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EXPERIMENTS ON CONTROL OF WEEDS
IN GRASS SEED CROPS

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FOREWORD

In Canada, the major grasses grown for seed include creeping red fescue, bromegrass, timothy, meadow fescue, Russian wild ryegrass, crested wheatgrass, slender wheatgrass, Kentucky bluegrass and reed canarygrass. One of the main areas of production is the Peace River region (producing nearly 100% of the Canadian production of creeping red fescue and substantial quantities of bromegrass and timothy). To this region, the grass seed industry represents an important source of income, a means of providing diversity of the cropping system and a method of improving soil conditions.

Progress in the control of weeds in grass seed crops has lagged behind that in cereal and oilseed crops. Small acreages combined with a large number of crop species have made progress difficult. Consequently, control recommendations are fewer and sometimes less effective than desired.

This report contains the results from a series of experiments conducted at the Beaverlodge Research Station on the control of weeds in chaffy grasses grown for seed production. Its purpose is to provide interested parties with information on the weed research program at Beaverlodge. It does not contain weed control recommendations. All uses of herbicides must be registered by appropriate federal agencies before their recommendation or use. Therefore, prior to making any recommendation or using procedures outlined here, appropriate provincial weed control recommendations should be consulted. Information presented in this report should not be reproduced without the consent of the author.

Experiments to determine the tolerance of seedling creeping red fescue, bromegrass and timothy to herbicides used for broadleaved weed control (page 7-8) were supported, in part, by the Agricultural Research Council of Alberta, Farming For The Future (Project Number 79-0083). This support is gratefully acknowledged.

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2. Seedling creeping red fescue, timothy and bromegrass exhibited good tolerance to bromoxynil + MCPA (Buctril M or Bromox 450M), Linuron (Lorox or Lexone) plus MCPA, cyanazine + MCPA (Blagal), Dowco 290 (Lontrel) and Dowco 290 + 2,4-D (Lontrel D) when these herbicides were applied at rates normally used in cereal crops.

3. Field and greenhouse studies conducted from 1974-1978 on wild oat control in creeping red fescue, crested wheatgrass, meadow fescue, bromegrass, intermediate wheatgrass, timothy, reed canarygrass, Kentucky bluegrass and Russian wild ryegrass at Beaverlodge, Alta. have indicated the following:

   a) Creeping red fescue, crested wheatgrass, intermediate wheatgrass and Russian wild ryegrass were generally tolerant to diclofop methyl (Hoegrass) (without Renex 36) at rates that gave satisfactory control (.84 to 1.40 kg/ha). Warm, humid conditions combined with early treatment resulted in injury to creeping red fescue in one of the years. Bromegrass varied from year to year in its tolerance to diclofop methyl. Injury occurred in the greenhouse and in one of the years in the field but not in the other two years in the field. All other chaffy grasses were severely injured by diclofop methyl. Applications of the herbicide to wild oats in the 1.5- to 2-leaf stage generally provided better control than applications to wild oats in the 4- to 5-leaf stage.

   b) All chaffy grasses, except possibly reed canarygrass and Kentucky bluegrass were tolerant to barban (Carbyne, Wypout) at .35 kg/ha when applied in the field. Barban caused greater injury in the greenhouse than in the field. Barban gave good wild oat control in 2 out of 3 years in the field. Increasing the rate from .35 to .70 kg/ha did not produce a major improvement in wild oat control.

   c) The tolerance of all chaffy grasses to difenzoquat (Avenge) was good. Wild oat control from applications of this herbicide ranged between poor and fair.

   d) All chaffy grasses, except reed canarygrass and possibly Kentucky bluegrass and timothy, were tolerant to flamprop methyl (Mataven) treatments. A rate of .84 kg/ha was required to give good, consistent wild oat control.

II. Control of weeds in established stands.

A. Crop tolerance to herbicides.

1. The tolerance of established creeping red fescue to 2,4-D ester may be summarized as follows:

Year No.	Date	Stage of crop	Reduction in yield First crop after treatment 2,4-D .56 kg/ha	2,4-D .70 kg/ha	2,4-D 1.12 kg/ha
1	June	Crop planted	-	-	-
	July	3-leaf	Nil		Very little
	Aug.				
	Sept.	Vegetative	25-50%		50%
	Oct.				
2	May	Before stem elongation	5-10%		15-20%
		Shot-blade			
	June	Early heading			
		Flowering		50-70%	
	July	Hard dough		Nil	
	Aug.	After harvest	Nil		Nil
	Sept.				

2. Established creeping red fescue exhibited good tolerance to dicamba (Banvel). When applied at rates up to 2.8 kg/ha in the fall of the year of seeding or during the spring (before stem elongation, shot-blade or early heading stages) to 1-year-old stands the herbicide did not reduce seed yields of this crop.

3. Established timothy exhibited limited tolerance to 2,4-D ester and very poor tolerance to dicamba. 2,4-D applied in the fall at .56 kg/ha to 3.5-month-old stands severely reduced seed yields the following year. Applications of 2,4-D at .56 kg/ha in the spring prior to stem elongation reduced yields by as much as 25%. However, little or no injury occurred when similar applications were made at the shot-blade or early heading stages. Applications of dicamba at times similar to those for 2,4-D resulted in serious seed yield reductions.

B. Dandelion control.

1. Improved dandelion control has been achieved with the addition of dicamba or picloram to 2,4-D. However, creeping red fescue seed yield increases have not been obtained until the second growing season after treatment.

2. The size and density of dandelions can be manipulated by grass species and row spacing. The size of dandelions growing in intermediate wheatgrass, bromegrass, meadow fescue, creeping red fescue and timothy

I. EXPERIMENTS ON THE CONTROL OF WEEDS IN SEEDLING STANDS.

1. *Tolerance of seedling creeping red fescue to herbicide used for broadleaf weed control.*

Introduction: Stinkweed, lamb'squarters, wild buckwheat and a large number of other annual broadleaf weeds are troublesome in seedling fescue. Since herbicides that control these weeds in cereal crops are available for general use, a study was initiated to determine their effects on seedling fescue.

Methods: Boreal creeping red fescue was seeded in rows spaced 30 cm apart in 1971, 1972 and 1973. When the grasses reached the 3-leaf stage the herbicides (Table 1) were applied in a spray volume of 168 L/ha Each herbicide treatment was replicated six times. Weeds were removed by tillage and hoeing to prevent their interference with crop yields. Seed yields were obtained one year after herbicide application.

Results and Discussion: In 1972, 2,4-D ester at .56 kg/ha caused a small yield reduction while at 1.12 kg/ha it caused nearly a 50% reduction in seed yield (Table 1). Similarly 2,4-D amine and MCPA at .84 kg/ha caused small reduction and at 1.68 kg/ha both herbicides caused severe seed yield reduction. Dicamba plus 2,4-D plus mecoprop (Banvel 3) reduced seed yields at 1.12 kg/ha but not at .56 kg/ha. All rates of 2,4,5-T plus MCPA (Celatox) reduced seed yields in 1972 while only the heaviest rates of bromoxynil plus MCPA (Buctril M or Brominal M) and picloram (Tordon) plus 2,4-D reduced seed yields. In 1973 and 1974 none of the herbicide treatments caused any seed yield reductions. Since the lowest rate of each herbicide or herbicide combination will give adequate broadleaf weed control, it would appear that there is minimal risk in treating seedling creeping red fescue at the 3-leaf stage.

All herbicide rates are given in terms of acid equivalent or active ingredient. For more information on herbicide formulations and factors for the conversion from the metric to English system see Appendix A.

Table 1. Effect of herbicides applied to seedling fescue on subsequent seed yields.

Herbicide	Rate, kg/ha	Fescue seed yields, kg/ha		
		1972[1]	1973[2]	1974[3]
Check	0	226	999	943
2,4-D ester	.56	171	969	948
2,4-D ester	1.12	120	956	915
Check	0	158	977	1063
2,4-D amine	.84	142	1040	953
2,4-D amine	1.68	78	998	1090
Check	0	221	1150	1077
MCPA	.84	167	1108	1109
MCPA	1.68	121	1090	953
Check	0	212	1165	945
Dicamba+2,4-D+mecoprop	.56	207	1132	1025
Dicamba+2,4-D+mecoprop	1.12	153	1055	852
Check	0	174	1096	1084
Bromoxynil + MCPA	.84	196	1170	1205
Bromoxynil + MCPA	1.68	134	1082	1030
Check	0	195	1049	952
Picloram + 2,4-D	.015+.52	196	1047	963
Picloram + 2,4-D	.07+.52	164	1152	868
Check	0	222	1017	1131
2,4,5-T + MCPA	.4+.3	185	1170	1086
2,4,5-T + MCPA	.8+.6	189	1088	1009

[1]Herbicides applied July 8, 1971. Seed harvested July, 1972

[2] " " July 11, 1972. " " July, 1973

[3] " " July 27, 1973. " " July, 1974.

