CHEMICAL WEED CONTROL AND WEED COMPETITION IN ESTABLISHING ALFALFA

By

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CHEMICAL WEED CONTROL AND WEED COMPETITION

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CHAPTER I

INTRODUCTION

Alfalfa is an herbaceous perennial legume that may live 15 to 20 years, depending on the cultural practices employed and the character of the soil. The plant has a fleshy crown that produces several stems that continue to arise from this crown after each harvest. The taproot of alfalfa may penetrate the soil to a depth of 10 meters or more under favorable conditions (4,9,15,26). In Oklahoma, alfalfa occupies some 260,000 hectares with an average annual forage production of 6700 kilograms per hectare (4).

In the past it was common for producers to use forage legumes in a rotational system with other crops. In more recent years, farmers have tended to use continuous cropping, but due to the increased cost of nitrogen fertilizers, legumes may become more popular (15,31). According to Schreiber (42), many producers have been reluctant to plow up old fields of legumes at the proper time because of the cost of reestablishment and the possibilities of seeding failures.

The first step in a satisfactory forage-legume program is the establighment of the legume. Success or failure here can mean the difference between a continued efficient rotation system and a financial loss. In Oklahoma, alfalfa is more commonly planted in the fall than in the spring. This is due to the combined effects of early summer drought and competition from vigorous annual weeds associated with spring plantings. One method of weed control in alfalfa is the use of companion crops, such as wheat or oats (common and scientific names of plant species are given in Table 1). Companion crops do suppress weeds, but are also serious competitors for moisture, nutrients, and sunlight needed for optimum development of alfalfa seedlings (15,41,42, 45). Another method of controlling weeds is the use of chemical herbcicdes. By the use of selective herbicides, it has been possible to obtain satisfactory stands of alfalfa from spring plantings with substantial forage production in the year of establishment.

There has been some preliminary evaluation of herbicides for establishment of alfalfa in Oklahoma. However, very little data on plant populations and the effects of cool season weed competition was taken in these past studies. Also there are some newer herbicides that could have more tolerance by alfalfa and possibly better weed control than some of the herbicides now labeled for use in Oklahoma. The objectives of this research were: (1) to evaluate the selectivity of several herbicides to seedling alfalfa, (2) to determine how effective these herbicides are in controlling weeds, and (3) to determine the competitive effects of weeds on seedling stands of alfalfa.

Table 1. Common and scientific names of plants.

Common name	Scientific name
Alfalfa	*Medicago sativa* L.
Annual bluegrass	*Poa annua* L.
Annual sunflower	*Helianthus annuus* L.
Barnyardgrass	*Echinochloa crus-galli* (L.) Beauv.
Blackeyedsusan	*Rudbeckia serotina* Nutt.
Cheat	*Bromus secalinus* L.
Common lambsquarters	*Chenopodium album* L.
Common ragweed	*Ambrosia artemisiifolia* L.
Crabgrass	*Digitaria* spp.
Cutleaf eveningprimrose	*Oenothera biennis* L.
Downy brome	*Bromus tectorum* L.
Giant foxtail	*Setaria faberi* Herrm.
Giant ragweed	*Ambrosia trifida* L.
Greenflower pepperweed	*Lepidium densiflorum* Schrad.
Henbit	*Lamium amplexicaule* L.
Johnsongrass	*Sorghum halepense* (L.) Pers.
Oats	*Avena sativa* L.
Pennsylvania smartweed	*Polygonum pensylvanicum* L.
Pigweed	*Amaranthus* spp.
Quackgrass	*Agropyron repens* (L.) Beauv.
Shepherdspurse	*Capella bursa-pastoris* (L.) Medic.
Tansy mustard	*Descurainia pinnata* (Walt.) Britt.
Texas panicum	*Panicum texanum* Buckl.
Treacle mustard	*Erysimum repandum* L.
Wheat	*Triticum aestivum* L.
White clover	*Trifolium repens* L.
Yellow foxtail	*Setaria lutescens* (Weigel) Hubb.

CHAPTER II

LITERATURE REVIEW

Weed Competition in Alfalfa

Seeds of alfalfa and other small seeded legumes often readily germinate, but the seedlings are not very competitive (15,28,41). As a result, they are very vulnerable to weed competition during establishment. Weeds can reduce seedling stands, yield, and quality of alfalfa hay. Weed competition has been reported to reduce root, crown, and shoot growth of alfalfa seedlings (14,42,46). Gist and Mott (14) report that much of this reduction of shoot and root growth was due to shading by the weeds. Root growth was affected more than shoot growth by decreasing light intensity. Larger alfalfa plants have a better chance for winter survival, but root size may not be the only factor in survival. Schreiber (42) reported that where weeds were controlled, alfalfa plants had significantly greater regrowth and this additional growth should provide more reserve materials in the roots. Several reports (7,15,22,28,29,33,42,46) have indicated that where chemical herbicides effectively controlled weeds, increased stands and yields of alfalfa were obtained in the seeding year. Kerkin and Peters (21) were able to more than triple alfalfa yields in the year of establishment by reducing weed competition. Peters (33) reported an increase of 450 kilograms of forage per hectare annually where herbicides effectively controlled weeds. Weeds not only reduce alfalfa production, but they can also reduce the protein content of alfalfa hay (8).

Chemical Weed Control

EPTC

Preplant incorporated herbicide treatments have generally been less damaging to alfalfa than preemergence and postemergence treatments (7). EPTC (common and chemical names of herbicides are listed in Table 2) usually controls weedy grasses better than broadleaf weeds in alfalfa (6,15,17,21,22,33,36,39). Hull and Wakefield (19) and Peters and Yokum (39) found that EPTC provided good grass control but did not control pigweed or common lambsquarters. Peters (33), from Missouri, reported similar results using EPTC, with excellent control of crabgrass and barnyardgrass but poor control of common ragweed in seedling alfalfa. Strand et al. (44), reporting from Minnesota, in 1974 found that EPTC at 3.36 kg/ha gave good broadleaf weed control but in 1975 (45) the same rate gave only fair control (78%) of common lambsquarters and poor control (48%) of pigweed. Elder (10) in 1957 and Harvey (16) and Peters and Lowance (36) in 1972 reported excellent broadleaf weed control with no injury to alfalfa from 3.36 kg/ha of EPTC.

Benefin

Preplant incorporated treatments of benefin have provided good grass control but have shown weaknesses in controlling specific broadleaf weeds (15). Harvey (16) and Strand et al. (44) reported

Table 2. Common and chemical names of herbicides.

