4	3	4
4	8	5	3	3
6	8	5	2	5
Untreated check	0	0	0	7

[1] 0 = no visible effect; 10 = all plants killed.

TABLE 4.—*Effect of IPC and EPTC, as preemergence treatments, on grass weed control and on crimson clover growth and seed production in experiments started on Sept. 23, 1958, and on Sept. 24, 1959, near Corvallis, Oreg.*

Herbicide and rate (pounds per acre)	Grass weed control [1]	Crimson clover injury [1]		Crimson clover seed per acre
	June 15, 1959	Feb. 3, 1959	June 15, 1959	
1958 experiment				*Pounds*
IPC:				
2	2	0	0	377
4	5	2	0	360
6	6	3	0	375
8	8	4	0	382
EPTC:				
2	4	2	0	378
4	5	3	0	454
6	5	3	0	435
8	7	3	0	391
Untreated check				344
L.S.D. at 5-percent level				80
	Oct. 22, 1960		Apr. 22, 1960	
1959 experiment				
IPC, emulsifiable:				
4	9		1	566
6	10		1	589
EPTC, granular:				
4	8		2	616
6	6		1	309
Untreated check	0		0	416
L.S.D. at 5-percent level				208

[1] 0=no visible effect; 10=all plants killed.

Postemergence Treatments

Tables 5 and 6 show the effects of herbicides, applied as postemergence treatments, on grass weed control and on crimson clover in experiments started in 1958, 1959, and 1960. The results of the most promising treatments are given.

In 1958, IPC and EPTC were applied at two rates each. As shown in table 5, IPC at both rates gave excellent weed control and resulted in higher seed yields than for the untreated check. The yield at 4 pounds was significantly higher than the check. EPTC failed to control weeds. Seed yields were about equal to the check at the 6-pound rate, but lower at 4 pounds.

TABLE 5.—*Effect of IPC and EPTC, as postemergence treatments, on grass weed control and on crimson clover growth and seed production in experiments started on Sept. 18, 1958, and on Sept. 24, 1959, near Corvallis, Oreg.*

Date and rate of herbicide application (pounds per acre)	Grass weed control [1]	Crimson clover injury [1]		Crimson clover seed per acre
	June 15, 1959	Feb. 3, 1959	June 15, 1959	
1958 experiment				*Pounds*
Dec. 23:				
IPC, emulsifiable:				
4	9	3	0	455
6	10	3	0	392
EPTC, emulsifiable:				
4	2	3	0	284
6	3	3	0	349
Untreated check	0	0	0	344
L.S.D. at 5-percent level				80
1959 experiment	Apr. 22, 1960		Apr. 22, 1960	
Nov. 6:				
IPC, emulsifiable:				
2	5		2	268
4	8		2	573
6	9		2	579
Dec. 16:				
IPC, emulsifiable:				
2	6		2	523
4	8		3	671
6	9		3	657
IPC, wettable powder:				
4	9		3	656
6	8		4	612
Untreated check	0		0	416
L.S.D. at 5-percent level				208

[1] 0=no visible effect; 10=all plants killed.

In 1959 and 1960, as indicated in tables 5 and 6, respectively, and also in other experiments not reported in this bulletin, IPC can be applied over a rather long period of time during the winter months and be effective in controlling weeds. However, IPC was more effective when applied during midwinter than early in the fall. When applications were made between December 1 and February 7, weed control was consistently good in all years and ranged from 80 to 100 percent when 4 or 6 pounds per acre were applied. The seed yield data in tables 5 and 6 show that in all 3 years IPC applied at 4 pounds per acre between December 1 and February 7 resulted in seed yields that were significantly higher than the untreated check.

TABLE 6.—*Effect of IPC and MCPA, as postemergence treatments, on control of grass and broadleaved weeds and on crimson clover growth and seed production in experiment started in 1960 near Corvallis, Oreg.*

Date and rate of herbicide application (pounds per acre)	Control of [1]—		Crimson clover	
	Grass weeds	Broad-leaved weeds	Injury [1]	Seed per acre
Dec. 1, 1960				
IPC: [2]				*Pounds*
Emulsifiable, 4	10	2	0	731
Wettable powder, 4	10	6	0	692
IPC, emulsifiable, 4	10	2	0	682
Dec. 15, 1960				
MCPA, ¼	0	3	0	524
Jan. 10, 1961				
IPC: [2]				
Emulsifiable, 4	10	7	0	688
Wettable powder, 4	10	8	0	803
Feb. 7, 1961				
IPC: [2]				
Emulsifiable, 4	10	8	0	658
Wettable powder, 4	10	9	0	768
Untreated check	0	2	0	550
L.S.D. at 5-percent level				163

[1] May 1, 1961. 0=no visible effect; 10=all plants killed.
[2] MCPA applied at ¼ pound per acre for controlling broadleaved weeds.