2. *Tolerance of seedling creeping red fescue, bromegrass and timothy to herbicides used for broadleaved weed control.*[1]

Introduction: Common chickweed, hemp nettle, corn spurry, cleavers and several other weeds which are resistant to herbicides developed prior to the mid-seventies, have recently become problems in seedling stands of grasses. Since several herbicides have been developed to control these weeds in cereal crops, a study was initiated to determine the tolerance of seedling grasses to these new herbicides.

Methods: Boreal creeping red fescue, Carlton bromegrass and Climax timothy were seeded in rows spaced 30 cm apart in 1978, 1979, 1980 and 1981 at the Beaverlodge Research Station and in 1980 at the Fort Vermilion Experimental Farm. When the grasses developed to the 3-leaf stage herbicide treatments (Table 2) were applied. Plots on which the herbicides were applied consisted of 3 rows of each grass. The plots were 9 m in length. The herbicides were applied to the front two-thirds of the plot leaving the remaining one-third as an untreated check. Each herbicide treatment was replicated at least twice. Weed populations were kept at a low level by tillage or hoeing. Crop tolerance ratings were obtained from 3 to 9 weeks after application of the herbicides.

Results: The three grasses exhibited good tolerance to all bromoxynil (Torch or Pardner), bromoxynil plus MCPA (Buctril M or Brominal M), Linuron (Lorox or Lexone) plus MCPA, cyanazine plus MCPA (Blagal), Dowco 290 (Lontrel) and Dowco 290 plus 2,4-D (Lontrel D) treatments (Table 2). All of these treatments appear to hold promise for weed control in seedling grasses. Metribuzin (Sencor) caused moderate to slight injury in the grasses with timothy appearing to be the most susceptible. All metribuzin treatments caused leaf burn in timothy and the other grasses while at the 2 highest rates it caused a retardation of growth and some grass mortality. Further work is required to determine the potential of metribuzin for weed control in seedling grasses.

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[1]Funds from the Agricultural Research Council of Alberta, Farming for The Future (Project Number 79-0083) supported this project during 1980 and 1981.

Table 2. Tolerance of seedling creeping red fescue, bromegrass and timothy to several herbicides used for broadleaved weed control.

		Crop tolerance (0-9)[1]													
		Creeping red fescue					Bromegrass					Timothy			
Herbicide	Rate, kg/ha	1978	1979	1980	1981[2]	Ave.	1978	1979	1980	1981[2]	Ave.	1978	1979	1980	Ave.
Bromoxynil	.28	8	9	9	-	8.7	8	9	9	-	8.7	9	9	9	9.0
Bromoxynil	.42	8	8	9	-	8.3	8	8	9	-	8.3	8	8	9	8.7
Bromoxynil	.56	-	8	9	-	8.5	-	8	9	-	8.5	-	9	9	9.0
Bromoxynil+MCPA	.28+.28	-	9	9	-	9.0	-	9	9	-	9.0	-	9	8	8.5
Linuron+MCPA	.21+.21	8	9	8	8	8.2	8	9	8	8	8.2	8	9	8	8.3
Linuron+MCPA	.28+.56	8	9	9	8	8.5	8	9	8	8	8.2	8	8	7	7.7
Cyanazine+MCPA	.28+.56	-	8	8	9	8.7	-	8	7	9	8.0	-	8	8	8.0
Cyanazine+MCPA	.56+1.12	-	7	8	8	7.7	-	8	7	8	7.7	-	8	7	7.5
Metribuzin	.14	-	7	8	8	7.7	-	7	8	8	7.7	-	6	8	7.0
Metribuzin	.21	-	7	8	8	7.7	-	7	7	8	7.3	-	6	6	6.0
Metribuzin	.28	-	6	8	7	7.0	-	7	6	8	7.0	-	6	6	6.0
Metribuzin	.42	-	5	8	5	6.0	-	6	6	6	6.0	-	4	6	5.0
Metribuzin+MCPA	.21+.56	-	6	8	8	7.3	-	7	8	8	7.7	-	5	7	6.0
Dowco 290	.30	-	-	8	9	8.5	-	-	8	8	8.0	-	-	8	8.0
Dowco 290+2,4-D	.15+.42	-	-	9	9	9.0	-	-	7	8	7.5	-	-	8	8.0

[1]Rating scale: 9-no damage; 7-8 slight damage; 4-6 moderate damage; 1-3 severe damage; 0 - complete kill

[2]Average of trials at Beaverlodge and Fort Vermilion.

[3]Dates of application: At Beaverlodge - July 18, 1978; July 16, 1979; July 22, 1980; July 15, 1981. At Fort Vermilion - July 20, 1981.

3. *The tolerance of several seedling grasses to barban, (Carbyne, Wypout), difenzoquat (Avenge), diclofop methyl (Hoegrass) and flamprop methyl (Mataven).*

Introduction: The use of herbicides to control wild oats in seedling chaffy grass crops has been limited because of a lack of information on crop tolerance to support product registration. When these crops are underseeded in an annual cereal or oilseed crop, herbicides frequently can not be applied because of the grass crop. The objective of this study was to determine the tolerance of several chaffy grasses to barban, difenzoquat, flamprop methyl and diclofop methyl.

Methods: Experiments were conducted in growth chambers and in the field from 1974 to 1978. Unless otherwise specified creeping red fescue (CRF-cv. Boreal), crested wheatgrass (CW-cv. Fairway), meadow fescue (MF-cf. Mimer), bromegrass (B-cv. Carlton), intermediate wheatgrass (IWG-cv. Chief), timothy (T-cv. Climax) reed canarygrass (RCG-cv. Castor), Kentucky bluegrass (KB-cv. Parkland) and Russian wild ryegrass (RWR-cv. Sawki) were used in each experiment. Wild oat control was also evaluated in each experiment.

Experiment 1. Three separate trials were conducted in growth chambers maintained at 20 C and a photoperiod of 16 hours. Ten seeds of each grass, except intermediate wheatgrass, were planted in plots (10 cm in diameter) containing vermiculite for each trial. The pots were subirrigated daily with one-half strength Hoagland's nutrient solution. In the first trial barban was applied 19 days after planting when the wild oats were in the 2-leaf stage. Kentucky bluegrass was in the 1- to 2-leaf stage at this time while the other grasses were in the 2-leaf stage. In the second trial difenzoquat treatments were applied 24 days after planting when the wild oat plants were in the 3- to 4-leaf stage. The chaffy grasses were at a similar stage of development. In the third trial, diclofop methyl (without Renex 36)* treatments were applied 16 days after planting. The wild oat plants and chaffy grasses were in the same stage of development as those treated with barban in the first trial. Barban was applied in a spray volume of 56 L/ha while the other herbicides were applied in a spray volume of 168 L/ha. The wild oat and chaffy grass shoots were harvested 31 days after treatment with barban, 17 days after treatment with diclofop methyl and 41 days after treatment with difenzoquat. The treatments in each trial were arranged in a randomized complete block design with three replicates. Results from this experiment are presented in Table 3.

Experiment 2. On June 4, 1973 all of the chaffy grasses plus wild oats were seeded in the field. Each grass was seeded in a 10.7 m long row. The rows were spaced 30 cm apart. Barban and diclofop methyl (without Renex 36) were applied on July 3 when the wild oat plants, crested wheatgrass and Kentucky bluegrass were in the 2-leaf stage and all other

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*Note: Commercial formulations of diclofop methyl contain a wetting agent, Renex 36, which enhances the activity of the herbicide.

grasses in the 3-leaf stage. Flamprop methyl and difenzoquat were applied on July 18 when the wild oat plants were in the 4-leaf to tillering stage. On this date the other grasses ranged between the 3-leaf and tillering stages. Barban and difenzoquat were applied in a spray volume of 56 L/ha while the other treatments were applied in a spray volume of 168 L/ha. The treatments were arranged in a randomized complete block design with four replications. The plots were hand-weeded. Chaffy grass tolerance to the herbicides was evaluated on September 25 while wild oat density and dry weight of shoots was obtained two weeks later. Results from this experiment are presented in Table 4.