Common name	Chemical name
Benefin	N-butyl-N-ethyl-a,a,a-trifluoro-2,6-dinitro-p-toluidine
Butralin	4-(1,1-dimethylethyl)-N-(1-methylpropyl)-2,6-dinitrobenzenamine
Dinoseb	2-sec-butyl-4,6-dinitrophenol
EPTC	S-ethyl dipropylthiocarbamate
Fluchloralin	N-(2-chloroethyl)-2,6-dinitro-N-propyl-4(trifluoromethyl) aniline
Pendimethalin	N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine
Profluralin	N-(cyclopropylmethyl)-a,a,a-trifluoro-2,6-dinitro-N-propyl-p-toluidine
Pronamide	3,5-dichloro(N-1,1-dimethyl-2-propynl)benzamide

excellent control of giant foxtail and good control of pigweed using 1.12 kg/ha of benefin with no injury to seedling alfalfa. Peek et al. (32) in 1974 and Mason and Santelmann (27) in 1976 reported good control of pigweed, but Peek found benefin failed to control common lambsquarters. Felton and Gleeson (13) reported good henbit control but poor control of shepherdspurse. Buchanan and Burns (6) and Peters and Lowance (35,36) found good control of crabgrass and giant foxtail but poor control of common ragweed using 1.12 kg/ha of benefin with no injury to seedling alfalfa. Cope et al. (7) reported that 1.12 kg/ha of benefin significantly reduced alfalfa stand and vigor in seedling alfalfa.

Butralin

Butralin has generally provided good weed control in seedling alfalfa. Harvey (16) and Strand et al. (44,45) reported that butralin exhibited good control of giant foxtail and common lambsquarters in seedling alfalfa when applied preplant incorporated, but when applied preemergence butralin failed to control both of these weed species (44). Mason and Santelmann (27), reporting from Oklahoma, found that butralin at 1.12, 1.68, and 2.24 kg/ha was effective in controlling pigweed in seedling alfalfa with little or no injury to alfalfa. Peters (37) found excellent crabgrass control and no alfalfa injury with 1.7 kg/ha of butralin. Murray and Santelmann (30), from Oklahoma, reported good control of Texas panicum and barnyardgrass with butralin.

Fluchloralin

Reports have varied concerning weed control with fluchloralin in seedling alfalfa. Behrens et al. (2), from Minnesota, reported that preplant incorporated treatments of fluchloralin at 0.84 kg/ha provided good control of giant foxtail, common lambsquarters, and pigweed in seedling alfalfa with only slight damage to the alfalfa. Strand et al. (43), reporting from Minnesota, found that 4.48 kg/ha of fluchloralin applied preplant incorporated failed to control quackgrass but gave good early season control of broadleaf weeds in alfalfa. Strand also reported some injury to alfalfa with fluchloralin at this rate. Fawcett and Harvey (12) reported good control of lambsquarters and giant foxtail but poor control of common ragweed and shepherdspurse with 1.1 kg/ha of fluchloralin.

Pendimethalin

Preplant incorporated treatments of pendimethalin have been shown to effectively control weeds and increase alfalfa yields in the year of establishment (25). Studies indicate that preemergence applications of pendimethalin at 2.24 kg/ha are excessively injurious to seedling alfalfa (3,40,43). Mason and Santelmann (27), from Oklahoma, and Behrens et al. (2), from Minnesota, reported good pigweed control with pendimethalin in alfalfa. Behrens reported good control of giant and yellow foxtail, while Strand et al. (43) found poor control of quackgrass with 2.24 kg/ha of pendimethalin with little injury to alfalfa.

Profluralin

In general, treatments of profluralin have resulted in good weed control in seedling alfalfa. Peek et al. (32), Strand et al. (45), and Mason and Santelmann (27) reported good control of pigweed and common lambsquarters and no alfalfa injury with 1.12 kg/ha of profluralin. Peek also found good control of barnyardgrass and giant and yellow foxtail with profluralin. Peters (38) reported good early season crabgrass control and significant increases in alfalfa yield where 1.1 kg/ha of profluralin was applied. Reports by Harvey and Jansen (17), from Wisconsin, and Behrens et al. (3), from Minnesota, indicate good control of giant foxtail and pigweed with no alfalfa reduction from 1.12 kg/ha of profluralin. Fawcett and Harvey (12), reporting from Wisconsin, found good control of giant foxtail but poor control of common ragweed and shepherdspurse with an application of 1.1 kg/ha of profluralin.

Pronamide

Pronamide has been demonstrated to control weedy grasses in seedling alfalfa stands but has generally resulted in poor broadleaf weed control. Walker et al. (47), from Ohio, in 1974 and Humburg and Alley (20), from Wyoming, in 1979 reported excellent control of orchardgrass and downey brome, respectively, and subsequent increases in alfalfa yields from treatments of 0.84 and 1.12 kg/ha of pronamide. Lee (23), reporting from Oregon, stated that pronamide resulted in 90 to 100 percent control of annual bluegrass, but only 3 to 14 percent control of annual sowthistle in white clover seedings. Cope et al. (7) reported poor control of henbit and pepperweed and no alfalfa injury with pronamide. Harvey and Jansen (18) found that 0.84 kg/ha of pronamide failed to control common lambsquarters and did not damage seedling alfalfa.

Dinoseb

Dinoseb (alkanolamine salt) applied postemergence has been effective in reducing weed competition and thereby increasing legume production (15,24). Some studies (7,18,41) have indicated severe defoliation and stand loss of alfalfa from 0.84 and 1.68 kg/ha of both the phenol and alkanolamine salt formulations of dinoseb. Peters and Yokum (39) found dinoseb, the alkanolamine salt, effective for the control of common lambsquarters in alfalfa. Arnold and Santelmann (1) reported that treatments of dinoseb at 1.68 and 3.36 kg/ha provided fair control of henbit when used as a December treatment, but later treatments were not as effective. Cope et al. (7), from North Carolina, reported that 1.7 kg/ha of the phenol formulation of dinoseb provided almost complete control of henbit but resulted in some early damage to seedling alfalfa.

CHAPTER III

METHODS AND MATERIALS

Five field studies in 1978 and 1979 were initiated at two locations to establish alfalfa with herbicides and to determine the effects of weed competition on seedling stands of alfalfa. Four studies, planted in the fall of 1978, were located at the Lake Carl Blackwell Research Area, Payne County, Oklahoma. Of these studies, one resulted in an infestation of henbit and mustards and will be referred to as Field Study I. Shepherdspurse was the dominant weed species in another study, which will be referred to as Field Study II. Cheat was overseeded on Field Study III to evaluate competition between a winter annual grass and seedling alfalfa. In Field Study IV, different formulations, rates, and times of applications of dinoseb were evaluated. In addition to these studies, a fifth experiment (Field Study V), utilizing preplant incorporated herbicides for spring alfalfa establishment, was initiated in 1979 at the Eastern Research Station, Muskogee County, Oklahoma. The study areas were fertilized and limed to meet soil test recommendations. A randomized complete block statistical design with four replications was used in each experiment. Plot size was 2.13 x 6.1 m in all experiments except in Field Study V where plot size was 2.13 x 7.62 m. All experimental data was subjected to statistical analysis and F tests at the .05% level of significance were used to compare treatment effects. When the F tests were significant, the least significant difference at the .05% level of significance were used to compare treatment effects.

