AN ABSTRACT OF THE THESIS OF

Gale Allen Gingrich for the degree of Master of Science

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Title: EFFECT OF BROADLEAF WEEDS ON WINTER WHEAT YIELDS

Redacted for privacy

Abstract approved: Dr. Norman Goetze

The use of diclofop {2-[4-(2,4-dichlorophenoxy)phenoxy] propanoic acid methyl ester} in winter wheat (Triticum aestivum L.) provided excellent control of Italian ryegrass (Lolium multiflorum Lam.) and wild oats (Avena fatua L.). This observation was made in six field experiments on soft white winter wheat in Western Oregon. The addition of either diuron [3-(3,4-dichlorophenyl)-1,1-dimethylurea] or metribuzin [4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)-one] during the winter months or spring applications of 2,4-D [(2,4-dichlorophenoxy) acetic acid], dicamba (3,6-dichloro-o-anisic acid) or MCPA {[(4-chloro-o-tolyl) oxy] acetic acid} controlled many broadleaf weeds. Applications of herbicides to high populations of grass and braodleaf weeds provided significant yield increases over the untreated checks. At three of the six locations significant yield increases were obtained by controlling the broadleaf weeds. Yields ranged from no increase to 23%

increase where treatment with diclofop, which controlled only the grass weeds, was compared to the metribuzin treatment, which controlled both grass and broadleaf weeds.

Time of broadleaf weed control did not significantly affect grain yields. At five of the locations, delaying control until spring did not result in significantly reduced yields when compared to winter control.

Broadleaf weeds were a much greater problem in fields where the previous crop was irrigated vegetables or a non-irrigated legume seed crop than in fields where the previous crop was winter wheat. A wide range in broadleaf weed density existed between locations with a low of 38 weeds/m^2 to nearly 1500/m^2. There were many species of broadleaf weeds present at each location with a total of 22 different species found.

Grass weeds were a problem in at least one location of each rotation system.

Effect of Broadleaf Weeds on Winter Wheat Yields

by

Gale Allen Gingrich

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This thesis is written
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EFFECT OF BROADLEAF WEEDS ON WINTER WHEAT YIELDS

INTRODUCTION

Wheat is an important cash crop in the Willamette Valley of Western Oregon. Because of the wide diversity of crops produced, it is grown extensively in rotation with many other types of crops as well as in a monoculture situation. Acreage and yields have increased significantly during the past two decades with improved varieties and better herbicide practices being important contributing factors. The majority of the soft white wheat grown is winter wheat and approximately 80% of this is treated each winter with diuron for Italian ryegrass and broadleaf weed control. Because of the widespread distribution and seriousness of Italian ryegrass and wild oats in winter wheat production, the major weed research on winter wheat in Western Oregon has been aimed at controlling these two weed species (1, 3).

Italian ryegrass populations of 45 to 62 plants/m^2 reduced yields of semi-dwarf wheat varieties by 37% and in taller varieties where populations were 69 to 85 plants/m^2, yields were reduced by over 20% (1). Recent experimental applications of a new herbicide, diclofop, have resulted in excellent Italian ryegrass and wild oat control and have increased grain yields by 2170 kg/ha over the most commonly used herbicide, diuron (3).

Crop and weeds compete primarily for light, moisture, and nutrients (6, 9). Which factor is most important is determined partially by crop, specific weed, and location of production (2, 7). In addition, some evidence exists which indicates that early removal of weeds results in greatest yield responses (4). Ryegrass has been found to be a strong competitor (1) and if not controlled soon after emergence, will cause yield reductions in wheat (8). Competition and influence on yield from other weed species are not always the same. In the semi-arid regions of the Pacific Northwest, blue mustard (Chorispora tenella (Willd.) DC) was found to cause the most serious damage to winter wheat yields during the winter months (10) and appreciable yield increases were not experienced if control was delayed until spring. An increase in mustard density also adversely affected yield. Swan and Furtick (11) on the other hand observed that only one coast fiddleneck (Amsinckia intermedia Fisch & May) per square foot caused yield reductions and at higher densities, little or no additional reduction was experienced.

Results from post emergence herbicide application for control of broadleaf weeds in winter wheat have been variable. Experiments in Europe have indicated that appreciable yield increases following spraying for broadleaf weed control are not general and in fact may result in some yield reduction (5).

This study was conducted in anticipation of registration of diclofop for use in winter wheat production. Since it has excellent activity on

Italian ryegrass and wild oats, many growers are expected to use this herbicide and reduce their dependence on fall applications of diuron. Three consequences of such a change are considered.