Experiment 3. On June 4, 1975 all chaffy grasses, plus the wild oat, were seeded in the field in rows 9.1 m long and spaced 45 cm apart. All plots contained a single row of each chaffy grass plus a row of wild oat plants. Three herbicides were evaluated: barban, difenzoquat and flamprop methyl. Barban treatments were applied on July 7 when the wild oat plants were in the 1.5- to 2-leaf stage, and the chaffy grasses in the 1- to 1.5-leaf stage. Difenzoquat and flamprop methyl treatments were applied on July 21 when the wild oat plants were in the 4- to 5-leaf stage. Russian wild ryegrass, timothy, intermediate wheatgrass and reed canarygrass were in the 2- to 4-leaf stage on this date, while the other grasses were in the 3-leaf stage. Barban and difenzoquat were applied in a spray volume of 56 L/ha while flamprop methyl was applied in a spray volume of 168 L/ha. The plots were arranged in a randomized block design with four replicates. The plots were hand-weeded. Wild oat plant density and shoot dry weights were obtained in early October while crop tolerance was evaluated on October 10. The experiment was repeated in 1976. The chaffy grasses and wild oat were seeded on June 4. Barban treatments were applied on June 21 when the wild oat plants were in the 2-leaf stage and the chaffy grasses in the 1-to 1.5-leaf stage. Difenzoquat and flamprop methyl treatments were applied on July 5 when the wild oat plants were in the 4- to 5-leaf stage. On this date, Kentucky bluegrass, crested wheatgrass, bromegrass and intermediate wheatgrass were in the 3- to 4-leaf stage. Russian wild ryegrass and reed canarygrass were in the 3-leaf stage, timothy was in the 3- to 5-leaf stage, meadow fescue was in the 4-leaf stage and creeping red fescue was in the 6-leaf stage. Wild oat shoot dry weights and crop tolerance evaluations were obtained in mid-September.

Results from this experiment are presented in Table 5.

Experiment 4. On June 4, 1975 crested wheatgrass, creeping red fescue, Russian wild ryegrass, bromegrass, intermediate wheatgrass and wild oats were seeded in the field in rows 9.1 m long and spaced 45 cm apart. All plots contained a single row of each chaffy grass plus a row of wild oats. Diclofop methyl (with Renex 36) at several rates was applied to one set of plots on July 7 when the wild oat plants and chaffy grasses were in the 1.5- to 2-leaf stage (stage 1) and another set of plots on July 21 when the wild oat plants were in the 4- to 5-leaf stage (stage 2). On July 21 Russian wild ryegrass and intermediate wheatgrass were in the 2- to 4-leaf stage and the other chaffy grasses in the 3-leaf stage. All treatments were applied in a spray volume of 168 L/ha. The plots were arranged in a randomized complete block design with four replicates. The plots were hand-weeded. Wild oat plant density and shoot dry weights were obtained in early October while crop tolerance evaluations were made on October 17.

The experiment was repeated in 1976. The grasses, plus the wild oat were seeded on June 4. Stage 1 diclofop methyl treatments were applied on June 21 when the wild oat plants were in the 1.5- to 2-leaf stage and the chaffy grasses in the 1- to 1.5-leaf stage. Stage 2 treatments were applied on July 5 when the wild oat plants were in the 4- to 5-leaf stage. On this date crested wheatgrass, bromegrass and intermediate wheatgrass were in the 3- to 4-leaf stage, Russian wild ryegrass was in the 3-leaf stage and creeping red fescue was in the 6-leaf stage. Wild oat plant density and shoot dry weights were obtained in mid-September. Crop tolerance evaluations were also made in mid-September.

Results from this experiment are presented in Table 6.

Results and Discussion:

a. Weather Conditions: The 1974 growing season was characterized by below average monthly air temperatures, a dry June but above normal precipitation in July, August and September. In 1975 air temperatures were generally near or above average. However, moisture conditions were generally dry during the spring and summer of 1975. In 1976, moisture conditions were excellent during the spring and early summer. However, above average precipitation in late July and in August produced excessively wet soil moisture conditions. Temperatures in June and July were cool but near or above normal during the other months. The 1977 growing season was characterized by excessive rainfall and below average temperatures.

b. Crop Growth in the Field: Grass emergence varied from year to year. In 1974 and 1975 emergence was irregular mainly because of an inadequate or irregular rainfall pattern. In 1976, emergence of all grasses, except bromegrass, was satisfactory. Improvements in the soil moisture situation in the latter parts of the growing seasons of 1974 and 1975, as well as continued adequate soil moisture in the latter part of the 1976 growing season, resulted in good stands of all grasses, except bromegrass, by the end of the season of seeding.

c. Wild Oat Control: In all experiments the wild oats were grown without crop competition. In fields where chaffy grasses are established without a companion crop the control ratings are probably good indicators of what can be expected. However, where the chaffy grasses are seeded with a companion crop, competition from the latter can be expected to improve the performance of many of the herbicides.

Barban at .49 kg/ha provided good wild oat control in 1975 and 1976 (Table 5) but poor control in 1974 (Table 4). Increasing the rate of barban to .70 kg/ha did not produce a significant increase in wild oat control.

Difenzoquat did not provide satisfactory wild oat control (Tables 4 and 5). Reductions in wild oat shoot dry weight were generally less than 50%. Presumably this poor control can be attributed to the lack of crop competition.

Flamprop methyl at 1.68 kg/ha provided good to excellent control in all field experiments (Table 4 and 5). At .84 kg/ha the herbicide provided good control in 1975 and 1976 but only fair control in 1974. Control with flamprop methyl at .42 kg/ha was inadequate.

Diclofop methyl at 1.12 kg/ha or more provided good to excellent wild oat control in all experiments (Tables 4 and 6). At rates below 1.12 kg/ha control varied from fair to excellent. Applications made to wild oat plants in the 1.5- to 2-leaf stage were generally better than those made to plants in the 4- to 5-leaf stage.

d. Tolerance of Grasses:

Creeping red fescue - In a greenhouse trial creeping red fescue exhibited good tolerance to diclofop methyl and difenzoquat but was injured by barban at .35 kg/ha (Table 3). In field experiments, the crop exhibited no injury symptoms from treatments of barban, difenzoquat or flamprop methyl (Tables 4 and 5). Creeping red fescue was tolerant to diclofop methyl treatments in the greenhouse (Table 3). In field experiments in 1974 and 1975 the crop also exhibited good tolerance to all diclofop methyl treatments (Tables 4 and 6). However, in 1976 diclofop methyl at 1.40 kg/ha or more applied to creeping red fescue in the 1- to 1.5-leaf stage caused serious injury (Table 6). At a rate of .84 kg/ha injury was less. Only major injury occurred from applications at the older stage in 1976. Warm, moist weather at the time of treatment may have contributed to the crop injury at stage 1.

Crested wheatgrass - Crested wheatgrass exhibited good tolerance to all barban, difenzoquat, diclofop methyl and flamprop methyl treatments (Tables 3, 4, 5 and 6).

Meadow fescue - In greenhouse trials, meadow fescue was tolerant to difenzoquat but was injured by all barban and diclofop methyl treatments (Table 3). In field trials meadow fescue exhibited good tolerance to barban, difenzoquat and flamprop methyl (Tables 4 and 5) but was severely injured by diclofop methyl treatments (Table 4).

Bromegrass - In greenhouse trials, bromegrass was injured by barban and diclofop methyl treatments and by difenzoquat at 1.12 kg/ha (Table 3). Difenzoquat at .56 and .84 kg/ha did not injure bromegrass. In field trials, bromegrass was tolerant to all barban, difenzoquat and flamprop methyl treatments (Tables 4 and 5). However, its tolerance to diclofop methyl in the field varied from year to year. In 1974, injury was minor (Table 4). In 1975, very little injury was apparent but in 1976 severe injury occurred (Table 6).

Intermediate wheatgrass - In field studies, intermediate wheatgrass exhibited good tolerance to all barban, difenzoquat, diclofop methyl and flamprop methyl treatments (Tables 4, 5 and 6).

Timothy: In the greenhouse, timothy was tolerant to difenzoquat treatments but was severely injured by barban and diclofop methyl treatments (Table 3). In the field, timothy exhibited good tolerance to barban at .35 kg/ha to all difenzoquat treatments and to flamprop methyl at .42 or .84 kg/ha (Tables 4 and 5). However, barban at .70 kg/ha and flamprop methyl at 1.68 kg/ha caused slight to moderate injury to the crop in some of the years. Diclofop methyl treatments severely injured timothy (Table 4).

Reed canarygrass - In the greenhouse, reed canarygrass was tolerant to difenzoquat treatments but was severely injured by barban and diclofop methyl treatments (Table 3). In the field, reed canarygrass was tolerant in all years to barban at .35 kg/ha, difenzoquat at .84 or 1.12 kg/ha and flamprop methyl at .42 kg/ha (Tables 4 and 5). Barban at .70 kg/ha and flamprop methyl at .84 and 1.12 kg/ha caused injury to the crop which ranged from moderate to severe. Diclofop methyl treatments severely injured reed canarygrass (Table 4).

Kentucky bluegrass - In the greenhouse, Kentucky bluegrass was tolerant to difenzoquat treatments but was severely injured by barban and diclofop methyl treatments (Table 3). In the field, injury from all treatments ranged from slight to severe (Tables 4 and 5).

Russian wild ryegrass - In both the greenhouse and the field, Russian wild ryegrass exhibited good tolerance to all barban, difenzoquat, diclofop methyl and flamprop methyl treatments (Tables 3, 4, 5 and 6).

Table 3. Tolerance of several grasses to barban, difenzoquat and diclofop methyl in a greenhouse trial (Experiment 1).