Fall Establishment Studies

Field Studies I, II, and III were conducted on a Port loam soil. Preplant incorporated herbicides were applied to these studies on September 23, 1978, with a compressed air tractor sprayer at 2.5 ksc and 262 l/ha carrier volume (see Table 3 for treatments). Air temperature was 23 C and relative humidity was 62%. Soil temperature was 19 C and soil moisture was good for incorporation. Precipitation is given in Table 4. Incorporation of the herbicides was accomplished by discing twice with a tandem disc. A mulch treader was used to prepare a seedbed for planting alfalfa. Alfalfa, cultivar, 'Arc', was planted on September 25, 1978, at a rate of 22.4 kg/ha with a Brillion seeder. The incorporation process caused a loss in soil moisture, and the alfalfa did not germinate until after the rainfall received on October 8, 1978 (Table 4).

Field Study I

At time of planting, greenflower pepperweed seed was overseeded at rates of 0, 1.4, 2.8, 5.6, and 11.2 kg/ha on plots with no herbicide treatments. These various rates were used to establish a variable in the competition levels between pepperweed and alfalfa. In addition to these treatments, the highest seeding rate (11.2 kg/ha) of greenflower pepperweed was overseeded on the herbicide treated plots. On December 12, 1978, plant counts were taken from two 15.2 x 91.4 cm quadrats randomly selected in each plot. Plant counts were taken in

Table 3. Herbicide treatments and application rates.

Herbicide	Treatment	Rate (kg/ha)
Benefin 1/	PPI 4/	1.12, 1.68
Butralin 1/	"	1.12
EPTC 1/	"	1.12, 3.36
Fluchloralin 1/	"	1.12
Pendimethalin 1/	"	1.12
Profluralin 1/	"	1.12
Pronamide 2/	Post 5/	1.12
Dinoseb (alkanolamine salt) 3/	"	0.84, 1.68
Dinoseb (dinitrophenol) 3/	"	0.84, 1.68

1/ Herbicides applied to Field Studies I, II, III, and V

2/ Herbicide applied to Field Study III

3/ Dinoseb formulations applied to Field Study IV

4/ Preplant incorporated treatments

5/ Postemergence treatments

Table 4. Rainfall data from September, 1978, through July, 1979.

		Lake Carl Blackwell			
Date	Centimeters	Date	Centimeters	Date	Centimeters
1978		1979			
Sept. 10	0.05	Jan. 5	0.25	April 1	0.25
Sept. 13	1.83	Jan. 10	0.05	April 3	1.04
Sept. 20	1.04	Jan. 13	0.28	April 18	0.51
Sept. 21	0.43	Jan. 20	2.34	April 21	0.25
Oct. 8	4.22	Jan. 23	0.36	April 27	0.28
Oct. 22	0.91	Jan. 25	0.20	April 28	0.28
Nov. 5	0.18	Jan. 26	0.13	May 2	6.10
Nov. 6	2.01	Jan. 29	0.15	May 3	2.59
Nov. 12	0.38	Jan. 30	0.13	May 18	0.41
Nov. 13	0.08	Feb. 6	0.64	May 21	2.01
Nov. 14	7.87	Feb. 14	0.05	May 28	0.53
Nov. 15	0.69	Feb. 20	0.10	June 8	1.60
Nov. 16	0.33	Feb. 28	0.18	June 9	4.75
Nov. 20	0.10	March 2	1.32	June 22	1.47
Nov. 22	0.41	March 10	3.71	June 24	1.14
Nov. 25	0.27	March 11	0.10	June 28	0.15
Nov. 26	0.30	March 17	0.25	July 5	3.38
Dec. 8	0.05	March 18	1.55	July 17	6.73
Dec. 30	0.13	March 19	0.08	July 25	0.30
Dec. 31	0.84	March 22	4.06	July 30	0.46
		March 23	0.23	July 31	0.81

Table 4. (Continued).

	Eastern Research Station		
Date	Centimeters	Date	Centimeters
1979			
Feb. 7	0.81	May 4	0.33
Feb. 22	1.04	May 10	3.25
Feb. 23	1.12	May 21	0.69
Feb. 24	0.05	May 22	0.84
Feb. 28	0.25	May 27	5.77
March 4	1.50	June 6	0.38
March 18	1.52	June 7	2.16
March 20	1.57	June 9	7.90
March 22	0.64	June 21	0.46
April 1	1.27	June 22	0.81
April 8	0.36	June 23	3.15
April 11	6.60	June 24	0.89
April 18	1.83	July 6	2.30
April 20	0.30	July 7	0.76
April 28	0.25	July 17	0.13
May 1	1.27	July 18	0.99
May 2	3.05	July 31	1.63
May 3	6.60		

the same manner from four 15.2 x 91.4 cm quadrats on June 13 and December 20, 1979. Forage production was estimated by hand clipping two 45.7 x 91.4 cm quadrats randomly selected from each plot on May 17 and July 24, 1979. These clippings were dried and weighed to determine dry matter production.

Field Study II

No weed seeds were overseeded on any of the plots in this experiment. Plant counts were taken December 20, 1978, from two 15.2 x 91.4 cm quadrats which were randomly selected from each plot. On June 13 and December 20, 1979, four 15.2 x 91.4 cm quadrats were used for taking plant counts. Harvesting on May 25 and July 24, 1979, was accomplished by clipping two 45.7 x 91.4 cm quadrats from randomly selected areas in each plot. Dry matter forage production was determined from these clippings.

Field Study III

At time of planting, cheat seed was overseeded at rates of 0, 4.2, 8.4, 16.8, and 33.6 kg/ha on plots with no herbicide treatments. These seeding rates of cheat were used to establish a variable in the competition levels between cheat and alfalfa. In addition to these cheat treatments, the highest seeding rate (33.6 kg/ha) of cheat was overseeded on the herbicide treated plots. On December 12, 1978, plant counts were taken from two 15.2 x 91.4 cm quadrats randomly selected in each plot. In addition to the preplant incorporated treatments a postemergence application of pronamide was applied on December 21, 1978 (Table 3). At this time alfalfa was in the third trifoliolate leaf stage, and cheat was 12 to 15 cm tall. Four 15.2 x 91.4 cm quadrats were used for taking plant counts on June 13 and November 15, 1979. Forage production was estimated by clipping two 45.7 x 91.4 cm quadrats randomly selected from each plot on May 24 and July 24, 1979. The alfalfa and cheat were hand separated, dried, and weighed to determine dry matter production of each component.

