TOLERANCE OF FIELD PEAS TO GRAMINICIDES AND METRIBUZIN COMBINATIONS

Najib Malik
Pesticides Directorate, Agriculture Canada, Ottawa, Ontario

Lawrence Townley-Smith
Agriculture Canada Research Station, Melfort, Saskatchewan

ABSTRACT

Tolerance of two cultivars of field peas (Pisum sativum L.) to sethoxydim, fenoxaprop-P-ethyl, clethodim, fluazifop-P-butyl and haloxyfop, and their combinations with metribuzin was investigated in 1987, 1988 and 1989. Both Trapper and Victoria peas exhibited satisfactory tolerance to metribuzin (0.21 kg a.i. ha^{-1}) and the graminicides when tested alone. However, tank mixed treatments caused some crop injury which sometimes affected pod maturity and seed yield. Tank mixes significantly reduced Victoria yield by 7% compared to graminicides alone. Trapper yield was not significantly reduced. The increased injury observed with metribuzin when tank mixed, was attributed to the use of adjuvants, required for enhancing graminicidal activity, which may have increased foliar uptake of metribuzin by peas. The adverse effect of metribuzin in tank mixes was more pronounced on both cultivars in 1988 when it was exceptionally hot and dry.

INTRODUCTION

In view of the increasing emphasis on crop diversification which supports a sustainable production system, the area of field peas, or dry peas (Pisum sativum L.) in Saskatchewan has dramatically increased from 28,000 ha in 1985 to a high of 170,000 ha in 1988. This rapid increase in the production of field peas in Saskatchewan from 57,000 tonnes in 1985 to 250,000 tonnes in 1987 was due to the importance of field peas as a cash crop, the low grain prices, and increased world demand for protein feed (Ali-Khan 1989). Since over 80% of Canadian field pea production is destined for export markets, Saskatchewan farmers have been successful in adopting the new cultivars that are in high demand.

In addition to the quick cash reward that peas provide to the farmers, fertilizer expenses for peas are less than for other crops. Legumes are considered to be an integral part of a sound rotation system. Since the roots of this pulse crop support nitrogen fixing bacteria, it improves soil fertility and may continue to have a residual beneficial effect on succeeding crops (Germida 1990). Comparison of a pulse-barley-wheat and a barley-barley-wheat cropping system on Black and Gray-wooded soils of northeastern Saskatchewan showed that peas increased cereal yields by 21% in the first year and 12% in the second year (Wright 1990a). Inclusion of field peas in this rotation also had a significant impact on quality of succeeding crops. Kernel mass of cereal grains increased by 1.9 mg, plumpness by 5 percentage units and protein content by 0.6 percentage unit (Wright 1990b).

Since field peas do not compete well with aggressive weeds, weed management is essential for successful production of field peas. In northeastern Saskatchewan, annual broadleaf weeds such as stinkweed (Thlaspi arvense L.), wild mustard [Brassica kaber (D.C.) L.C. Wheeler], shepherd's-purse [Capsella bursa-pastoris (L.) Medicus], lamb's-quarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), volunteer oilseed crops; and annual grass weeds such as wild oats (Avena fatua L.), green foxtail (Setaria viridis L.), and volunteer cereals compete with field peas. Even light infestations of weeds such as lamb's-quarters, false cleavers (Galium spurium L.), and Canada thistle (Cirsium arvense L.) which may not reduce yields directly, can hamper harvesting operations and downgrade seed quality due to staining.

Reports on weed interference in field peas are rather limited in published literature. Using traditional varieties in Minnesota, Nelson and Nyland (1962) found that 28 wild mustard plants m^{-2} reduced pea stand by 25%, fresh wt. of pea foliage 39-71%, and seed yields 0-64%. In a similar study, a green foxtail density of 250 plants m^{-2} was required for comparable stand and yield reductions. At Morden, Manitoba, Friesen (1988) investigated the comparative competitive effects of wild mustard on a semi-leafless cultivar (Tipu) and a traditional cultivar (Century). For most agronomic factors studied, the threshold level of wild mustard was found to be below 60 plants m^{-2}. Plant height of Tipu was reduced significantly when wild mustard was removed 7 days after emergence. Plant height of Century, however, was reduced significantly only after 21 days of competition. Significant reductions in yield were observed when wild mustard was removed 7 days after emergence in Tipu, but 14 days after emergence in Century.