Grass species	Dry weight of check, mg/plant	Dry weight, % of check		
		Barban .35 kg/ha		
Creeping red fescue	111	8.1*		
Meadow fescue	430	1.9*		
Reed canarygrass	424	2.3*		
Timothy	236	0.8*		
Bromegrass	361	23.8*		
Kentucky bluegrass	48	8.3*		
Crested wheatgrass	176	98.9		
Russian wild ryegrass	87	142.5		
Wild oats	1818	15.3*		
		Difenzoquat .56 kg/ha	Difenzoquat .84 kg/ha	Difenzoquat 1.12 kg/ha
Creeping red fescue	38	168.4	169.7	120.7
Meadow fescue	166	108.9	66.5	85.1
Reed canarygrass	303	82.8	98.1	75.6
Timothy	105	112.9	97.0	85.3
Bromegrass	194	68.7	96.8	59.9*
Kentucky bluegrass	20	110.0	85.8	85.8
Crested wheatgrass	114	94.2	117.0	71.3
Russian wild ryegrass	79	59.3	111.2	68.9
Wild oats	372	32.3*	21.2*	8.4*
		Diclofop methyl .56 kg/ha	Diclofop methyl 1.12 kg/ha	Diclofop methyl 1.68 kg/ha
Creeping red fescue	18	125.7	108.6	125.7
Meadow fescue	68	10.9*	6.6*	8.0*
Reed canarygrass	69	5.8*	2.9*	4.3*
Timothy	32	6.2*	1.6*	3.1*
Bromegrass	76	75.0	40.8*	27.0*
Kentucky bluegrass	10	15.0*	5.0*	5.0*
Crested wheatgrass	56	107.1	40.2	65.2
Russian wild ryegrass	29	155.2	81.0	131.0
Wild oats	418	25.9*	12.8*	18.2*

*Indicates a significant reduction in dryweight from the untreated check at P = .05.

Table 4. Crop tolerance and wild oat control in several seedling grass crops with barban, difenzoquat, diclofop methyl and flamprop methyl (Experiment 2).

Treatment	Rate, kg/ha	Crop tolerance (0-9)[1]									Dry weight of wild oats, g/m^2
		CRF	CW	MF	B	IWG	T	RCG	KB	RWR	
Check		9	9	9	9	9	9	9	9	9	261 a[2]
Barban	.35	9	9	9	9	9	9	9	8	8	163 b
Barban	.70	8	8	7	7	8	7	7	5	9	147 bc
Difenzoquat	.56	9	9	9	8	8	9	9	-	9	125 bcd
Difenzoquat	.84	9	9	9	8	8	8	9	7	9	168 b
Difenzoquat	1.12	8	8	9	9	9	8	9	7	9	179 b
Diclofop methyl	.56	9	9	2	8	9	5	2	2	9	81 cd
Diclofop methyl	1.12	9	8	2	7	8	1	2	1	8	65 de
Diclofop methyl	2.24	9	8	0	7	8	0	0	0	8	11 e
Flamprop methyl	.42	9	9	9	9	9	9	9	9	9	157 bc
Flamprop methyl	.84	9	9	9	9	9	9	9	8	8	174 b
Flamprop methyl	1.68	9	9	9	8	9	7	8	7	8	54 de

[1] Rating scale: 9 - no damage; 7-8 slight damage; 4-6 moderate damage; 1-3 severe damage; 0 - complete kill.

[2] Means within the column followed by the same letter are not significantly different at P = .05.

Table 5. Crop tolerance and wild oat control in several seedling grass crops with barban, difenzoquat and flamprop methyl (Experiment 3).

Treatment	Rate, kg/ha	Crop tolerance (0-9)[1] CRF	CW	MF	B	IWG	T	RCG	KBG	RWR	Dry weight wild oats, g/m² 1975	1976
Check		9	9	9	9	9	9	9	9	9	380 a[2]	635 ab
Barban	.35	9	8	9	8	9	8	8	8	9	38 c	76 d
Barban	.70	8	8	8	8	8	8	6	7	9	33 c	27 d
Difenzoquat	.84	9	9	8	9	9	9	9	8	9	206 b	510 b
Difenzoquat	1.12	8	9	8	9	8	9	9	8	8	168 b	705 a
Flamprop methyl	.42	9	9	9	8	9	9	8	9	9	244 b	331 c
Flamprop methyl	.84	8	8	8	8	8	8	6	8	8	60 c	54 d
Flamprop methyl	1.68	8	8	8	8	8	8	4	8	8	11 c	5 d

[1]Tolerance ratings averaged for 1975 and 1976. Rating scale: 9 - no damage; 7-8 slight damage; 4-6 moderate damage; 1-3 severe damage; 0 - complete kill.

[2]Means within each column followed by the same letter are not significantly different at P = .05.

Table 6. Crop tolerance and wild oat control in several seedling grass crops with diclofop methyl (Experiment 4.)

Rate of diclofop methyl, kg/ha	Stage	Crop tolerance (0-9)[1]										Dry weight of wild oats, g/m²[2]	
		CRF		CW		IWG		B		RWR			
		1975	1976	1975	1976	1975	1976	1975	1976	1975	1976	1975	1976
0	1	9	9	9	9	9	9	9	9	9	9	196 a[2]	695 a[2]
.84		9	8	9	9	9	8	9	8	8	8	109 b	0 b
1.40		9	6	9	8	9	8	9	2	9	7	16 c	0 b
2.24		9	5	9	7	9	8	9	2	8	7	5 c	0 b
0	2	9	9	9	9	9	9	9	9	9	9	240 a	456 a
.84		9	9	9	9	9	9	9	7	8	9	60 a	32 b
1.40		9	9	9	9	9	8	9	4	9	8	49 b	5 b
2.24		9	9	9	9	9	9	9	4	8	9	38 b	5 b

[1]Rating scale: 9 - no damage; 7-8 slight damage; 4-6 moderate damage; 1-3 severe damage; 0 - complete kill.

[2]Means within each column and within each stage followed by the same letter are not significantly different at P = .05.

II EXPERIMENTS ON THE CONTROL OF WEEDS IN ESTABLISHED STANDS.

1. *Crop tolerance to herbicides.*

A. *Tolerance of established creeping red fescue to herbicides used for broadleaf weed control.*

Introduction: The use of herbicides in established stands of grasses for seed has received minimal attention from researchers in western Canada. In Europe, most workers feel that considerable care is required when applying any herbicide to seed-producing grasses. Work by Elliott at our Station, as well as by Gallagher and Vanden Born at the University of Alberta, would indicate the need for care under Alberta conditions. Table 7 shows work carried out by Elliott in 1968 on the effect of 2,4-D ester on seed production in creeping red fescue. Seed yield reductions occurred from treatment at all stages prior to the hard dough stage. Similar results were obtained by Gallagher and Vanden Born at the University of Alberta. They also observed that dicamba (Banvel Liquid Herbicide) at more than .56 kg/ha reduced seed yields. In 1973 studies were initiated to obtain more information on the tolerance of creeping red fescue to fall and spring applications of 2,4-D and dicamba.

Methods: Creeping red fescue (cv. Boreal) was seeded in rows spaced 30 cm apart in June of 1972, 1973 and 1974. 2,4-D and dicamba were applied at several rates in September to 3.5 month-old-stands or in the spring to 1-year-old stands. Spring applications of the herbicides were made prior to stem elongation, at the shot-blade stage or at the early heading stage (the first two weeks in May, late May and late May to early June, respectively). The herbicide treatments were applied in a spray volume of 1.68 L/ha. Each treatment was replicated six times. The fescue was maintained in a generally weed-free condition by hoeing and cultivation. Fescue seed was harvested in late July or early August of the year after applications in the fall or during the same year after applications in the spring.

Results and Discussion: When applied in September of the year of seeding, 2,4-D at .56 or 1.12 kg/ha severely reduced seed yields the following year (Table 8). However, dicamba at rates up to .56 kg/ha did not have any effect on seed yields.

The effect of spring applications of 2,4-D on creeping red fescue seed yield is shown in Table 9. When applied at .56 kg/ha, 2,4-D ester caused yield reductions in 1974 but not in 1973 or 1975. Applications of 1.12 kg/ha of the herbicide caused yield reductions in all three years. The stage of the fescue at the time of herbicide application did not appear to have a significant influence on the amount of the seed yield reduction.

Dicamba applied in the spring at rates up to .56 kg/ha did not reduce the seed yields of fescue. The stage of the fescue at the time of herbicide application had little influence on the seed yield.

The results of these experiments clearly show that considerable care is required when applying herbicides to creeping red fescue that is grown for seed production. 2,4-D should not be applied in the fall of the year of seeding. It would appear that not more than .56 kg/ha of 2,4-D ester should be applied in the spring to established creeping red fescue. It would also appear that creeping red fescue is more tolerant to dicamba than 2,4-D when these herbicides are applied at rates that give equivalent weed control.