Dinoseb Study

Field Study IV

The study was conducted on a Port loam soil. The experimental area was disced twice with an offset disc. A mulch treader was used to prepare a seedbed for planting alfalfa. On September 23, 1978, alfalfa, cultivar 'Cody', was planted at a rate of 20.2 kg/ha with a Brillion seeder. Two formulations of dinoseb (alkanolamine salt and dinitrophenol) were applied postemergence on December 1, 1978, and March 7, 1979, at 0.84 and 1.68 kg/ha (Table 3). Alfalfa was in the third trifoliolate leaf stage, henbit was 5 cm tall, and mustards were in the rosette stage in December. In March, alfalfa was in the fourth trifoliolate leaf stage, henbit was 7 cm tall, and mustards were still in the rosette stage. Treatments were applied with a carbon dioxide sprayer at 2.1 ksc and a carrier volume of 234 l/ha. Air temperature on December 1, 1978 was 16 C and relative humidity was 64%. Soil temperature was 8 C and soil moisture was good. When treatments were applied in March, air temperature was 12 C, relative humidity was 54%, and soil temperature was 9 C. Plant counts were taken from two 15.2 x 91.4 cm quadrats randomly selected in each plot on December 20, 1978.

On June 8 and December 21, 1979, plant counts were taken from four 15.2 x 91.4 cm quadrats. Harvesting was accomplished by clipping two 45.7 x 91.4 cm quadrats randomly selected from each plot on May 16 and July 23, 1979. These clippings were dried and weighed to determine dry matter production.

Spring Establishment Study

Field Study V

The experiment was conducted on a Taloka silt soil. Herbicide treatments were applied on March 15, 1979, with a carbon dioxide sprayer at 2.1 ksc and 234 l/ha carrier volume (see Table 3 for listing of treatments). Air temperature was 18 C and relative humidity was 27% at time of treatment. Soil temperature was 9 C and soil moisture was good for incorporation. Herbicides were incorporated by discing twice with a tandem disc. A harrow was used to prepare a seedbed for planting alfalfa. Alfalfa, cultivar 'Kanza', was planted with a Brillion seeder at a rate of 22.4 kg/ha on March 15, 1979. Although the incorporation process caused a loss in soil moisture, alfalfa germination and emergence was not impeded because of the rainfall received on March 18, 20, and 22, 1979 (Table 4). Visual ratings of percent composition were taken just before harvesting on June 11 and July 16, 1979. A Jari mower was used to harvest the plots on both harvest dates. An area of 1.0 x 6.6 m was harvested from each plot. Clipping weights were obtained in the field and samples were taken to determine dry matter production.

CHAPTER IV

RESULTS AND DISCUSSION

Fall Establishment Studies

Field Study I

Plant counts were taken at various times and the resulting plant populations are given in Table 5. Greenflower pepperweed was overseeded on the plots, but because of poor emergence no data was obtained for this species. On December 12, 1978, there was a light infestation of tansy and treacle mustards (13 plants/m^2) and a moderate infestation of henbit (31 plants/m^2) in the control plots. Mustard plants were controlled by the treatment of EPTC. All herbicide treatments, except butralin, significantly reduced henbit populations. A decrease in alfalfa populations was noted as the season progressed. On December 12, 1978, there were approximately 100 alfalfa plants/m^2 in the plots, while on December 20, 1979, populations ranged from 58 to 81 plants/m^2. When compared to the control plots, no significant differences in alfalfa populations were found at any time.

Alfalfa forage yields are given in Table 6. At first harvest, 2420 kg/ha of alfalfa was harvested from the control plots. No significant differences in forage yield among treatments resulted at this time. At second harvest, when compared to the control plots (1020 kg/ha), alfalfa production was significantly decreased in all

Table 5. Effects of herbicides on mustard, henbit, and alfalfa populations at Lake Carl Blackwell. [1]

Treatment (9/23/78)	Rate	Mustard [2] (12/12/78)	Henbit [2] (12/12/78)	Alfalfa (12/12/78)	Alfalfa (6/13/79)	Alfalfa (12/20/79)
	(kg/ha)	(plants/m^2)				
EPTC	3.36	0	3	104	77	64
Fluchloralin	1.12	15	3	98	79	67
Profluralin	1.12	5	2	98	60	60
Pendimethalin	1.12	2	8	93	66	64
Benefin	1.12	11	7	112	85	81
Butralin	1.12	3	13	118	79	72
Control	----	13	31	100	74	58
$LSD_{0.05}$		NS	22	NS	NS	NS
CV (%)		161	69	32	15	24

1/ Alfalfa planted September 25, 1978

2/ Natural infestations

Table 6. Influence of herbicides on alfalfa forage production at Lake Carl Blackwell.[1/]

Treatment (9/23/78)	Rate	Dry Matter Production (5/17/79)	Dry Matter Production (7/24/79)	Total DM Production
	(kg/ha)	(kg/ha)		
EPTC	3.36	2960	710	3670
Fluchloralin	1.12	2600	700	3300
Profluralin	1.12	2890	670	3560
Pendimethalin	1.12	3070	650	3720
Benefin	1.12	3030	590	3620
Butralin	1.12	2800	780	3580
Control	----	2420	1020	3440
$LSD_{0.05}$		NS	270	NS
CV (%)		21	23	24

[1/] Alfalfa planted September 25, 1978

herbicide treated plots except butralin. However, there were no differences in total forage production. Therefore, the differences at second harvest can be attributed to the higher yields in the herbicide treated plots at first harvest, which depleted the soil of moisture needed for maximum regrowth of alfalfa.

Field Study II

Table 7 contains plant population densities obtained at various times during the course of the experiment. There was a moderate natural infestation of shepherdspurse in the plots on December 20, 1978. Shepherdspurse densities ranged from 11 plants/m^2 in EPTC treated plots to 27 plants/m^2 in benefin treated plots. No significant differences in shepherdspurse populations from any of the treatments were found when compared to the control plots which had 18 plants/m^2. Also at this time no differences resulted in alfalfa populations from any of the treatments with the control plots having a density of 103 alfalfa plants/m^2. On June 13, 1979, no significant differences in alfalfa populations were found when compared to the control (77 plants/m^2). A general decrease in alfalfa population was observed as the season progressed, and by December 20, 1979, the thinnest stand (51 plants/m^2) was in the fluchloralin treated plots, but this was not significantly different from the stand in the plots that had not been treated (61 plants/m^2). The best stand (75 plants/m^2) at this December 20, 1979, date was in the plots that had been treated with EPTC.