CONTROL OF HAIRY VETCH AND OTHER BROADLEAVED WEEDS

Table 7 shows the stages of growth of crimson clover, hairy vetch, and wild turnip at various dates during one growing season. Since development was similar during all years in which these investigations were conducted, this information is presented for only 1 year.

Results of the four experiments on the control of vetch and other broadleaved weeds are shown in tables 8–11. Several herbicides and different rates and dates of application were compared. As shown in table 8, MCPA at one-fourth or one-half pound per acre was ineffective in controlling hairy vetch when applied on December 30 or February 5. However, at all later dates at these rates it showed good to excellent control. At 1 pound per acre excellent vetch control resulted regardless of the date of application.

MCPA caused significant reductions in crimson clover seed yields when applied at one-fourth pound per acre on March 27 or April 25, at one-half pound on March 11, 27, and April 25, and at 1 pound on all dates of application except February 5.

MCPA at one-fourth, one-half, or 1 pound per acre gave satisfactory control of wild turnip or wild radish at all dates of application prior to

TABLE 7.—*Stages of growth of crimson clover, hairy vetch, and wild turnip at various dates of applying MCPA near Corvallis, Oreg., from December 1958 to April 1959*

Date	Height	Diameter	Growth habit	Rate of growth	Remarks
		CRIMSON CLOVER			
	Inches	*Inches*			
Dec. 30	1–1½	2–4	Rosette	Slow	Plants have 15–20 leaves.
Feb. 3	1–1½	2–5	do	do	Well stooled.
Feb. 12	1–2	3–5	do	do	Do.
Mar. 2	2	5–6	do	Moderate	Many leaf buds appearing at crown. Evident that upright growth about to begin.
Mar. 16	4–6	6–7	Erect	Rapid	Stems on which seed will form being produced.
Apr. 2	6–8	7	do	Very rapid	Approaching early bud stage.
		HAIRY VETCH			
Dec. 30	2–3	10–12	Prostrate	Slow	Branches lying on ground.
Feb. 3	3	10–12	do	do	Well stooled, branches still lying on ground.
Feb. 12	4	10–20	do	Moderate	Do.
Mar. 2	4–6	10–20	Branches becoming erect.	Rapid	
Mar. 16	6–10	15–30	Erect	do	Beginning to form canopy over clover.
Apr. 2	12 or more	25 or more	do	Very rapid	Complete canopy over clover.
		WILD TURNIP			
Dec. 30	6	12	Rosette	Rapid	
Feb. 3	12–14	12	Bolting	Very rapid	
Feb. 12	12–20	12	Bud	do	
Mar. 2	12–34	12	Flowering	Rapid	
Mar. 16	18–40	12	do	do	
Apr. 2	35–50	12	Seed being formed	Little growth	

TABLE 8.—*Comparison of several herbicides and dates and rates of application for control of hairy vetch and other broadleaved weeds and for effect on crimson clover growth and seed production near Corvallis, Oreg., 1957–58*

Date and rate of herbicide application (pounds per acre)	Control of [1]—				Crimson clover	
	Wild turnip	Wild radish	Dog-fennel	Hairy vetch	Injury [1]	Seed per acre
Dec. 30, 1957						*Pounds*
MCPA:						
¼	10	7	2	0	2	219
½	10	10	2	7	2	194
1	10	10	2	10	6	110
4-(2, 4-DB):						
1	10	9	4	5	1	225
2	10	10	4	4	2	154
2-(2,4-DP) + MCPA, ¼	10	10	1	7	5	125
4-(2,4-DB) + MCPA, ¼	10	10	2	5	3	154
4-(MCPB) + MCPA, ¼	10	10	1	7	3	190
Feb. 5, 1958						
MCPA:						
¼	10	10	3	3	1	194
½	10	10	3	4	2	147
1	10	10	3	10	5	167
Feb. 28, 1958						
MCPA:						
¼	10	10	1	10	2	193
½	8	8	3	10	4	146
1	10	10	4	10	6	107
Mar. 11, 1958						
MCPA:						
¼	10	10	1	9	1	204
½	9	9	2	10	3	101
1	10	10	4	10	6	54
Mar. 27, 1958						
MCPA:						
¼	3	3	1	6	3	69
½	7	5	1	10	2	108
1	8	8	3	10	2	109
Apr. 25, 1958						
MCPA:						
¼	1	1	1	10	5	109
½	4	4	5	10	6	48
1	4	4	8	10	8	22
Untreated check	0	0	0	0	0	208
L.S.D. at 5-percent level						68