Table 7. Effect of 2,4-D ester at .70 kg/ha on seed production of creeping red fescue.

Date of treatment	Stage of plant development	Seed yield, kg/ha
Not treated		1001
June 2	2% heading	683
6	100% heading	706
11	5% flowering	701
13	50% flowering	587
19	90% flowering	444
23	50% flowering	533
25	20% soft dough	656
July 2	25% hard dough	1060
4	50% hard dough	1012
	L.S.D. (P = .05)	113

Table 8. Yields of 1-yr-old creeping red fescue seed produced during growing season following September applications of herbicides

Herbicide	Rate, kg/ha	Seed yield,[1] kg/ha	
		1974	1975
Control	-	735 a	708 a
2,4-D	.56	365 bc	503 b
2,4-D	1.12	253 c	309 c
Dicamba	.14	670 a	780 a
Dicamba	.28	516 ab	774 a
Dicamba	.56	668 a	786 a

[1]Means within each column followed by the same letter are not significantly different at P = .05.

Table 9. Effect of 2,4-D ester on seed yield of creeping red fescue.

Rate of 2,4-D, kg/ha	Stage of application	Seed yield, kg/ha			
		1973	1974	1975	Average
0	-	580 a	1052 a	694 a	775 a
.56	Before stem elongation	570 a	773 b	629 ab	684 a
.56	Shot-blade	574 a	839 b	535 b	649 a
.56	Early heading	588 a	867 b	675 ab	710 a
0	-	622 a	967 a	730 a	787 a
1.12	Before stem elongation	555 a	861 b	591 b	649 b
1.12	Shot-blade	564 a	762 b	538 b	621 b
1.12	Early heading	499 a	837 b	507 b	614 b

B. *Tolerance of established timothy to herbicides used for broadleaf weed control.*

Introduction: The use of herbicides such as dicamba (Banvel Liquid Herbicide) and 2,4-D, in established stands of timothy has occasionally resulte in severe seed yield losses. Therefore, a study to examine the effects of 2,4-D and dicamba on timothy seed yields was conducted.

Methods: A procedure similar to that used in the previous experiment was employed. Timothy (cv. Climax) was seeded in rows spaced 30 cm apart in June 1977 and again in June 1978. 2,4-D and dicamba were applied at several rates in September to 3.5 month-old-stands or in the spring to 1-year-old stands. Spring applications of the herbicides were made prior to stem elongation, at the shot-blade stage or at the early heading stage (May 4, 1978 or May 14, 1979; May 31, 1978 or June 7, 1979; June 13, 1978 or June 28, 1979). The herbicide treatments were applied in a spray volume of 168 L/ha. The timothy was maintained in a generally weed-free condition by hoeing and cultivation. Each treatment was replicated five times. Timothy seed was harvested in September of the year after applications in the fall or the year of application in the spring. Seed weight and seed germination were determined the winter following harvest.

Results and Discussion: Fall applications of 2,4-D ester caused severe seed yield reductions (Table 10). Spring treatments were less injurious than those in the fall. Yield reductions from 2,4-D at .56 kg/ha were 16% in 1978 and 25% in 1979. Little or no injury occurred from 2,4-D at .56 kg/ha applied at the shot-blade and early heading stages. Spring treatments of 2,4-D at 1.12 kg/ha reduced yields from 15 to 32%. None of the 2,4-D treatments affected seed weight or seed germination.

All treatments of dicamba caused seed yield reductions in timothy (Table 11). Seed germination was also reduced by dicamba, particularly when applied at the shot-blade and early heading stages.

The results clearly show extreme care is required when applying herbicides to timothy. The use of dicamba appears inadvisable. If 2,4-D is used, only applications of less than .56 kg/ha in late May (just prior to the shot blade stage) appear possible without injury and subsequent yield loss.

Table 10. Effect of 2,4-D ester on the seed yield of timothy.

Rate of 2,4-D, kg/ha	Stage of application	1978 Seed yield, kg/ha	1978 % reduction	1979 Seed yield, kg/ha	1979 % reduction
0	-	360 a[1]		332 a[1]	
.56	Fall	195 ab	46	172 dc	48
.56	Before stem elongation	304 a	16	250 bc	25
.56	Shot-blade	366 a	0	310 ab	6
.56	Early heading	363 a	0	332 a	0
1.12	Fall	108 b	70	124 c	62
1.12	Before stem elongation	259 ab	28	224 dc	32
1.12	Shot-blade	276 ab	24	243 bc	27
1.12	Early heading	269 ab	25	281 abc	15

[1]Means within each column followed by the same letter are not significantly different at P = .05.

Table 11. Effect of dicamba on the seed yield and seed germination of timothy.

Rate of dicamba, kg/ha	Stage application	1978 Seed yield, kg/ha	1978 % reduction	1978 % germination	1979 Seed yield, kg/ha	1979 % reduction	1979 % germination
0	-	276 b[1]		95 a[1]	349 a[1]		92 a[1]
.14	Fall	319 a	0	91 abc	272 b	22	86 a
.14	Before stem elongation	209 bcd	24	88 abcd	170 cd	51	87 a
.14	Shot-blade	186 cde	33	85 bcde	93 ef	73	65 c
.14	Early heading	131 efg	52	79 ef	-	-	-
.28	Fall	227 bc	17	93 abc	269 b	23	89 a
.28	Before stem elongation	159 def	42	84 cde	109 e	69	76 b
.28	Shot-blade	87 ghi	68	80 def	47 fg	86	61 cd
.28	Early heading	82 ghi	70	75 fg	-	-	-
.56	Fall	115 fgh	58	93 ab	164 d	53	84 ab
.56	Before stem elongation	115 fgh	58	84 bcde	69 efg	80	82 ab
.56	Shot-blade	48 hi	82	70 g	31 g	91	55 d
.56	Early heading	44 i	84	76 efg	-	-	-

[1]Means within each column followed by the same letter are not significantly different at P = .05.

2. *Control of dandelions.*

A. *Chemical control of dandelions.*[1]

Introduction: Dandelions are probably the number one weed problem i creeping red fescue grown for seed. In regions with a warmer or more humid climate than northern Alberta 2,4-D has generally given good dandelion control. In northern Alberta, dandelions, particularly well established plants, are quite tolerant to 2,4-D. Because of the dandelion problem in fescue fields, studies were initiated in 1969 to find improved methods for their control.

Methods: The studies consisted of herbicide trials conducted in dandelion infested, commercial fields of creeping red fescue. In all trials the herbicide treatments were applied with experimental sprayers. All evaluations of herbicide effectiveness were made during the first growing season after treatment, i.e. treatments applied in the fall (early to mid-September) or in the spring (early to mid-May) were evaluated in the following June, July or August. All trials were located in the Beaverlodge area.

Results: Dandelion control was poor from both fall and spring treatments of 2,4-D (Table 12). Fall treatments appeared to be slightly more effective than spring treatments. Within all treatments, large variations in percent dandelion control occurred from year-to-year. For example, control with 2,4-D applied at .56 kg/ha in the fall ranged from 0 to 66%. There is no good explanation for this variability at present. However, unfavourable soil moisture conditions before and after treatment may account for some of the poor dandelion control.

Picloram plus 2,4-D provided better dandelion control than 2,4-D alone (Table 13). The optimum combination of these 2 herbicides in terms of efficiency and cost appears to be picloram plus 2,4-D at .07 + 1.12 kg/ha. On the average, this combination produced a 15 to 20% improvement in dandelion control over 2,4-D alone.

Combinations of dicamba plus 2,4-D have also given improved dandelion control in comparison with 2,4-D alone (Table 14). In terms of crop tolerance, cost and effective dandelion control the combination of dicamba plus 2,4-D at .28+.56 kg/ha appears to be optimum. A combination of dicamba plus 2,4-D at .42+1.12 kg/ha gave good dandelion control but caused considerable fescue injury.

In addition to the herbicides or herbicide combinations mentioned above we have examined combinations of 2,4,5-T plus 2,4-D and dichloroprop plus 2,4-D. Both of these combinations have given good dandelion control but severe fescue injury has been observed. Another combination, Dowco 290 (Lontrel) plus 2,4-D has given excellent control without causing fescue injury.

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[1]Work on these trials was conducted in cooperation with W. Yarish, Plant Industry Division, Alberta Agriculture, Edmonton.

In most trials we have applied 56 to 67 kg/ha of N fertilizer in the fall to one-half of each plot. This fertilization has resulted in a positive herbicide-fertilizer effect on dandelion control in 2 of the 9 trials. In addition, in most trials we have obtained a beneficial fertilizer effect on seed yields.

Consistent increases in seed yield from treatments applied in the above trials have not been obtained. Seed yield data from some of the most promising treatments are shown in Table 15. With the possible exception of fall applied 2,4-D plus dicamba, none of the herbicides produced increased yields during the growing season following treatment.