Forage production, taken May 25 and July 24, 1979, is given in Table 8. There was a considerable amount of shepherdspurse in the plots at first harvest, and forage yields for this species as well as

Table 7. Effects of herbicides on shepherdspurse and alfalfa populations at Lake Carl Blackwell. [1/]

Treatment (9/23/78)	Rate	Shepherdspurse [2/] (12/20/78)	Alfalfa (12/20/78)	Alfalfa (6/13/79)	Alfalfa (12/20/79)
	(kg/ha)	(plants/m^2)			
EPTC	3.36	11	126	71	75
Fluchloralin	1.12	16	119	61	51
Profluralin	1.12	16	94	68	58
Pendimethalin	1.12	14	118	73	64
Benefin	1.12	27	94	64	66
Butralin	1.12	22	110	73	66
Control	----	18	103	77	61
$LSD_{0.05}$		NS	NS	NS	12
CV (%)		71	23	13	13

[1/] Alfalfa sown September 25, 1978

[2/] Natural infestation

Table 8. Herbicide effects on forage yields of shepherdspurse and alfalfa at Lake Carl Blackwell. 1/

Treatment (9/23/78)	Rate	Dry Matter Production: Shepherdspurse 2/ (5/25/79)	Alfalfa (5/25/79)	Alfalfa (7/24/79)	Total Alfalfa
	(kg/ha)	(kg/ha)			
EPTC	3.36	30	3000	1130	4130
Fluchloralin	1.12	70	2480	880	3360
Profluralin	1.12	120	3220	1060	4280
Pendimethalin	1.12	80	2670	990	3660
Benefin	1.12	230	2800	1110	3910
Butralin	1.12	60	2390	1140	3530
Control	----	210	2650	1370	4020
LSD 0.05		170	NS	390	NS
CV (%)		99	33	24	30

1/ Alfalfa sown September 25, 1978

2/ Natural infestation

for alfalfa were determined. Comparing to the control, which produced 210 kg/ha of shepherdspurse, EPTC was the only treatment significantly reducing shepherdspurse forage, producing 30 kg/ha. However, no correlation was found between shepherdspurse production and alfalfa yield, and at first harvest no significant differences in alfalfa forage yield resulted from any of the treatments.

At second harvest, July 24, 1979, the control plots produced 1370 kg/ha of alfalfa. Alfalfa yield was significantly less in the plots treated with fluchloralin, resulting in 880 kg/ha of alfalfa produced. However, no significant differences in total alfalfa production were found. These results indicate that with the production levels in this study, shepherdspurse had little or no effect on alfalfa populations and yield. Perhaps under more competitive conditions, alfalfa would be more affected by this weed species.

Field Study III

Based on December 12, 1978 plant counts, the various treatments resulted in a good variable in cheat population, ranging from a low of 19 plants/m^2 in plots receiving no cheat and no herbicide to a high of 167 cheat plants/m^2 in plots treated with profluralin (Table 9). Cheat was not seeded in the no cheat plots but was carried into these plots in runoff water from other plots from a rain shower received on October 8, 1978 (Table 4). Plots not seeded to cheat, those seeded with 4.2 kg/ha of cheat, and EPTC plots (with 33.6 kg/ha of cheat) had significantly lower cheat densities than the heaviest seeding rate (33.6 kg/ha) which resulted in 134 cheat plants/m^2 (Table 9). Although there was variation in cheat populations at this time, there were no

Table 9. Influence of treatment on cheat and alfalfa populations at Lake Carl Blackwell. 1/

Treatment 2/	Rate	Cheat	Alfalfa		
		(12/12/78)	(12/12/78)	(6/13/79)	(11/15/79)
	(kg/ha)	(plants/m^2)			
No cheat seeded	----	19	147	76	51
Cheat seeded	4.2	31	123	81	43
Cheat seeded	8.4	99	125	66	46
Cheat seeded	16.8	117	139	56	48
Cheat seeded	33.6	134	111	51	40
Pronamide 3/	1.12	---	---	98	52
EPTC	3.36	37	127	91	49
Fluchloralin	1.12	158	86	82	49
Profluralin	1.12	167	146	75	46
Pendimethalin	1.12	129	144	78	44
Benefin	1.12	146	143	75	63
Butralin	1.12	124	108	49	42
$LSD_{0.05}$		58	NS	20	10
CV (%)		36	29	19	16

1/ Alfalfa and cheat planted September 25, 1978

2/ Herbicide treatments overseeded with 33.6 kg/ha cheat

3/ Treatment applied December 21, 1978. Other herbicide treatments were applied September 23, 1978.

significant differences in alfalfa densities among any of the treatments on December 12, 1978. There was a general decrease in plant population throughout the study. On December 12, 1978, plots had between 86 and 147 alfalfa plants/m^2, but about one year later (November 15, 1979), alfalfa plants numbered between 40 and 63 plants/m^2.

Forage yields taken May 24 and July 24, 1979, and alfalfa plant counts taken June 13, 1979, are given in Table 10. At first harvest cheat production varied with treatment. Cheat yield was significantly reduced by all herbicide treatments, except butralin, when compared to the control treatment of cheat at 33.6 kg/ha which produced 5970 kg/ha of cheat forage. The postemergence application of pronamide provided excellent cheat control. EPTC and fluchloralin were the two best preplant incorporated treatments for control of cheat, but there was still over 1000 kg/ha of cheat produced in these plots.

The corresponding yields of alfalfa and cheat at first harvest were statistically analyzed by regression analysis to find what effect cheat production had on alfalfa production. In general, alfalfa production decreased as cheat production increased (Figure 1). For every 1000 kg/ha of cheat produced, alfalfa production decreased by 380 kg/ha. The equation for the line on this plot is: $Y = 2454 - 0.38X$. The coefficient of determination for this relationship is 0.77. If the coefficient of determination had been 1.00, then all of the data points would have fallen on the line.

Corresponding alfalfa populations (plant counts taken June 13, 1979) and cheat yields were also analyzed by regression to find what effect cheat production had on alfalfa population. In general, alfalfa population decreased as cheat production increased (Figure 2). For

Table 10. Treatment effects on cheat and alfalfa forage production and alfalfa population at Lake Carl Blackwell. 1/

Treatment	Rate	1st Harvest DM Production 2/ Cheat	1st Harvest DM Production 2/ Alfalfa	Alfalfa 3/	2nd Harvest DM Production 4/ Alfalfa	Total DM Production
	(kg/ha)	(kg/ha)	(kg/ha)	(plants/m^2)	(kg/ha)	(kg/ha)
No cheat seeded	---	880	2060	76	1180	4120
Cheat seeded	4.2	3090	1210	81	1300	5600
Cheat seeded	8.4	3940	670	66	1320	5930
Cheat seeded	16.8	6450	310	56	1460	8220
Cheat seeded	33.6	5970	220	51	1440	7630
Pronamide	1.12	0	3130	98	1420	4550
EPTC	3.36	1660	1990	91	1190	4840
Fluchloralin	1.12	1180	2170	82	1040	4390
Profluralin	1.12	2390	1340	75	1090	4820
Pendimethalin	1.12	3490	1420	78	1170	6080
Benefin	1.12	4200	830	75	1150	6180
Butralin	1.12	5370	290	49	1510	7170
LSD 0.05		1650	720	20	NS	130
CV (%)		36	38	19	20	19