[1] June 12, 1958. 0 = no visible effect; 10 = all plants killed.

seed-head formation. After the seed heads had developed, the plants were increasingly difficult to control, and even though formative effects were noted on the plants, the seed was matured. The other herbicides compared in this experiment were no more effective than MCPA. Since the rates of application needed to get results comparable to MCPA were generally higher than required for MCPA, this herbicide was considered the most promising and the other chemicals were not included in later work.

Table 9 shows the results of applying MCPA at various rates on March 26 and April 10 and 30, 1958. At all rates and dates of application it caused reductions in crimson clover seed yields. These reductions were significant when the applications were made on March 26 or April 30. The results of this experiment agree with those of the preceding experiment (table 8), where all rates of MCPA showed yield reductions when the applications were made after late March.

Table 10 shows the results of applying MCPA at several rates and dates in 1958–59. These results closely resembled those of the previous experiments in 1957–58. When MCPA was applied in December, none of the rates gave satisfactory vetch control. When applications were made in February, control was much improved, but the rates needed for satisfactory vetch control were higher than can safely be used on crimson clover. When the treatments were delayed until the first half of March, excellent vetch control resulted from rates of application that have not shown injurious effects on the clover.

TABLE 9.—*Effect of dates and rates of applying MCPA on control of hairy vetch and on crimson clover growth and seed production at McMinnville, Oreg., 1957–58*

Date and rate of MCPA application (pounds per acre)	Hairy vetch control [1]	Crimson clover	
		Injury [1]	Seed per acre
Mar. 26, 1958			*Pounds*
1/8	8	0	167
1/4	10	1	229
3/8	10	3	167
1/2	10	2	202
Apr. 10, 1958			
1/8	10	1	369
1/4	10	2	367
3/8	10	2	401
1/2	10	1	379
Apr. 30, 1958			
1/8	10	1	295
1/4	10	3	177
3/8	10	4	108
1/2	10	5	54
Untreated check	0	0	435
L.S.D. at 5-percent level			81

[1] June 5, 1958. 0 = no visible effect; 10 = all plants killed.

Figures 1 and 2 show crimson clover that was treated on March 2 and 16, 1959, with MCPA at one-fourth pound per acre. When the treatment was delayed until April 2, MCPA caused rather pronounced formative effects on the clover.

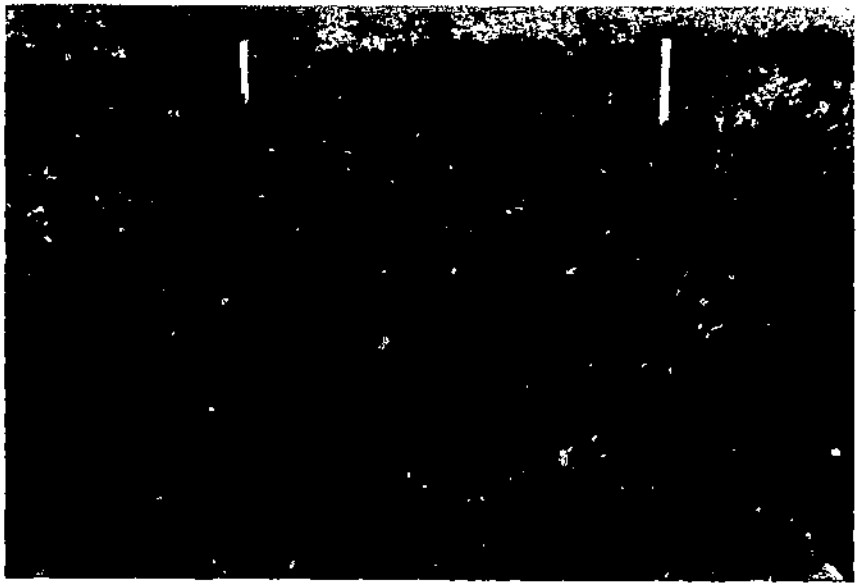

FIGURE 1.—Crimson clover in foreground treated March 2, 1959, with MCPA at one-fourth pound per acre for control of hairy vetch. Picture taken May 15, 1959.