1. If diclofop becomes the major fall-applied herbicide replacing diuron, will broadleaf weed infestations become a winter wheat production problem?
2. If broadleaf weeds do cause grain yield reductions, what combination of broadleaf weed herbicides with diclofop will result in greatest yield increases?
3. Is there a difference in broadleaf weed problems between three common wheat rotation systems?

MATERIALS AND METHODS

The experiments in this study were conducted in winter wheat on six commercial farms in Western Oregon. They were carried out during two successive crop years, 1976 and 1977, at three locations each year.

Because of the diversity of crops raised on many Western Oregon farms, each of the experiments was conducted on a different crop rotation situation each of the two years. The preceding crop was a vegetable crop, crimson clover for seed, or wheat. Fields did not receive supplemental irrigation during summer months; however, where vegetables were the previous crop, the fields had been irrigated during the summer before wheat was planted.

All fields were located in the mid-Willamette Valley near Salem, Oregon. The area has a modified marine climate with approximately 70% of the 1000 mm average annual precipitation occurring during the 5-month period from November through March. Most of the winter precipitation is in the form of rain. The soil type on which plots were located is a Woodburn silt loam which is a mesic Aquultic Argixeroll. This series is composed of moderately well-drained soils that have formed in silty alluvium and loess of mixed mineralogy. The surface is a very dark brown silt loam about 43 cm thick. The surface is somewhat acidic with a pH 5.6 to 6.0 and is quite fertile. Depth of root penetration is restricted by a seasonal perched water table but subsurface

tiling has partially solved this problem.

The experiments were established in the fields after the cooperating farmer cultivated and planted the wheat according to his normal cultural practices. Planting time varied from early October to late November. Two cultivars of soft white winter wheat, Yamhill and Hyslop, were used in the study. All fields were seeded at a rate of approximately 112 kg/ha. Only one of the fields, a second-year wheat field, received fall-applied fertilizer. All six locations received 67 to 168 kg N/ha in the spring in the form of urea or a solution of ammonium nitrate, urea, and water. The rate depended on the previous crop with the higher rate used when wheat followed wheat. The experiments were designed as randomized complete blocks with six replications.

The herbicide treatments included diclofop alone and diclofop in combination with other herbicides for annual broadleaf weed control. Table 1 lists treatments and rates used each year at each location. These combinations included both fall and spring-applied herbicides. The diclofop applications were made in late fall or early winter, November through early January.

Herbicide applications were made with a bicycle-wheel plot sprayer. Water was used as the carrier at a rate of 230 L/ha. Plot size was 3 m by 9.1 m the first year and 3 m by 7.6 m the second year.

Visual evaluations of the weed control were made prior to harvest. Numbers of weeds in three of the treatments, diclofop, metribuzin, and

untreated checks in three randomly selected 0.37-m^2 quadrats were counted during early spring when broadleaf weeds were in the rosette stage and the grasses were in the two-to-five-leaf stage. The weeds recorded in the counts were categorized only as grass weeds and broadleaf weeds. Perennial weeds were not considered a serious problem at any location. In the wheat-wheat rotation in 1977, there were a few scattered quackgrass (Agropyron repens (L.) Beav.) plants.

Grain yields were obtained by harvesting each plot with a small-plot combine in late July to early August. The harvested grain samples were recleaned to remove foreign material before weighing. Yields from all locations were analyzed statistically and L.S.D.'s at the 5% level of probability were determined (Table 1).

RESULTS AND DISCUSSION

Weed Populations

Weed counts taken in control plots at each location where winter wheat was grown under one of three different rotation systems showed considerable variation in broadleaf weed population density (Table 2). When wheat was grown in rotation with crimson clover and vegetable crops, broadleaf weed populations were high. Broadleaf weed density was low to moderate when wheat followed wheat. In 1977, broadleaf weeds were extremely heavy, more than $600/m^2$, in the clover and vegetable rotations. The number of broadleaf weeds of each species was not determined; however, totals of all weed species were recorded. Ivyleaf speedwell (Veronica hederaefolia L.) was the most abundant species found in the clover and vegetable rotation in 1977. Other commonly encountered broadleaf weeds found in the various fields included mayweed (Anthemis cotula L.), common chickweed (Stellaria media L.), sticky chickweed (Cerastium viscosum L.), and common groundsel (Senecio vulgaris L.).

Grass weeds were also counted and their densities are recorded in Table 3. Italian ryegrass and wild oats were found to be most numerous. A few annual bluegrass (Poa annua L.) and quackgrass (Agropyron repens (L.) Beauv.) were found in several plots. Total grass weed populations ranged from 9 to $248/m^2$ in the control plots. Relatively high populations

were counted in each rotation system in at least one of the two years.