In six trials seed yields were obtained in the second year following herbicide treatment. In three of the six trials large increases in yield (33 to 70%) were obtained. In the other three trials only small seed yield increases occurred. This data suggests several possible things may be occurring.

a) the dandelions are depressing seed yields but the depressing effects of the herbicides are cancelling out their beneficial effects,

b) competition effects from the dandelions and injurious effects of the herbicide treatments are negligible, or

c) the benefits from removing dandelions do not appear until the second growing season after treatment. Further research is required to determine which of these possibilities is occurring.

The results of these trials suggest a need for more research in developing a method of controlling dandelions in fescue. At present it would appear that herbicides should not be used unless the dandelion infestation is heavy (i.e. possibly more than 12 large plants/m^2). Where fescue is established using a companion crop, application of herbicides in the fall of the year of seeding appear best. Seed yields during the year after seeding are usually very low, and thus, the depressing effects of the herbicide on seed yields will result in little economic loss. Where the fescue is established without a companion crop and treated as a biennial crop, herbicides should probably be applied in the early spring of the first year of seed production.

Table 12. Percent control of dandelions with 2,4-D amine in seed-producing stands of creeping red fescue.

		Rate of 2,4-D, kg/ha			
		Fall applied		Spring applied	
Year	Location	.56	1.12	.56	1.12
1969	1	-	-	11	17
1970	1	0	11	-	-
1971	1	-	-	-	-
1972	1	-	-	-	-
1973	1	-	-	60	60
1974	1	49	58	59	65
	2	66	66	49	50
1975	1	45	54	31	39
	2	52	68	0	17
1976	1	0	30	21	26
Average		35	48	33	37

Table 13. Percent control of dandelions with picloram plus 2,4-D in seed-producing stands of creeping red fescue.

		Rate of Picloram + 2,4-D, kg/ha					
		Fall applied			Spring applied		
Year	Location	.07+1.12	.14+1.12	.42+.84	.07+1.12	.14+1.12	.42+.84
1969	1	-	-	-	38	-	83
1970	1	11	-	33	-	-	-
1971	1	-	-	-	56	50	89
1972	1	86	42	69	-	-	-
1973	1	-	-	-	93	-	-
	2	-	-	-	84	-	-
1974	1	68	64	-	65	-	-
	2	74	78	-	63	-	-
1975	1	83	-	-	50	-	-
	2	75	-	-	68	-	-
1976	1	78	-	-	15	-	-
Average		68			59		

Table 14. Percent control of dandelions with dicamba plus 2,4-D in seed-producing stands of creeping red fescue.

		Rate of Dicamba + 2,4-D, kg/ha					
		Fall applied			Spring applied		
Year	Location	.28+.56	.28+.84	.42+1.12	.28+.56	.28+.84	.42+1.12
1971	1	-	-	-	-	-	81
1972	1	-	-	76	-	-	-
1973	1	-	-	-	-	-	99
	2	-	-	-	-	-	94
1974	1	-	-	65	57	-	-
	2	-	-	92	65	-	-
1975	1	78	93	78	43	62	-
	2	80	83	86	51	74	-
1976	1	78	89	96	56	50	-
Average		79	88	82	54	62	91

Table 15. Seed yields (kg/ha) of creeping red fescue in the growing season following treatment with herbicides.

Herbicide treatment	Site years	Herbicide applied in fall	Site years	Herbicide applied in spring
Check	3	410	5	340
2,4-D, 1.12kg/ha		380		349
Check	3	410	3	420
2,4-D + dicamba, .56+.28 kg/ha		480		400
Check	3	410	7	300
2,4-D + picloram, 1.12+.07 kg/ha		430		300

B. *Crop competition for dandelion control.*

Introduction: Crop competition is a major tool in suppressing weed growth and invasion. A study was conducted in cooperation with Dr. C.R. Elliott to determine the effectiveness of six grass species, each growing at varying row spacings, in reducing the establishment and growth of dandelions.

Methods: Intermediate wheatgrass (cv. Chief), bromegrass (cv. Carlton), meadow fescue (cv. Mimer), Russian wild ryegrass (cv. Sawki), creeping red fescue (cv. Boreal) and timothy (cv. Climax) were each seeded in seven-row plots. The rows were arranged in a fan-shaped design so that the spacing between rows was 10 cm at one end and 100 cm at the other end. Two seedings were made: one in 1972 and the other in 1973. Dandelions were allowed to infest the grasses. Annual measurements of dandelion density and canopy diameter (the average distance between leaf tips in east-west and north-south directions) were made at row spacings of 30, 50, 70 and 90 cm for 3 years following the year of seeding.

Results and Discussion: Both grass species and row spacing had a significant effect on dandelion growth. At narrow row spacings (30 cm) the size of dandelions growing in vigorous, aggressive grasses such as intermediate wheatgrass, bromegrass, meadow fescue, creeping red fescue and timothy was much smaller than the size of dandelions growing in the slow growing, low yielding Russian wild ryegrass (Figure 1). At row spacings greater than 30 cm grass species had very little effect on the size of the dandelions.

Dandelion density between the rows of all grass species was similar when comparisons were made within each of the selected row spacings. However, dandelion density between rows, averaged over all grasses, declined as row spacing declined. In 1976, the density of dandelions growing amongst grasses seeded in 1973 was approximately 40% less in row spacings of 30 cm than in row spacings of 90 cm.

These results have demonstrated several important features relating to the control of dandelions and presumably many other weeds. Intermediate wheatgrass, bromegrass, meadow fescue, creeping red fescue when seeded in narrow rows (30 cm or less) were able to compete vigorously with dandelions. In these grasses, row spacing can be considered as an important method of weed control. Russian wild ryegrass, on the other hand, had only a minor effect on the dandelion, regardless of row spacing. For this grass under northern conditions, as well as for the other grasses seeded in row spacings greater than 30 cm, tillage and other methods of control appear more important than crop competition.

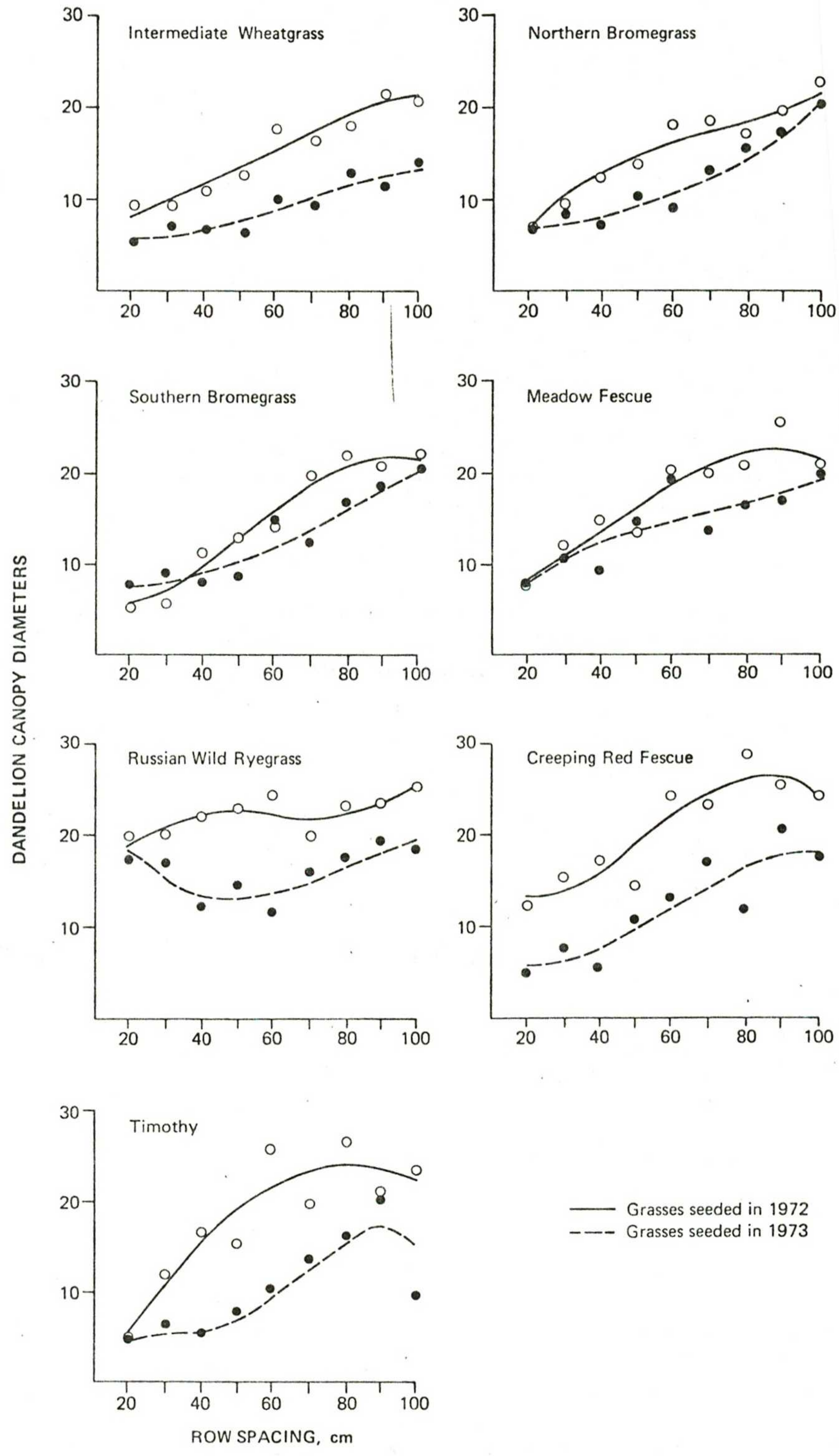

Figure 1. Effect of grass species and row spacing on the canopy diameter (cm) of dandelions. Dandelion canopy diameters from grasses seeded in 1972 are the average from samplings made in 1973, 1974 and 1975 while those from grasses seeded in 1973 are the average made in 1975 and 1976.