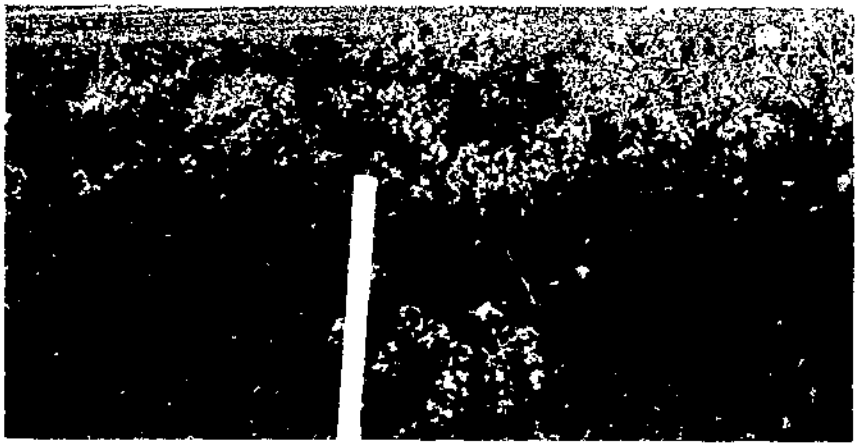

FIGURE 2.—Crimson clover: Left, treated March 16, 1959, with MCPA at one-fourth pound per acre for control of hairy vetch. Right, untreated; note abundance of wild turnip, wild radish, and hairy vetch. Picture taken May 15, 1959.

TABLE 10.—*Effect of dates and rates of applying MCPA on control of wild turnip and hairy vetch and on crimson clover growth near Corvallis, Oreg., 1958–59*

Date and rate of MCPA application (pounds per acre)	Control of [1]—		Crimson clover injury [1]
	Wild turnip	Hairy vetch	
Dec. 30, 1958			
1/8	7	1	0
1/4	7	2	0
3/8	10	4	1
1/2	10	5	1
Feb. 3, 1959			
1/8	10	4	0
1/4	10	6	0
3/8	10	8	0
1/2	10	9	0
Feb. 12, 1959			
1/8	10	4	0
1/4	10	5	0
3/8	10	7	0
1/2	10	8	0
Mar. 2, 1959			
1/8	7	6	0
1/4	8	9	0
3/8	9	10	0
1/2	10	10	0
Mar. 16, 1959			
1/8	6	4	0
1/4	8	7	0
3/8	8	9	0
1/2	9	9	0
Apr. 2, 1959			
1/8	1	9	2
1/4	6	10	4
3/8	8	10	4
1/2	8	10	5

[1] May 19, 1959. 0 = no visible effect; 10 = all plants killed.

Table 11 shows the results of applying MCPA at various rates and dates in 1959–60. As in the previous experiments, vetch control was much better when the treatment was delayed until early March. On this date one-fourth pound per acre of MCPA was sufficient to give nearly complete control. As in the previous experiments, the crimson clover seed yields were not reduced, as compared to the untreated check, at rates of application satisfactory for good vetch control. Unlike the previous experiments, seed yields were not reduced by treatments made on April 5. However, since severe yield reductions had occurred in 1957–59 at this date, it is likely that yield reductions could be expected in some years from the treatments made after late March.

TABLE 11.—*Effect of dates and rates of applying MCPA on control of hairy vetch and on crimson clover growth and seed production near Corvallis, Oreg., 1959–60*

Date and rate of MPCA application (pounds per acre)	Hairy vetch control [1]	Crimson clover	
		Injury [1]	Seed per acre
Dec. 16, 1959			*Pounds*
0	0	0	203
1/4	3	0	215
3/8	5	0	297
1/2	5	0	245
Feb. 10, 1960			
0	0	0	283
1/4	7	2	333
3/8	8	2	210
1/2	9	3	237
Mar. 1, 1960			
0	0	0	180
1/4	7	1	240
3/8	7	2	202
1/2	8	2	217
Mar. 16, 1960			
0	0	0	222
1/4	10	4	293
3/8	10	5	346
1/2	10	6	229
Apr. 5, 1960			
0	0	0	222
1/4	10	5	280
3/8	10	5	282
1/2	10	6	327
L.S.D. for date at 5-percent level			57.08
L.S.D. for rate at 5-percent level			39.88

[1] Apr. 25, 1960. 0 = no visible effect; 10 = all plants killed.