Grain Yield and Herbicide Treatment

Significant yield increases from herbicide applications (P=0.05) were obtained at five of the six locations (Table 1). The clover-wheat rotation in 1976 did not have significant yield increases from herbicide application. At this location there were very few grass weeds and broadleaf weed populations were only moderate. In addition, a portion of the broadleaf weed count included seedling red clover (Trifolium pratense L.) that had been underseeded by the grower a month prior to weed count.

Table 3 shows that diclofop gave excellent grass weed control and that metribuzin, applied alone, provided both excellent grass and broadleaf weed control. These two treatments were used to determine the effect of broadleaf weeds on grain yields. The effect of broadleaves on wheat yield was determined by comparing yields from diclofop, which controlled only the grass, and metribuzin, which controlled both grasses and broadleaves. Broadleaf control resulted in significant yield increases in three of six locations (Table 4). In two locations, where no yield differences occurred, broadleaf weed populations were relatively low. In the 1977 vegetable rotation, broadleaf weed populations were high and yield differences approached significance at the 5% level. However, significant yield differences between other treatments where

both grass and broadleaf weeds were controlled in the fall were obtained (Table 1). Although significant differences in yield were observed between treatments at a given location, no significant correlation of weed density and yield was obtained when regressions were completed over the entire study.

Timing of Weed Control

In addition to weed counts taken in the three treatments, a visual evaluation of weed control was made of all treatments. Several herbicide treatments provided good broadleaf weed control (Table 5). In 1976 good control of broadleaf weeds resulted from both fall-applied metribuzin and from spring applications of 2,4-D, MCPA, and dicamba. Poor control with spring applications were indicated in 1977; however, this may be due to the short time elapsed between treatment and evaluation and thus complete control had not yet occurred.

At only one location was there a significant yield increase from controlling broadleaf weeds in the winter when compared to delaying control until spring. Yield differences were not significant where the highest yield from winter broadleaf control was compared to the highest yield from treatments that provided control in the spring (Table 6). There were no statistical yield differences between the various spring broadleaf weed killers applied sequentially to winter application of diclofop. Yields from treatments of 2,4-D alone trended higher than

MCPA alone or 2,4-D plus dicamba applications in five of six locations.

Grain yield is not the only consideration by the grower when considering herbicide applications. A lack of significant yield increase from winter broadleaf weed control compared to delaying treatment until spring may not be reason enough to delay control until spring. Spring weather in Western Oregon is unstable and soil conditions are often too wet to permit timely ground application. A fall or winter herbicide treatment of diuron or metribuzin, in combination with diclofop, to control broadleaf weeds could be advantageous from both an economical and application standpoint.

Results of the experiments indicate that if broadleaf weeds are not controlled when present in high numbers, grain yield reductions can be expected. Where spring-applied herbicides are properly timed and effective, delaying treatment for broadleaf weed control until early spring should not significantly reduce yields of winter wheat under western Oregon conditions.

Crop Rotation

Crop rotation has long been considered a major benefit in helping to control various types of weeds. In this study, broadleaf weed populations were significantly higher where the previous crop was either clover or vegetables (Table 2). In clover seed stands,

particularly annual clovers, control of broadleaf weeds is difficult because available herbicides with adequate selectivity are limited. This study indicates that crop rotation does not necessarily reduce weed problems. Grass weeds were associated with all rotation systems and broadleaf weeds were most prevalent in the cropping system where wheat was rotated with other crops.

Table 1. Average winter wheat yields at six locations.

Herbicide[a]	Rate	Previous crop: Vegetables		Wheat		Clover		Avg
		Year of harvest						
	(kg/ha)	1976	1977	1976	1977	1976	1977	(kg/ha)
diclofop	1.12	6310	2701	6203	2997	6767	4093	4845
diuron	1.79	4449	2164	5154	3434	6928	4106	4373
metribuzin	0.56	7238	3474	6021	3783	6801	5295	5435
diclofop + diuron	1.12 + 1.34	6975	4193	6289	3454	6518	4576	5318
diclofop + metribuzin	1.12 + 0.28	7022	4428	6075	3494	6875	4912	5468
diclofop + 2,4-D	1.12 + 0.84	7540	3172	6512	3347	6532	4968	5348
diclofop + 2,4-D + dicamba	1.12 + 0.56 + 0.14	6861	3044	5954	3266	6342	4912	5063
diclofop + MCPA	1.12 + 0.84	6733	3098	6256	3333	6646	4470	5089
diclofop + diuron + 2,4-D	1.12 + 1.34 + 0.84	6848	4825	6223	3152	6357	5349	5459
Control	0	2399	1035	5248	1532	6781	2984	3330
	L.S.D. 0.05	685	779	800	585	383	585	

[a]Diclofop, diuron, and metribuzin were applied post-emergence to wheat in the fall or early winter. Dicamba, 2,4-D, and MCPA were applied in the spring.