One of the most common herbicide treatments for field peas is metribuzin, however since broad-spectrum weed control is desired, farmers wish to supplement metribuzin with either a preplant incorporated treatment of trifluralin or with a post-emergence treatment of the relatively new generation of graminicides. Research into developing weed management practices at Melfort Research Station began in 1985 in view of the increasing importance of this crop in northeastern Saskatchewan (Malik 1988). The objective of this field investigation was to evaluate tank mixes of metribuzin and five graminicides on Trapper and Victoria cultivars.

MATERIALS AND METHODS

1987

Inoculated Trapper and Victoria field peas were seeded at the rate of 135 and 165 kg ha^{-1}, respectively; and seeding depth of 5 cm into Melfort silty clay loam (pH = 6.3, O.M. = 12%) on May 19, 1987. The two crops were seeded as 5-m wide parallel strips each having 16 rows. Seed placed fertilizers with the seed drill included 40 kg ha^{-1} of 11-51-0 and 80 kg ha^{-1} of 21-0-0-24. Four rows each of wild oats and green foxtail were seeded as parallel strips in between the two pea cultivars. The annual grasses were therefore not competing with the crop. After crop and weed emergence, the site was used to establish a randomized complete block design field experiment with 4 replicates and 10 treatments for each variety. The main plots were 2.75 m x 12.00 m. Three rows of winter wheat were sown in between each plot in order to keep the plots physically apart and prevent intertwining of pea vines in adjacent plots.

Metribuzin was tested alone and as tank-mixed treatments with four graminicides, namely sethoxydim, fluazifop-P-butyl, haloxyfop, and fenoxyprop-P-ethyl.

A tractor-mounted shielded sprayer equipped with a 2-m boom and 4 nozzles was used to apply the herbicide treatments in 125 L ha^{-1} spray volume at 275 kPa. The treatments were applied postemergence on June 9 (20 C) when peas were 10-15 cm long (3-4 pair of leaves), wild oats 15-20 cm (3-4 leaves), and green foxtail 5-10 cm (1-2 leaves). A heavy infestation of stinkweed (4-8 leaves) dominated the broadleaf weeds. Light infestations of redroot pigweed and lamb's-quarters (2-4 leaves) were also present. Visual assessments of crop vigor and weed control were recorded 3 wk after the treatment date. A 1.25 m x 5.00 m area of each pea cultivar was harvested with Wintersteiger plot combine on Sept. 11. Records of precipitation for the growing season at Melfort are presented in Table 1.

Table 1. Precipitation (mm) for the growing season at Melfort Research Station, Saskatchewan.

Year	May	June	July	August	Total
	----------	----------	mm	----------	----------
1987	31	25	88	74	218
1988	14	16	34	80	144
1989	53	64	3	62	182
Normals	38	71	64	54	227

1988

The two field pea cultivars and the annual grass weeds were seeded in close proximity to the 1987 site on May 16. The experimental design was expanded to accommodate five more treatments. In addition to the four graminicides tested alone and in combination with metribuzin, clethodim was also added to the list of treatments (Table 2). The treatments were applied June 10 (23 C), when field peas were 8-15 cm (3-4 pair of leaves), wild oats 20-25 (3-4 leaves), green foxtail 5-10 cm (1-2 leaves), and stinkweed seedlings in the 4-8 leaf stage. Assessments of crop vigor and weed control ratings were recorded 4 wk later. Peas were harvested August 9, as reported for the 1987 experiment.