1/ Alfalfa and cheat planted September 25, 1978

2/ May 24, 1979

3/ Counts taken June 13, 1979

4/ July 24, 1979

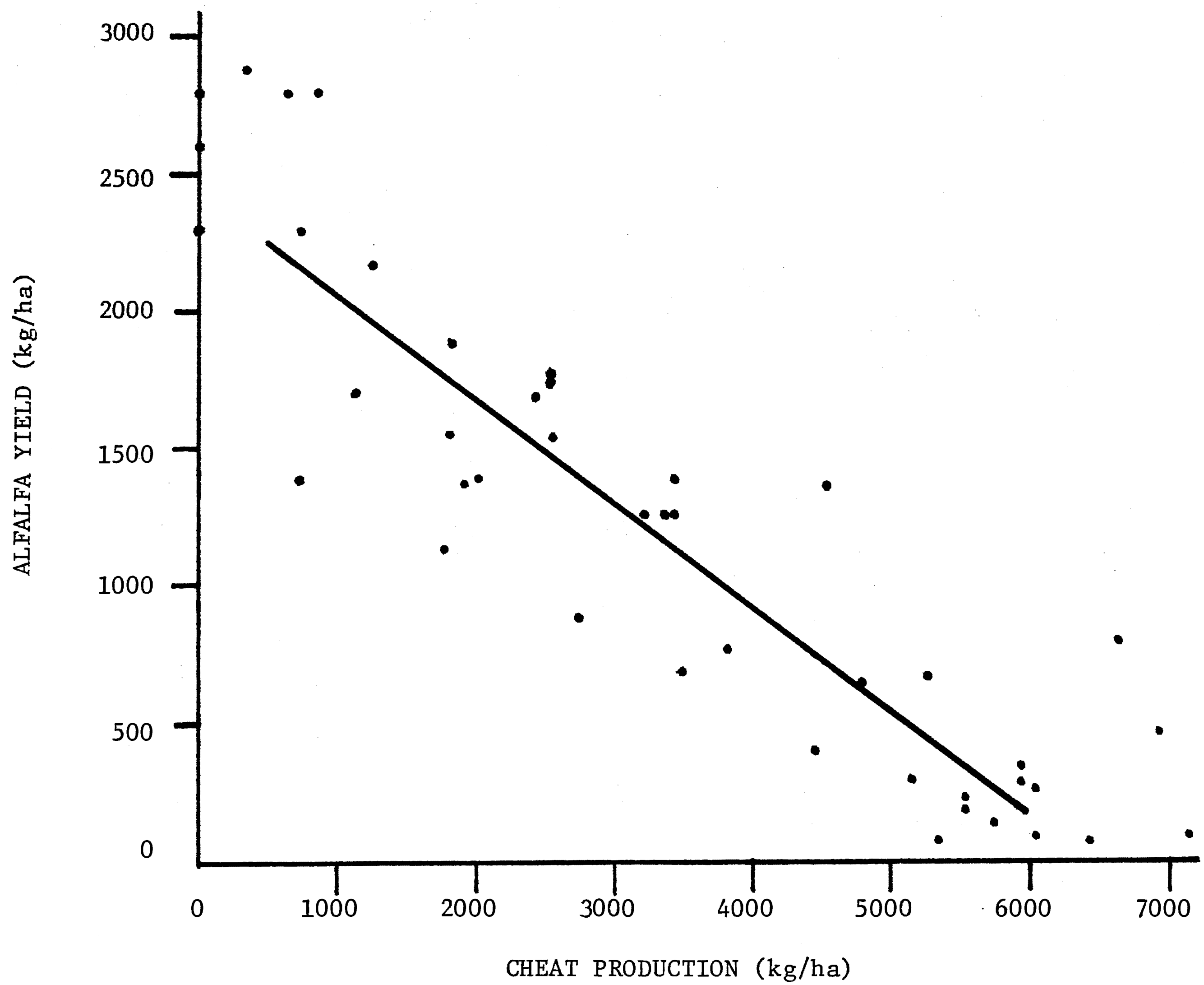

Figure 1. Influence of cheat production on alfalfa forage yield at first harvest.