Table 2. Average broadleaf weed density and winter wheat yields in control plots.

Previous crop	1976		1977	
	Density weeds/m^2	Yield kg/ha	Density weeds/m^2	Yield kg/ha
Vegetable	161	2399	735	1035
Wheat	117	5248	38	1532
Clover	206	6781	1496	2984

Table 3. Broadleaf and grass weed population densities in winter wheat in three rotations[a].

	Broadleaf weeds						Grass weeds					
	Previous crop											
	Vegetable		Wheat		Clover		Vegetable		Wheat		Clover	
	Year of harvest											
Treatment	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
	weeds/m^2											
diclofop	152	665	106	57	195	1409	20	16	0	5	0	1
metribuzin	31	12	-	15	16	37	12	4	-	8	0	1
Control	161	735	117	38	206	1496	154	212	11	248	9	100

[a]Average number of weeds counted in three randomly selected quadrants in each of six replications. Counts were made in early spring.

Table 4. Winter wheat yield comparisons of grass control alone with grass plus broadleaf control in three rotations.

Treatment	Previous crop: Vegetable, Year of harvest 1976*	Vegetable 1977	Wheat 1976	Wheat 1977*	Clover 1976	Clover 1977*
	(kg/ha)					
Grass control alone (diclofop)	6310	2701	6203	2997	6767	4093
Grass plus broadleaf control (metribuzin)	7237	3474	6021	3783	6801	5297
L.S.D. 0.05	685	779	800	585	383	585

*Significant difference at the 5% level.

Table 5. Visual evaluation of broadleaf and grass weed control[a].

	Broadleaf weeds						Grass weeds					
	Previous crop											
	Vegetable		Wheat		Clover		Vegetable		Wheat		Clover	
	Year of harvest											
Treatment	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
	Weed control[b]											
diclofop	48	28	37	-	47	3	90	100	98	-	-	90
diuron	85	38	78	-	77	33	47	58	52	-	-	40
metribuzin	88	99	85	-	95	97	80	100	82	-	-	99
diclofop + diuron	78	63	87	-	93	37	93	100	97	-	-	99
diclofop + metribuzin	92	99	92	-	93	93	97	100	88	-	-	100
diclofop + 2,4-D	90	20	97	-	92	4	90	100	95	-	-	99
diclofop + 2,4-D + dicamba	95	26	98	-	98	5	93	100	93	-	-	99
diclofop + MCPA	90	21	92	-	95	5	93	100	100	-	-	99
diclofop + diuron + 2,4-D	95	64	98	-	100	34	92	100	97	-	-	100
Control	0	0	0	0	0	0	0	0	0	0	0	0

[a]Evaluations were made in spring or early summer.

[b]Evaluation based on: 100 = complete control, 0 = no control.

Table 6. Winter wheat yield comparisons between fall broadleaf control and spring broadleaf control.

	Previous crop					
	Vegetable		Wheat		Clover	
	Year of harvest					
	1976	1977*	1976	1977	1976	1977
	(kg/ha)					
High Yield - fall control	7237	4428	6189	3783	6928	5295
High yield - spring control	7540	3172	6512	3347	6646	4968
L.S.D. 0.05	685	779	800	585	383	585

*Significant difference at the 5% level.

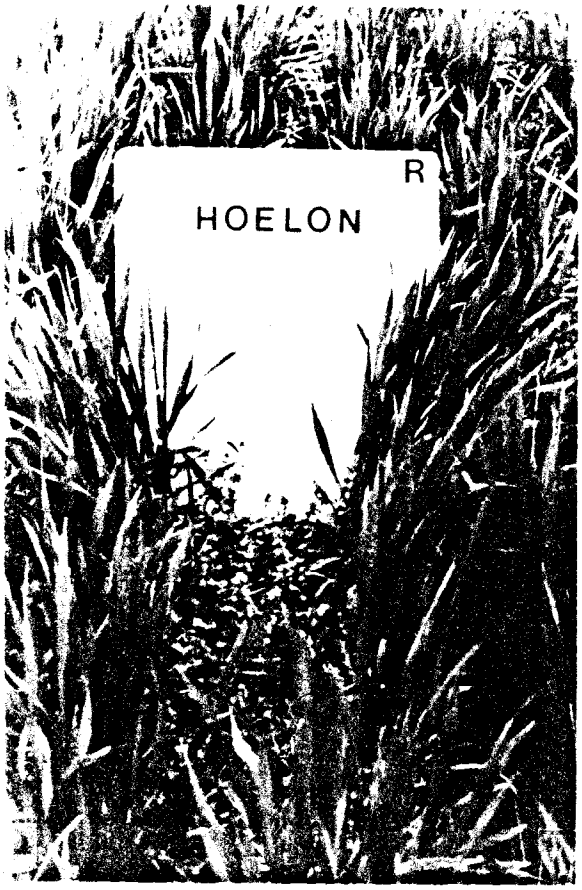

Figure 1. Weed control in treatment with diclofop at 1.12 kg/ha in wheat-vegetable rotation, 1977.