DISCUSSION

Based on all grass weed control experiments during 1957–61, the midwinter postemergence IPC treatments gave slightly better weed control and were more consistent in increasing crimson clover seed yields than were the preplanting soil-incorporated treatments. Typical results of these two treatments are seen in figure 3. For comparison, figure 4 shows an untreated plot.

Other advantages of the midwinter postemergence IPC treatments over the preplanting soil-incorporated treatments were as follows: (1) They can be applied during the winter at a time when most operators have few demands on their time, whereas the preplanting soil-incorporated treatments must be applied and incorporated immediately, thereby demanding equipment and manpower during a rush period. (2) They permit a grower to see the weed problem

before treating and thus give an incentive to treat if a weed problem is present. This is not the case when the treatment is made at seeding time. Where the crop is grown on soil free of weeds, treatment may not be needed. (3) They avoid the injury and retarded growth of the crimson clover in early fall and winter, which follow

FIGURE 3.—Crimson clover: Left, treated with postemergence application of IPC at 4 pounds per acre December 23, 1958; right, treated with preplanting soil-incorporated application of IPC at 2 pounds per acre. Broadleaved weeds controlled with December application of MCPA at one-fourth pound per acre. Picture taken May 15, 1959.

FIGURE 4.—Untreated check plot in crimson clover seed field used for grass weed control experiments in 1958 and 1959. Note crimson clover seed heads in foreground. Experimental field sprayed with MCPA at one-fourth pound per acre during December for broadleaved weed control. Picture taken May 15, 1959, about 5 weeks before harvest.

preplanting or preemergence treatment. This makes the clover less susceptible to winter injury. (4) At the present price of herbicides, the midwinter IPC treatments would be somewhat cheaper than either the EPTC or CIPC treatment.

During the 3 years that IPC was applied at 4 pounds per acre as a postemergence treatment, seed yields were increased about 200 pounds per acre. The average price paid to growers during this same period was 18.8 cents per pound. The average gross return on the increased seed yield would have amounted to about $37.60 per acre. The cost of the chemical and application was approximately $10 per acre. Thus the increased return to the grower was about $27.60 per acre. The postemergence IPC treatment not only gave excellent control of weed grasses in crimson clover but resulted in a substantially increased income for the grower.

SUMMARY

During 1957–61 nine experiments were conducted in western Oregon on controlling weeds in crimson clover (*Trifolium incarnatum* L.) grown for seed production. Five experiments dealt primarily with herbicides that were effective in controlling grass weeds and four experiments with herbicides that were effective for broadleaved weed control.

In the research on grass weed control, several herbicides were compared at different rates when applied at preplanting, preemergence, and several postemergence stages of plant development. CIPC and EPTC each at 6 pounds per acre as preplanting soil-incorporated treatments and IPC at 4 pounds per acre as a midwinter postemergence treatment were the most promising in these investigations. The midwinter postemergence IPC treatments showed slightly better weed control and were more consistent in increasing crimson clover seed yields than were the preplanting soil-incorporated treatments.

During the 3 years that IPC was applied at 4 pounds per acre as a postemergence treatment, seed yields were increased about 200 pounds per acre. The average price paid to growers during this same period was 18.8 cents per pound. The average gross return on the increased seed yield would have amounted to about $37.60 per acre. The cost of the chemical and application was about $10 per acre. Thus the increased return to the grower was about $27.60 per acre.

In the research on control of hairy vetch (*Vicia villosa* Roth) and other broadleaved weeds in crimson clover, various herbicides were compared at different rates when applied at several postemergence stages of development. MCPA at rates tolerated by crimson clover gave the best overall weed control without reducing crimson clover seed yields. Rate of application and stage of development of both the crimson clover and the hairy vetch at the time of treatment were very critical in determining the degree of weed control and the effect of the herbicide on crop seed yields.

Crimson clover tolerated higher rates of MCPA without reduction in seed yield when the applications were made in December or February while the clover was in the rosette stage of growth. However, hairy vetch also tolerated these higher rates of MCPA during this early stage and control was poor. Hairy vetch became increasingly

sensitive to MCPA as the season progressed. Best vetch control without clover seed yield reductions was obtained when MCPA was applied at one-fourth pound per acre between February 25 and March 15. Treatments made after March 15 gave excellent vetch control, but the likelihood of seed yield reductions increased as the clover approached the bud stage.

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