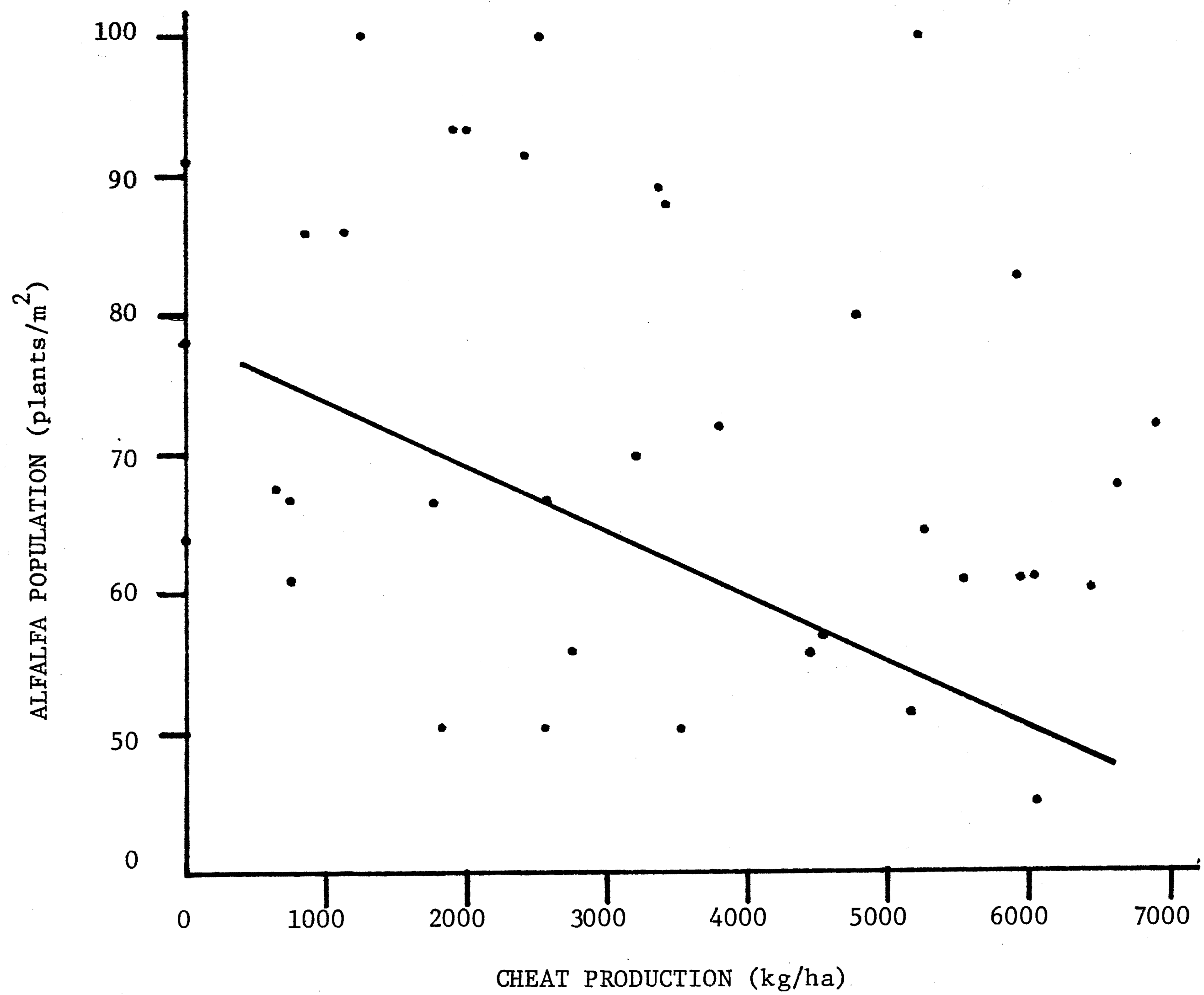

Figure 2. Influence of cheat production on alfalfa population.

every 1000 kg/ha of cheat produced, alfalfa population decreased by about 5 plants/m^2. The equation for the line on this plot is: $Y = 78 - .0046X$. The coefficient of determination for this relationship is 0.51. This implies that predictions are not as reliable for alfalfa populations due to cheat competition as if the coefficient of determination had been closer to 1.00. This also means that the main effect from cheat production was reduced alfalfa production and not a stand reduction of alfalfa.

Although alfalfa populations were decreased with increased cheat production, the resulting stands were still adequate, because no significant differences in alfalfa forage production were found at second harvest on July 24, 1979 (Table 10). Total forage production was significantly reduced by all herbicide treatments when compared to the control treatment, which produced a total of 7630 kg/ha of forage (Table 10). Although alfalfa production increased as cheat was controlled, the alfalfa could not compensate for the tremendous amount of cheat produced in the control plots (33.6 kg/ha of cheat seeded with no herbicide). In this study it was demonstrated that cheat competition can reduce seedling stands of alfalfa as well as reduce early forage production of alfalfa.

Dinoseb Study

Field Study IV

There was a moderate natural infestation of tansy and treacle mustards and a heavy natural infestation of henbit plants in this study (Table 11). Mustard populations, in plots not treated in

Table 11. Effects of dinoseb formulation on mustard, henbit, and alfalfa populations at Lake Carl Blackwell. 1/

Treatment	Rate	Mustard 2/	Henbit 2/	Alfalfa		
		(12/20/78)	(12/20/78)	(12/20/78)	(6/8/79)	(12/21/79)
	(kg/ha)	(plants/m^2)				
Applied December 1, 1978						
Alkanolamine salt	0.84	0	0	269	348	100
" "	1.68	0	0	209	277	87
Dinitrophenol	0.84	0	1	191	248	90
"	1.68	0	0	109	200	91
Applied March 7, 1979		Pretreatment Counts				
Alkanolamine salt	0.84	47	271	297	320	82
" "	1.68	41	292	280	311	100
Dinitrophenol	0.84	16	220	234	338	110
"	1.68	13	251	288	364	82
Control	----	49	222	311	323	104
LSD 0.05		NS	78	90	80	NS
CV (%)		207	38	25	18	14

1/ Alfalfa sown September 23, 1978

2/ Natural infestations

December, varied from 13 to 49 plants/m^2, while henbit populations varied from 220 to 292 plants/m^2. Both formulations and rates of of dinoseb, applied December 1, 1978, controlled all of the mustards and most of the henbit. The 1.68 kg/ha rate of the alkanolamine salt and both rates of the dinitrophenol formulation of dinoseb, applied as December treatments, significantly decreased alfalfa populations when compared to the control (311 plants/m^2). However, there was a decrease in alfalfa populations in the plots not treated and by June 8, 1979, the only December treatment that resulted in a significant reduction in alfalfa population was the 1.68 kg/ha rate of the dinitrophenol formulation. The March applications of dinoseb were not as damaging to alfalfa as the December applications. No significant reduction in stand from plant counts taken June 8, 1979, were associated with any of the March treatments. Alfalfa populations in June were higher than in December of 1978. This was probably due to germination of hard seed in the spring of 1979. By December 21, 1979, alfalfa populations had decreased in all plots and no differences existed in the plots.

Table 12 contains forage yields taken on May 16 and July 23, 1979, as well as total forage production. By May 16, the mustards and henbit had completed their life cycles, and consequently, no yields were obtained for these species. At first harvest the control plots produced 770 kg/ha of alfalfa. Both formulations and rates of dinoseb applied in December and the March treatment of the dinitrophenol formulation at 1.68 kg/ha resulted in significant increases in alfalfa yield because of decreased weed competition. The highest alfalfa yields were obtained from the December applications of dinoseb, consequently, it would appear that March applications are too late to obtain maximum

Table 12. Effects of dinoseb formulation on alfalfa forage production at Lake Carl Blackwell. 1/

Treatment	Rate	Dry Matter Production (5/16/79)	Dry Matter Production (7/23/79)	Total DM Production
	(kg/ha)	(kg/ha)		
Applied December 1, 1978				
Alkanolamine salt	0.84	1700	860	2560
" "	1.68	1510	1150	2660
Dinitrophenol	0.84	1410	710	2120
"	1.68	1210	820	2030
Applied March 7, 1979				
Alkanolamine salt	0.84	1070	1340	2410
" "	1.68	1000	1380	2380
Dinitrophenol	0.84	850	1470	2320
"	1.68	1160	1350	2510
Control	----	770	970	1740
$LSD_{0.05}$		310	NS	140
CV (%)		18	41	24

1/ Alfalfa sown September 23, 1978

benefits in controlling mustards and henbit in seedling alfalfa. No significant differences in alfalfa forage production were found among treatments at second harvest. However, all herbicide treatments significantly increased total forage production when compared to the control plots. Therefore, since there were no differences at second harvest, competition from these cool season weeds (tansy and treacle mustard and henbit) were most important in effecting forage production at first harvest in this study.

Spring Establishment Study

Field Study V

There was an extremely heavy natural infestation of summer annual broadleaf weeds at first harvest. Visual ratings of percent composition by weight were taken immediately before harvesting and the results are given in Table 13. Giant ragweed and common lambsquarters were the two most abundant weed species. Other broadleaf weeds present were annual sunflower, blackeyedsusan, and cutleaf evenprimrose. No treatment successfully controlled giant ragweed. All other herbicides were better than EPTC in controlling lambsquarters. In general, poor broadleaf weed control was exhibited by all treatments. By July 16, 1979, the control plots had a light natural infestation of Pennsylvania smartweed and a moderate natural infestation of johnsongrass. The butralin treatment was least effective in controlling Pennsylvania smartweed, and EPTC and butralin were the two least effective treatments for controlling johnsongrass.