Figure 2. Weed control in treatment with metribuzin at 0.56 kg/ha in wheat-vegetable rotation, 1977.

Figure 3. Check plot in wheat-vegetable rotation, 1977.

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APPENDICES

Appendix Table 1. Analysis of variance of wheat yields in wheat-vegetable rotation locations.

Harvest year 1976

Source of variation	df	Analysis of variance ss	MS	F
Reps	5	5,558,018.31	1,111,603.66	
Trts	9	138,222,007.0	15,358,000.7	29.107
Reps x Trts	45	23,743,573.4	527,634.96	

C.V. = 11.6% $L.S.D._{0.05}$ = 685.4 kg/ha

Harvest year 1977

Source of variation	df	Analysis of variance ss	MS	F
Reps	5	3,176,297.36	635,259.47	
Trts	10	115,223,409.0	11,522,340.9	22.2498
Reps x Trts	50	25,893,181.8	517,863.64	

C.V. = 19.55% $L.S.D._{0.05}$ = 779.5 kg/ha

Appendix Table 2. Analysis of variance of wheat yields in wheat-wheat rotation locations.

Harvest year 1976

Source of variation	Analysis of variance df	ss	MS	F
Reps	5	3,745,008.75	749,001.75	
Trts	9	15,779,135.4	1,753,237.27	2.472
Reps x Trts	45	31,911,537.1	709,145.27	

C.V. = 11.5% $L.S.D._{0.05}$ = 799.7 kg/ha

Harvest year 1977

Source of variation	Analysis of variance df	ss	MS	F
Reps	5	29,712,961.3	5,942,592.27	
Trts	9	23,598,862.4	2,622,095.82	8.872
Reps x Trts	45	13,299,652.0	295,547.82	

C.V. = 15.77% $L.S.D._{0.05}$ = 584.6 kg/ha

Appendix Table 3. Analysis of variance of wheat yields in wheat-clover rotation locations.

Harvest year 1976

Source of variation	Analysis of variance df	ss	MS	F
Reps	5	2,673,837.13	534,767.42	
Trts	9	2,329,903.75	258,878.19	2.422
Reps x Trts	45	4,809,283.75	106,872.97	

C.V. = 4.9% L.S.D. $_{0.05}$ = 383.0 kg/ha

Harvest year 1977

Source of variation	Analysis of variance df	ss	MS	F
Reps	5	10,033,910.3	2,006,782.06	
Trts	12	70,856,698.7	5,904,724.89	20.961
Reps x Trts	60	16,902,339.8	281,705.66	

C.V. = 11.28% L.S.D. $_{0.05}$ = 584.6 kg/ha

Appendix Table 4. Weed species found in wheat-vegetable rotation.

Year of harvest	
1976	1977
Wild geranium	Ivyleaf speedwell
Mayweed	Vetch
Common chickweed	Sticky chickweed
Sticky chickweed	Common chickweed
Common groundsel	Field pea
Vetch	Wild carrot
Bachelor button	Annual ryegrass
Annual ryegrass	Wild oats
Wild oats	

Appendix Table 5. Weed species found in wheat-wheat rotation.