1989

Another site close to the 1988 site was selected to repeat the experiment. Field peas and the annual grass weeds were sown May 30. The herbicide treatments were applied June 27 (20 C), rather later than the intended date because of a rainy period. Field peas were 6-15 cm (mostly 4 pair of leaves), wild oats 20-35 cm (flag leaf), volunteer wheat (10-15 cm), and green foxtail 5-10 cm (1-2 leaves). The main broadleaf weeds were redroot pigweed (4 leaves) and lamb's-quarter (4-7 leaves). Visual ratings of weed control and crop vigor were recorded in late July. Field peas were harvested August 22. Data were subjected to analysis of variance and the means separated by LSD at the 5% level of significance.

RESULTS AND DISCUSSION

Crop Vigor

In 1987, with the exception of the tank-mixed application of metribuzin plus sethoxydim, excellent crop vigor was observed for Trapper peas with all other treatments (Table 2). Victoria peas, however, appeared to be more sensitive to the tank-mixed applications as is evident from lower vigor ratings recorded when each one of the four graminicides was combined with metribuzin. In 1988, Trapper peas was injured slightly when metribuzin was tank-mixed with clethodim, fluazifop-P-butyl, and haloxyfop. The only significant injury noted on Victoria, however, was caused by combination of haloxyfop and metribuzin. In 1989, none of the herbicide treatments had any adverse effect on Trapper, while Victoria was injured to some extent when metribuzin was tank-mixed with sethoxydim, fenoxaprop-P-ethyl, clethodim, and fluazifop-P-butyl.

In general, Victoria peas appeared to be more vulnerable to herbicide injury caused by tank-mixing of metribuzin and the graminicides Since metribuzin at the 0.21 kg ha^{-1} rate tested alone, and the graminicides tested alone at the X and 2X rates did not injure the crop, it is believed that the adjuvant, added to enhance graminicidal activity, may increase foliar uptake and absorption of metribuzin by field pea plants and hence increase risk of injury.

Weed Control

Satisfactory control (rating of 7.5 and above) of wild oats was achieved with sethoxydim, fenoxaprop-P-ethyl, haloxyfop, and only the higher rate of clethodim and fluazifop-P-butyl (Table 3). A slight reduction in the activity of the graminicides was observed when tank-mixed with metribuzin. This antagonism was more apparent for the tank-mixed application of fluazifop-P-butyl plus metribuzin.

Control of green foxtail was satisfactory with sethoxydim, haloxyfop and the higher rate of clethodim and fluazifop-P-butyl. A slight reduction in graminicidal activity was apparent except for haloxyfop, in tank mixes with metribuzin.

Table 2. Crop vigor assessments recorded 3-4 wk after application of herbicides to Trapper and Victoria field peas at Melfort, Saskatchewan

Treatment	Rate kg a.i. ha^{-1}	Trapper				Victoria			
		1987	1988	1989	Mean	1987	1988	1989	Mean
		rating[1]							
Metribuzin	0.21	9.0	8.8	8.0	8.6	9.0	8.6	8.0	8.5
Sethoxydim + Assist + Ammonium sulphate	0.25 + 1% + 4%	9.0	8.8	8.0	8.6	9.0	8.8	7.8	8.5
Metribuzin + Sethoxydim + Assist + Ammonium Sulphate	0.21 + 0.25 + 1% + 4%	7.8	8.1	7.8	7.9	7.8	8.1	7.2	7.7
Fenoxaprop-P-ethyl	0.11	9.0	8.6	8.0	8.5	9.0	8.5	7.8	8.4
Fenoxaprop-P-ethyl + Metribuzin	0.11 + 0.21	9.0	8.1	7.8	8.3	7.8	8.4	7.0	7.8
Clethodim + Crop Oil Concentrate[2]	0.12 + 1%	–	8.8	8.0	8.4	–	8.6	7.5	8.1
Clethodim + Crop Oil Concentrate[2]	0.24 + 1%	–	8.5	8.0	8.2	–	8.9	7.8	8.4
Clethodim + Metribuzin + Crop Oil Concentrate[2]	0.12 + 0.21 + 1%	–	7.8	8.0	7.9	–	8.2	7.0	7.6
Fluazifop-P-butyl[3] + Superior Oil Concentrate	0.12 + 1%	9.0	8.6	8.0	8.5	9.0	9.0	7.8	8.6
Fluazifop-P-butyl[3] + Superior Oil Concentrate	0.25 + 1%	–	8.2	8.0	8.1	–	8.8	8.0	8.4
Fluazifop-P-butyl[3] + Metribuzin + Superior Oil Concentrate	0.12 + 0.21 + 1%	9.0	7.9	8.0	8.3	7.8	8.4	7.2	7.8
Fluazifop-P-butyl (TF 1195)	0.12	–	8.4	8.0	8.2	–	8.8	8.0	8.4
Haloxyfop + Canplus	0.15 + 1%	9.0	8.6	8.0	8.5	9.0	9.0	8.0	8.7
Haloxyfop + Canplus + Metribuzin	0.15 + 1% + 0.21	9.0	7.8	8.0	8.3	7.9	7.6	7.5	7.7
Check	–	9.0	8.6	8.0	8.5	8.7	8.9	8.0	8.5
LSD (0.05)		0.9	0.6	NS		0.8	1.1	0.7	