C. *Combination of cultural and chemical procedures for weed control in creeping red fescue.*

Introduction: Research on the use of single herbicide treatments has not provided a consistent means of controlling dandelions (see Tables 12-15). Cultural controls, such as crop competition and row spacing, have been successful in controlling dandelions. However, other agronomic considerations often prevent the use of such methods. Casual observations indicate that young, immature dandelion plants are easy to control while old, established plants are almost impossible to control. The purpose of this study was to develop a systematic approach to the control of dandelions utilizing cultural and chemical control techniques.

Methods:

Experiment 1. Weed control in fescue seeded without a companion crop.

On May 25, 1977, Boreal creeping red fescue was sown in rows spaced 30 cm apart. The following treatments were imposed on the fescue.

1. Check - no weed control.

2. Bromoxynil plus MCPA at .28 + .28 kg/ha applied July 14, 1977 when fescue in the 3-leaf stage and weeds in 4- to 8-leaf stage. Interrow spaces rotovated July 25, 1977.

3. Same as 2 except no rotovation between rows.

4. Same as 2 but in addition, dicamba plus 2,4-D at .25+ .55 kg/ha were applied on August 15, 1977 when the fescue was 10 cm in height. Interrow spaces rotovated July 25, 1977.

5. Same as 4 except no rotovation between rows.

6. Same as 2 but, in addition, dicamba plus 2,4-D applied May 5, 1978 when the fescue was in the 3-leaf stage and the weeds in the rosette stage. Interrow spaces rotovated July 25, 1977.

7. Same as 6 except no rotovation between rows.

Herbicide treatments were applied in a spray volume of 168 L/ha. Each treatment was replicated four times. On October 18, 1977 the plots were fertilized with 50 kg/ha N. Weed counts were obtained in June 1978 and in July 1979. Fescue seed yields were obtained in 1978 and 1979.

On June 7, 1978, the same experiment was seeded again. However, in plots where rotovation was used the rows were spaced 60 cm apart rather than 30 cm apart. The dates on which the herbicide treatments were applied are listed in Table 16. Stages of crop and weed development at the time of herbicide application were similar to those described for the 1977 seeding. Fescue seed yields and weed counts were obtained in 1979.

Experiment 2. Weed control in fescue seeded with a companion crop.

Boreal creeping red fescue was underseeded either with Galt barley or Torch rapeseed on May 27, 1977 on a silt loam to clay loam soil. The barley was harvested either as silage (S) on August 2, 1977 or as grain (G) on September 23, 1977. The rapeseed was harvested August 31, 1977. Bromoxynil plus MCPA at .28 + .28 kg/ha, dicamba plus 2,4-D at .25 + .55 kg/ha and 2,4-D at .4 kg/ha were applied in a spray volume of 168 L/ha on dates listed in Table 17. Each treatment was replicated four times. Weed counts and fescue seed yields were obtained on all plots in June, 1978 and July, 1979.

On June 4, 1979 the same experiment was seeded again. The barley - S was harvested on August 8, 1979 while the barley - G; was harvested on September 18, 1979. The rapeseed was harvested on August 30, 1979. Weed counts were obtained in July of 1980 and 1981 while fescue seed yields were obtained in 1981.

Results: Crop growth in all years except 1980 was good. Drought conditions in the fall, 1979 and early spring 1980 resulted in either very poor seed yields or no seed yields. Weed growth was greater in experiments seeded in 1978 than in experiments seeded other years. Major weed species included dandelions, peppergrass, shepherd's purse, stinkweed, clover species, lamb'squarters, common groundsel and wild buckwheat.

Experiment 1 - in plots seeded in 1977 effective weed control was obtained from all treatments (Table 16). Bromoxynil + MCPA applied at the 3-leaf stage of the fescue in 1977 followed in August, 1977 or May, 1978 by an application of dicamba plus 2,4-D provided the most effective weed control. Fescue seed yields were greater in plots with good dandelion control than in the weedy check in 1979 but not in 1978. A single rotovation between the rows of fescue in 1977 did not improve dandelion control.

In plots seeded in 1978, bromoxynil + MCPA followed by dicamba + 2,4-D in the fall or early spring again provided the best weed control when the rows of fescue were spaced 30 cm apart. Increasing the row spacing to 60 cm resultedin a marked decline in weed control. Fescue seed yields were not increased as a result of the herbicide treatments in either 30 or 60 cm row spacings. Seed yields were higher in plots where the fescue rows were 30 cm apart than in plots where the fescue rows were 60 cm apart.

Experiment 2 - Applications of bromoxynil + MCPA followed by applications of dicamba + 2,4-D provided the best weed control regardless of whether the barley was used for silage or grain (Table 17). This weed control was maintained for the 3-year-period following each seeding. In plots where barley was used for silage weed populations tended to be greater and weed control from herbicides poorer than in plots where barley was used for grain. Weed control was not as good from the use of rapeseed as a companion crop and a single application of 2,4-D as from sequential applications of bromoxynil+MCPA and dicamba+2,4-D.

Where barley was used for silage, the seed yield of fescue 2 years after seeding was higher in plots receiving herbicide treatment than in the untreated check plots. Where barley was used for grain the use of herbicides did not increase fescue seed yields. In 1978, seed yields one year after seeding were higher in plots where the barley had been used for silage than in plots where it had been used for grain. No seed was produced in 1980 from plots seeded in 1979.

Conclusions: Sequential applications of bromoxynil+MCPA at .28 + .28 kg/ha shortly after seeding (when the crop is in the 3-leaf stage) and dicamba + 2,4-D in the late summer (August) or early spring (May) provided the best control of dandelions and other broadleaved weeds in creeping red fescue..

Table 16. Weed control in creeping red fescue sown without a companion crop.

A. Results from 1977 seeding

Herbicide	Date of applic.	Rotovation between rows	Fescue yield, kg/ha		Dandelions/m^2		Total weeds/m
			1978	1979	1978	1979	1978
Check, weedy	-	N	520 a[1]	360 d[1]	27 a[1]	31 a[1]	32 a[1]
Bromoxynil+MCPA	14/7/77	Y	540 a	480 bcd	2 bc	2 b	3 bc
Bromoxynil+MCPA	14/7/77	N	520 a	540 abcd	4 c	5 b	5 b
Bromoxynil+MCPA Dicamba+2,4-D	14/7/77 15/8/77	Y	440 a	660 a	0 c	1 b	1 c
Bromoxynil+MCPA Dicamba+2,4-D	14/7/77 15/8/77	N	460 a	640 ab	0 c	1 b	1 c
Bromoxynil+MCPA Dicamba+2,4-D	14/7/77 5/5/78	Y	440 a	560 abc	0 c	1 b	1 c
Bromoxynil+MCPA Dicamba+2,4-D	14/7/77 5/5/78	N	550 a	480 bcd	2 bc	4 b	2 ab

B. Results from 1978 seeding

Herbicide	Date applic.	Row spacing, cm	Fescue yield kg/ha 1979	Dandelions /m^2 1979	Total weeds /m^2 1979
Check, weedy	-	30	890 ab[1]	10 ab[1]	31 ab
Check, weedy	-	60	740 bcd	10 ab	37 ab
Bromoxynil+MCPA	16/7/78	30	940 a	4 c	13 bc
Bromoxynil+MCPA	16/7/78	60	470 e	12 a	50 a
Bromoxynil+MCPA Dicamba+2,4-D	16/7/78 28/8/78	30	640 cde	2 c	5 c
Bromoxynil+MCPA Dicamba+2,4-D	16/7/78 28/8/78	60	670 bcde	6 bc	28 abc
Bromoxynil+MCPA Dicamba+ 2,4-D	16/7/78 7/6/79	30	870 abc	1 c	3 c
Bromoxynil+MCPA Dicamba+2,4-D	16/7/78 7/6/79	60	520 de	6 bc	26 abc

[1]Means within each column followed by the same letter are not significantly different at P = .05.