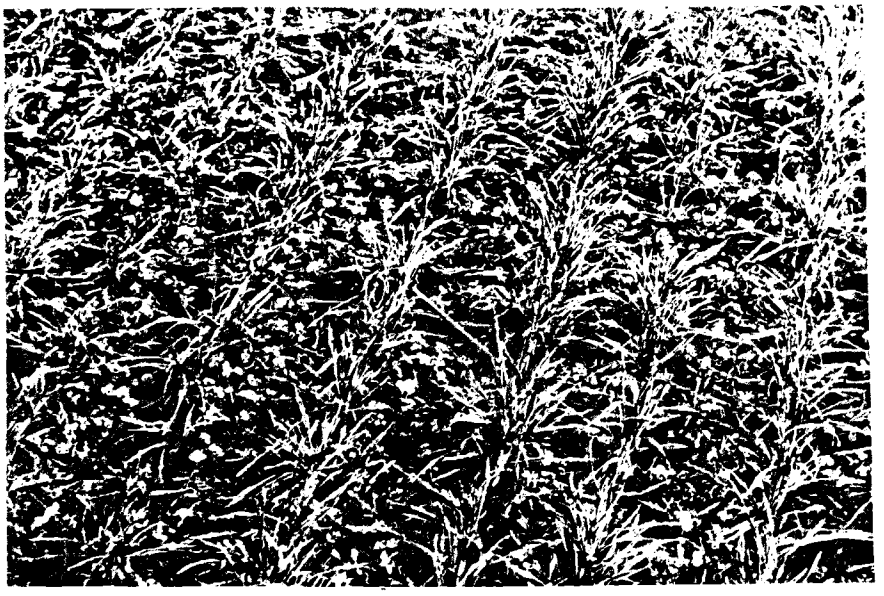
Year of harvest	
1976	1977
Miner's lettuce	Vetchling
Vetchling	Mayweed
Common chickweed	Sticky chickweed
Prostrate knotweed	Common chickweed
Wild carrot	Little bittercress
Mayweed	Vetch
Annual ryegrass	Wild garlic
Wild oats	Annual ryegrass
Annual bluegrass	Quackgrass
	Wild oats

Appendix Table 6. Weed species found in wheat-clover rotation.

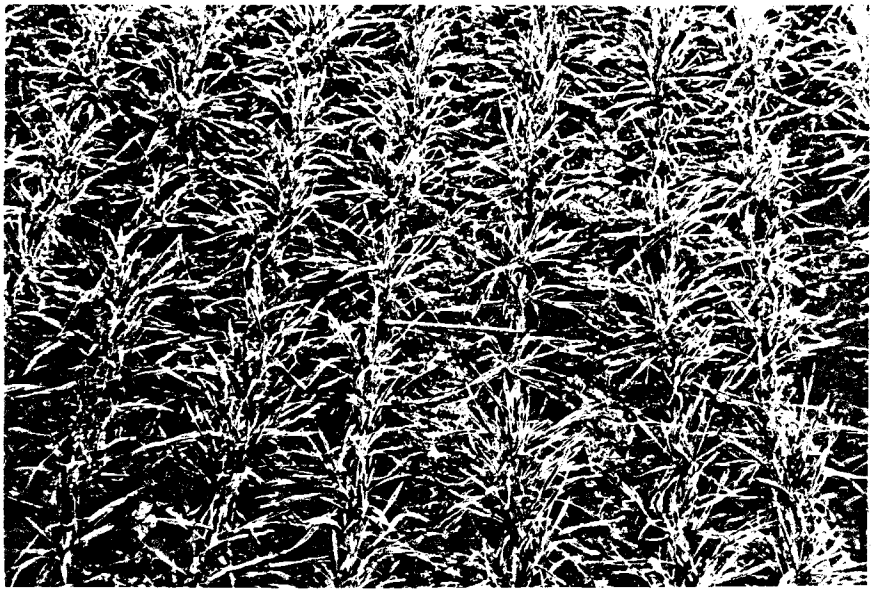
Year of harvest	
1976	1977
Common groundsel	Common groundsel
Common mustard	Mayweed
Sticky chickweed	Sticky chickweed
Common chickweed	Common chickweed
Little bittercress	Ivyleaf speedwell
Vetchling	Shepherd's purse
Wild carrot	Miner's lettuce
Prostrate knotweed	Little bittercress
Prickly lettuce	Annual ryegrass
Bachelor button	
Annual ryegrass	
Annual bluegrass	

Appendix Table 7. Latin name of weeds found in all locations.