Forage yields at first harvest for the various components are

Table 13. Percent composition by weight of alfalfa and various weeds at the Eastern Research Station. 1/

Treatment (3/15/79)	Rate	First Harvest (6/11/79)				Second Harvest (7/16/79)		
		Alfalfa	Giant ragweed 2/	Lambs-quarters 2/	Other broadleaf weeds 2/	Alfalfa	Pennsylvania smartweed 2/	Johnson-grass 2/
	(kg/ha)	(%)						
EPTC	1.12	34	28	15	23	77	3	20
Fluchloralin	1.12	41	33	8	18	92	2	6
Profluralin	1.12	37	41	9	13	91	3	6
Pendimethalin	1.12	40	37	7	16	94	4	2
Benefin	1.12	60	24	1	15	90	2	8
Benefin	1.68	67	14	4	15	92	2	6
Butralin	1.12	44	42	2	12	78	8	14
Control	----	23	34	14	29	58	10	32

1/ Alfalfa planted March 15, 1979

2/ Natural infestations

given in Table 14. These yields were obtained from plot weights and percent composition data taken on June 11, 1979 (Table 13). Even though giant ragweed yields ranged from 107 kg/ha in plots treated with benefin at 1.68 kg/ha to 1580 kg/ha in butralin plots, no significant differences were found in ragweed production when compared to the control (950 kg/ha). The control plots produced 180 kg/ha of lambsquarters and no significant differences resulted from any herbicide treatment. Also, no significant differences were found in yields of other broadleaf weeds at first harvest. No differences resulted in the yields for these weeds at first harvest because of the high variations associated with them. Because of this general lack of control of broadleaf weeds, no significant differences in alfalfa production resulted from any of the herbicide treatments at first harvest.

Component yields for second harvest, determined from percent composition data (Table 13) and plot weights taken July 16, 1979, are given in Table 15. There were no significant differences in forage yield of Pennsylvania smartweed among any of the treatments at second harvest. There was 225 kg/ha of johnsongrass produced in the control plots. Significant reductions in johnsongrass yield resulted from all herbicide treatments. Alfalfa yield was significantly increased by all treatments, except butralin, when compared to the control, which produced 370 kg/ha of alfalfa forage. This was probably due to decreased weed competition at first and second harvests in the herbicide treated plots. Results from this study indicate that the herbicides evaluated were not effective in controlling some of the summer broadleaf weeds in a spring establishment program for alfalfa. These conclusions agree

Table 14. Herbicide effects on forage production of giant ragweed, lambsquarters, other broadleaf weeds, and alfalfa at the Eastern Research Station. 1/

Treatment (3/15/79)	Rate	Dry Matter Production (6/11/79)			
		Giant ragweed 2/	Lambs-quarters 2/	Other broadleaf weeds 2/	Alfalfa
	(kg/ha)	(kg/ha)			
EPTC	1.12	660	230	340	560
Fluchloralin	1.12	1070	90	330	800
Profluralin	1.12	1230	130	260	700
Pendimethalin	1.12	1170	140	310	690
Benefin	1.12	900	20	290	1060
Benefin	1.68	170	60	150	960
Butralin	1.12	1580	40	330	930
Control	----	950	180	680	630
$LSD_{0.05}$		NS	NS	NS	NS
CV (%)		114	132	119	73

1/ Alfalfa planted March 15, 1979

2/ Natural infestations

Table 15. Influence of herbicides on forage production of Pennsylvania smartweed, johnsongrass, and alfalfa at the Eastern Research Station. [1/]

Treatment (3/15/79)	Rate	Dry Matter Production (7/16/79)		
		Pennsylvania smartweed [2/]	Johnson-grass [2/]	Alfalfa
	(kg/ha)	(kg/ha)		
EPTC	1.12	25	140	530
Fluchloralin	1.12	25	30	660
Profluralin	1.12	15	45	550
Pendimethalin	1.12	15	20	580
Benefin	1.12	15	50	620
Benefin	1.68	10	35	540
Butralin	1.12	40	85	440
Control	----	80	255	370
LSD 0.05		NS	110	120
CV (%)		174	130	22

[1/] Alfalfa planted March 15, 1979

[2/] Natural infestations

with many of the reports in the literature reviewed for these herbicides. Many of these reports indicate that the herbicides used in this study have shown weaknesses in controlling certain summer broadleaf weeds.

CHAPTER V

SUMMARY

Field studies were conducted to establish alfalfa with preplant incorporated and postemergence herbicides. These studies were conducted to determine the selectivity of various herbicides to seedling alfalfa and their effectiveness as weed control agents. The competitive effects of weeds on seedling stands of alfalfa were also evaluated.

In the fall sown studies, several herbicides resulted in good control of cool season weeds and good tolerance by alfalfa. In the fall sown study overseeded with cheat, the control of cheat varied with treatment. The postemergence application of pronamide exhibited excellent control of cheat and the two best preplant incorporated treatments were EPTC and fluchloralin. It was demonstrated that competition from cheat can reduce stands of fall sown alfalfa as well as reduce alfalfa forage production at first harvest. Even though alfalfa yield was affected at first harvest, no significant differences were found at second harvest. It would appear that winter annual grasses, such as cheat, have their major effect on alfalfa forage production at first harvest.

December applications of both formulations and rates of dinoseb provided excellent control of mustards and henbit. However, the dinitrophenol formulation was more damaging than the alkanolamine salt to seedling alfalfa. Even though alfalfa population was reduced by

some of these early applications of dinoseb, the resulting stands were still adequate and at first harvest alfalfa production was higher in all herbicide treated plots than in the control plots. March applications of dinoseb were less damaging to alfalfa and less effective on the weeds than December applications.

In the spring sown experiment there was a heavy infestation of giant ragweed, lambsquarters, and other broadleaf weeds in the plots at first harvest. No increases in alfalfa yield resulted from any of the herbicide treatments at first harvest because of this poor broadleaf weed control. When compared to the check, all treatments, except butralin, resulted in a significant increase in alfalfa yield at second harvest. This was probably due to partial control of weeds at first and second harvests in the herbicide treated plots.

It was demonstrated that weeds can be very serious competitors in the seedling year of alfalfa establishment. This competition resulted in decreased survival of alfalfa plants and decreased alfalfa yield at first harvest. However, at the seeding rates used, in most of these studies there were still enough plants to have maximum yield at time of second harvest. It is possible that if the seeding rate was reduced, the resulting stand loss due to weed competition could have a serious effect on stand longevity. This aspect of being able to decrease seeding rates with the use of herbicides for establishment needs to be investigated. Also, the control of some of the summer broadleaf weeds was not satisfactory with the herbicides evaluated in the spring establishment study. Additional herbicides or mixtures need to be evaluated to control these broadleaf weeds.

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VITA 2

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