Table 17. Weed control in creeping red fescue sown with a companion crop.

A. Results from 1977 seeding

Companion crop and use	Herbicide application date		Fescue seed yield, kg/ha		Dandelions/m²		Total weeds /m²
	1	2	1978	1979	1978	1979	1978
Barley - S	N.A.[1]	N.A.	130 a[2]	630 a[2]	36 a[2]	26 a[2]	57 a[2]
Barley - S	24/6/77	N.A.	110 ab	870 a	17 bc	12 bc	10 cd
Barley - S	24/6/77	15/8/77	30 cd	900 a	6 c	4 e	1 d
Barley - S	24/6/77	5/5/78	100 abc	860 a	1 d	4 e	24 bcd
Barley - G	N.A.	N.A.	10 d	690 ab	15 bc	15 b	44 ab
Barley - G	24/6/77	N.A.	10 d	850 a	9 c	11 bcd	15 cd
Barley - G	24/6/77	29/9/77	10 d	780 a	4 c	5 de	4 d
Barley - G[3]	N.A.	N.A.	-	800 a	16 bc	9 bcde	19 cd
Rapeseed[4]	N.A.	N.A.	50 bcd	770 a	13 bc	11 bcd	21 cd

[1]N.A. = not applied. [2]Means within each column and followed by the same letter are not significantly different at P = .05. [3]Mowed for weed control in 1978. [4]2,4-D applied May 31, 1978.

B. Results from 1979 seeding

Companion crop and use	Herbicide application date		Fescue yields, kg/ha	Dandelions/m²		Total weeds/m²	
	1	2	1981	1980	1981	1980	1981
Barley - S	N.A.[1]	N.A.	590 c[2]	7.0 ab[2]	6.9 a[2]	57.0 a[2]	7.8 a[2]
Barley - S	29/6/79	N.A.	840 bc	2.0 c	2.1 c	11.0 de	2.6 bc
Barley - S	29/6/79	22/7/79	850 ab	0.6 c	3.4 c	21.0 cd	4.9 b
Barley - S	29/6/79	13/6/80	900 a	0.5 c	1.8 c	3.0 e	1.8 c
Barley - G	N.A.	N.A.	760 abc	6.0 ab	7.0 a	43.0 b	7.5 a
Barley - G	29/6/79	N.A.	770 abc	1.2 c	2.2 c	8.7 e	2.7 bc
Barley - G	29/6/79	13/6/80	740 abc	1.0 c	3.0 bc	20.7 cd	4.1 bc
Barley - G[3]	N.A.	N.A.	830 ab	1.0 c	1.8 c	11.5 de	2.5 bc
Rapeseed[4]	N.A.	N.A.	810 abc	2.8 b	4.0 bc	24.2 c	5.1 b

[1]N.A. = not applied. [2]Means within each column followed by the same letter are not significantly different at P = .05. [3]Mowed for weed control in 1980. [4]2,4-D applied June 13, 1980.

3. *Control of narrow-leaved hawk's-beard.*

A. *Control of narrow-leaved hawk's-beard in established creeping red fescue.*

Introduction: Narrow-leaved hawk's-beard is a slender, yellow-flowered annual or winter annual species which is a member of the composit family. In recent years this weed has been rapidly invading seed-producing fields of creeping red fescue in the Peace River region of Alberta and British Columbia. Work at the University of Alberta by Vanden Born and Shraa has shown that 2,4-DB (Embutox) applied at 1.12 to 1.68 kg/ha in late September or early October will give effective control of hawk's-beard in alfalfa. Since information on the control of this weed in fescue was lacking we conducted a study to evaluate the effect of several chemicals for hawk's-beard control.

Methods: The study was conducted in a commercial field of creeping red fescue seeded in 1970. Herbicide treatments were applied either in the fall (October 5 to 16) or in the spring (May 12 to 17). The hawk's-beard was in the rosette stage at all times of application. Fall treatments were repeated for each of 3 years while spring treatments were repeated for each of 2 years. Each year the herbicide treatments were replicated 5 times. All treatments were applied in a spray volume of 168 L/ha. Weed harvests were made in late June or in July each year.

Results and Discussion: The major findings of this work are:

a) Applications of 2,4-DB at 1.40 kg/ha or more and of 2,4-D ester at 1.12 kg/ha in the fall (early to mid-October) consistently provided good hawk's-beard control over the 3.5 year period (Table 21). A combination of 2,4-D dicamba and mecoprop (Banvel 3) at .56 kg/ha provided good control in 2 out of 3 years. With these treatments the hawk's-beard plants were not immediately killed but became distorted in the fall and died during the following spring.

b) Spring applications (early to mid-May) of 2,4-DB at 1.40 kg/ha, 2,4-D ester at 1.12 kg/ha and dicamba plus 2,4-D plus mecoprop at .56 kg/ha provided good hawk's-beard control. However, control tended to be poorer than from fall applied treatments.

c) A combination of 2,4,5-T plus MCPA (Celatox) provided adequate hawk's-beard control in only one of the 3 years of evaluation.

d) Bromoxynil plus MCPA (Buctril M or Brominal M) at .56 and .84 kg/ha, MCPB (Tropotox) at 1.12 or 1.68 kg/ha and MCPA at .56 and 1.12 kg/ha were each evaluated for one year. None of these treatments provided adequate hawk's-beard control.

Table 18. Effect of several herbicides on narrow-leaved hawk's-beard growing in an established stand of creeping red fescue.

Herbicide	Rate, kg/ha	Hawk's-beard dry weight, kg/ha			
		1971-72	1972-73	1973-74	Average
Fall-applied treatments					
Check	0	300	486	233	340
2,4-DB	1.12	129	46	3	59
2,4-DB	1.40	13	34	4	17
2,4-DB	1.68	13	16	29	19
2,4-D ester	.56	40	41	4	29
2,4-D ester	1.12	19	26	24	22
(MCPA+2,4,5-T)	.42	121	206	144	157
(MCPA+2,4,5-T)	.84	21	102	96	73
(Dicamba+2,4-D) +mecoprop)	.28	96	136	32	88
(Dicamba+2,4-D +mecoprop)	.56	4	68	13	29
Spring-applied treatments					
Check	0	-	315	170	242
2,4-DB	1.40	-	22	12	18
2,4-D ester	1.12	-	31	18	25
(MCPA+2,5-T	.84	-	95	21	58
(Dicamba+2,4-D +mecoprop)	.56	-	44	4	24

Table 19. List of herbicide common names (CSA approved), trade names and formulations used in studies.

Common name	Trade name	Formulation
2,4-D	Various names	Various formulations
MCPA	Various names	50% EC
Dicamba+2,4-D+mecoprop	Banvel 3	50% EC
Bromoxynil+MCPA	Buctril M, Brominal M	40% EC
Picloram	Tordon 22K	24% EC
2,4,5-T	Brushkil	48% EC
Barban	Carbyne, Wypout	12% EC
Difenzoquat	Avenge	32% Solution
Diclofop methyl*	Hoe-Grass	36% EC
Flamprop methyl	Matavan	10.5% EC
Dicamba	Banvel Liquid Herbicide	40% EC
2,4-DB	Embutox E	40% EC
MCPB	Tropotox	40% EC
Dowco 290	Lontreal	36% EC
Linuron	Lorox, Lexone	50% WP
Cyanazine+MCPA	Blagal	37.5% WP
Metribuzin	Sencor	48% WP

*No Renex 36 in formulation.

Metric Conversions

Conversion for oz/A and lb/A to kg/ha.

oz/A	kg/ha	oz/A	kg/ha
1	.07	17	1.19
2	.14	18	1.26
3	.21	19	1.33
4	.28	20	1.40
5	.35	21	1.47
6	.42	22	1.54
7	.49	23	1.61
8	.56	24	1.68
9	.63	25	1.75
10	.40	26	1.82
11	.77	27	1.89
12	.84	28	1.96
13	.91	29	2.03
14	.98	30	2.10
15	1.05	31	2.17
16	1.12	32	2.24

To convert oz/A to kg/ha multiply ounces/acres x .070063 = __________ kg/ha.

lb/A	kg/ha	lb/A	kg/ha
1	1.121	4	4.484
1 1/4	1.401	4 1/2	5.044
1 1/2	1.681	5	5.605
1 3/4	1.961	6	6.726
2.0	2.242	7	7.847
2 1/2	2.802	8	8.968
3	3.363	9	10.089
3 1/2	3.923	10	11.210

To convert lbs/acre into kg/ha multiply lbs/acre x 1.121 = __________ kg/ha.

Water Volume: Gal. (Imp.)/A x 11.233 = __________ liters/ha.

Spray Pressure: lb/in^2 x 0.070 = __________ kg/cm^2.

Chemical Activity: lb/gal. (Imp.) x 0.1 = __________ kg/liter

lb/gal. (U.S.) x 0.12 = __________ kg/liter