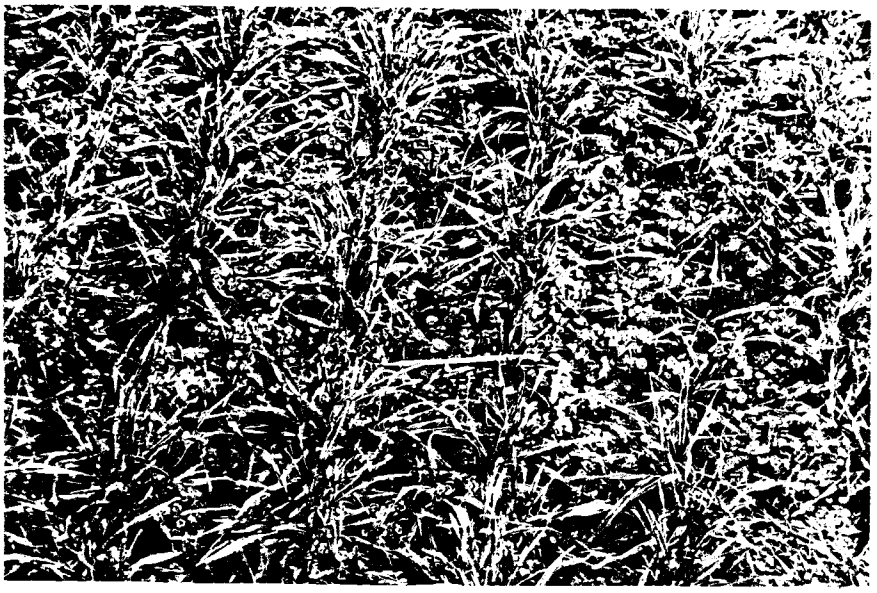
Annual bluegrass	Poa annua (L.)
Annual ryegrass	Lolium multiflorum (Lam.)
Bachelor button	Centaurea cyanus (L.)
Common chickweed	Stellaria media (L.) Cyr.
Common groundsel	Senecia vulgaris (L.)
Common mustard	Brassica rapa (L.)
Field pea	Pisum arvense
Ivyleaf speedwell	Veronica hederaefolia (L.)
Little bittercress	Cardamine oligosperma (Nutt.)
Mayweed	Anthemis cotula (L.)
Miner's lettuce	Montia perfoliata (L.)
Prickly lettuce	Lactuca scariola (L.)
Prostrate knotweed	Polygonum aviculare (L.)
Quackgrass	Agropyron repens (L.) Beauv.
Shepherd's purse	Capsella bursa-pastoris (L.) Moench.
Sticky chickweed	Cerastium viscosum (L.)
Vetch	Vicia sp.
Vetchling	Lathyrus sp.
Wild carrot	Daucus carota (L.)
Wild garlic	Allium vineale (L.)
Wild geranium	Geranium sp.
Wild oats	Avena fatua (L.)



Appendix Figure 1. Weed control in treatment with diclofop at 1.12 kg/ha in wheat-vegetable rotation, 1977.



Appendix Figure 2. Weed control in treatment with metribuzin at 0.56 kg/ha in wheat-vegetable rotation, 1977.



Appendix Figure 3. Check plot in wheat-vegetable rotation, 1977.

Appendix Table 8. General information and application data for Cecil Roth farm, wheat-vegetable rotation, 1976.

Planting date:	October 10, 1975
Harvest date:	August 20, 1976
Previous crop:	Bush beans
Wheat variety:	Yamhill
Plot size:	3 m by 9.1 m
Row spacing:	15 cm
Soil type:	Willamette silt loam
Fertilizer:	Spring - 112 kg N/ha

Application data

Date:	11/12/1975	1/16/1976	4/2/1976
Condition:			
Air temp.	6C	11C	16C
Soil temp.	9C	10C	12C
Rel. humidity	92%	93%	50%
% cloud cover	0	100	0
Wind speed	0-3 km/h	0	0-10 km/h
Wind direction	S	-	N-W
Method of application:	Broadcast	Broadcast	Broadcast
Carrier & volume	Water, 230 L/ha	Water, 230 L/ha	Water, 230 L/ha
Nozzle size	8002	8002	8002½
Pressure	2.0 kg/cm^2	2.0 kg/cm^2	2.0 kg/cm^2
Stage of growth:			
Wheat	2-3 leaf	3 tiller	8-9 tiller
Grass	1-3 leaf	1-3 tiller	4-6 tiller
Broadleaf	pre-emergence	rosette	seedling
Herbicides applied:	diclofop diuron	metribuzin	2,4-D MCPA dicamba

Appendix Table 9. General information and application data for Gerald Roth farm, wheat-vegetable rotation, 1977.

Planting date:	October 15, 1976
Harvest date:	August 1, 1977
Previous crop:	Bush beans
Wheat variety:	Hyslop
Plot size:	3 m by 7.6 m
Row spacing:	17 cm
Soil type:	Woodburn silt loam
Fertilizer:	Spring - 67 kg N/ha

Application data

Date:	11/12/1976	3/21/1977
Conditions:		
Air temp.	17C	18C
Soil temp.	14C	17C
Rel. humidity	70%	52%
% cloud cover	0	40
Wind speed	8-16 km/h	8 km/h
Wind direction	N	S
Method of application:	Broadcast	Broadcast
Carrier & volume	Water, 230 L/ha	Water, 230 L/ha
Nozzle size	80015	8002
Pressure	2.0 kg/cm^2	2.0 kg/cm^2
Stage of growth:		
Wheat	5-6 leaf	7-9 tillers
Grass	1-3 leaf	2-4 tillers
Broadleaf	rosette	seedling
Herbicides applied:	diclofop	2,4-D
	diuron	MCPA
	metribuzin	dicamba

Appendix Table 10. General information and application data for K & K farms, wheat-wheat rotation, 1976.

Planting date:	November 8, 1975
Harvest date:	August 3, 1976
Previous crop:	Winter wheat
Wheat variety:	Yamhill
Plot size:	3 m by 9.1 m
Row spacing:	15 cm
Soil type:	Woodburn silt loam
Fertilizer:	Fall - 22 kg N/ha
	Spring - 168 kg N/ha

Application data		
Date:	1/20/1976	4/26/1976
Conditions:		
Air temp.	11C	20C
Soil temp.	11C	20C
Rel. humidity	75%	74%
% cloud cover	0	10
Wind speed	8-16 km/h	10-11 km/h
Wind direction	NE	NE
Method of application:	Broadcast	Broadcast
Carrier & volume	Water, 230 L/ha	Water, 230 L/ha
Nozzle size	8002	8002
Pressure	2.0 kg/cm^2	2.0 kg/cm^2
Stage of growth:		
Wheat	3-4 leaf	7 tillers
Grass	1-3 leaf	5-6 tillers
Broadleaf	rosette	bud
Herbicides applied:	diclofop	2,4-D
	diuron	MCPA
	metribuzin	dicamba

Appendix Table 11. General information and application data for Leonard Squier farm, wheat-wheat rotation, 1977.

Planting date:	October 6, 1976
Harvest date:	August 1, 1977
Previous crop:	Winter wheat
Wheat variety:	Hyslop
Plot size:	3 m by 7.6 m
Row spacing:	15 cm
Soil type:	Woodburn silt loam
Fertilizer:	Spring - 112 kg N/ha

Application data

Date:	11/12/1976	3/21/1977
Conditions:		
Air temp.	17C	19C
Soil temp.	12C	19C
Rel. humidity	70%	62%
% cloud cover	0	10
Wind speed	0-8 km/h	0
Wind direction	N	-
Method of application:	Broadcast	Broadcast
Carrier & volume	Water, 230 L/ha	Water, 230 L/ha
Nozzle size	80015	8002
Pressure	2.0 kg/cm^2	2.0 kg/cm^2
Stage of growth:		
Wheat	3-4 leaf	2-3 tiller
Grass	1-2 leaf	2-4 tiller
Broadleaf	pre-emergence	seedling-bud
Herbicides applied:	diclofop	2,4-D
	diuron	MCPA
	metribuzin	dicamba

Appendix Table 12. General information and application data for Ray Satter farm, wheat-clover rotation, 1976.

Planting date:	November 3, 1975
Harvest date:	August 20, 1976
Previous crop:	Crimson clover
Wheat variety:	Hyslop
Plot size:	3 m by 9.1 m
Row spacing:	15 cm
Soil type:	Woodburn silt loam
Fertilizer:	Spring - 112 kg N/ha

Application data

Date:	1/16/1976	4/26/1976
Conditions:		
Air temp.	11C	18C
Soil temp.	10C	19C
Rel. humidity	93%	74%
% cloud cover	100 (fog)	30
Wind speed	0	8-11 km/h
Wind direction	-	NE
Method of application:	Broadcast	Broadcast
Carrier & volume	Water, 230 L/ha	Water, 230 L/ha
Nozzle size	8002	8002
Pressure	2.0 kg/cm^2	2.0 kg/cm^2
Stage of growth:		
Wheat	3 leaf	7-8 tillers
Broadleaf	seedling	seedling - bud
Herbicides applied:	diclofop	2,4-D
	diuron	MCPA
	metribuzin	dicamba

Appendix Table 13. General information and application date for Clarence Schmidt farm, wheat-clover rotation, 1977.

Planting date:	October 20, 1976
Harvest date:	August 1, 1977
Previous crop:	Crimson clover
Wheat variety:	Yamhill
Plot size:	3 m by 7.6 m
Row spacing:	15 cm
Soil type:	Woodburn silt loam
Fertilizer:	Spring - 112 kg N/ha

Applicationsdata

Date:	12/21/1976	3/21/1977
Conditions:		
Air temp.	3C	17C
Soil temp.	3C	17C
Rel. humidity	90%	48%
% cloud cover	100 (fog)	40
Wind speed	0	0
Wind direction	-	-
Method of application:	Broadcast	Broadcast
Carrier & volume	Water, 230 L/ha	Water, 230 L/ha
Nozzle size	8002	8002
Pressure	2.0 kg/cm^2	2.0 kg/cm^2
Stage of growth:		
Wheat	5-6 leaf	6-8 tiller
Grass	2-4 leaf	2-4 tiller
Broadleaf	seedling	seedling - bud
Herbicides applied:	diclofop	2,4-D
	diuron	MCPA
	metribuzin	dicamba

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