[1]Assessments based on a scale of 0-9; where 9 = no injury, 0 = plants killed.
[2]In 1989 OC 16255 was used.
[3]ICIA 0005 DF

Table 3. Visual assessments of weed control, recorded 3-4 wk after application of herbicides, averaged over 2-3 yr at Melfort

Treatment	Rate kg a.i. ha^{-1}	Wild oats	Green foxtail	Stinkweed	Lamb's-quarters
		rating[1]			
Metribuzin	0.21	2.0	3.5	9.0	7.6
Sethoxydim + Assist + Ammonium sulphate	0.25 + 1% + 4%	7.8	8.5	0.0	0.0
Metribuzin + Sethoxydim + Assist + Ammonium Sulphate	0.21 + 0.25 + 1% + 4%	6.7	7.5	9.0	8.0
Fenoxaprop-P-ethyl	0.11	8.0	7.0	0.0	0.0
Fenoxaprop-P-ethyl + Metribuzin	0.11 + 0.21	6.7	6.0	9.0	7.6
Clethodim + Crop Oil Concentrate[2]	0.12 + 1%	6.5	7.0	0.0	0.0
Clethodim + Crop Oil Concentrate[2]	0.24 + 1%	8.6	9.0	0.0	0.0
Clethodim + Metribuzin + Crop Oil Concentrate[2]	0.12 + 0.21 + 1%	6.8	8.0	9.0	7.8
Fluazifop-P-butyl[3] + Superior Oil Concentrate	0.12 + 1%	6.3	7.0	0.0	0.0
Fluazifop-P-butyl[3] + Superior Oil Concentrate	0.25 + 1%	8.4	8.0	0.0	0.0
Fluazifop-P-butyl[3] + Metribuzin + Superior Oil Concentrate	0.12 + 0.21 + 1%	5.5	6.5	9.0	7.4
Fluazifop-P-butyl (TF 1195)	0.12	5.8	6.5	0.0	0.0
Haloxyfop + Canplus	0.15 + 1%	8.0	7.5	0.0	0.0
Haloxyfop + Canplus + Metribuzin	0.15 + 1% + 0.21	6.7	8.0	8.0	8.1
Check	-	0.0	0.0	0.0	0.0
LSD (0.05)		1.5	1.3	0.5	1.7

[1] Assessments based on a scale of 0-9; where 0 = no control, 9 = complete control.
[2] In 1989 CC 16255 was used.
[3] ICIA 0005 DF

Metribuzin tested alone or in combination with the five graminicides provided excellent control of the dominant broadleaf weed, stinkweed, at each of the three experimental sites. Satisfactory control of the relatively light infestations of lamb's-quarters and redroot pigweed was observed during each of the 3 yr. Addition of graminicides to metribuzin did not affect performance of the latter herbicide on the broadleaf weeds present at the experimental sites.

Trapper Seed Yield

In 1987, all metribuzin mixtures with graminicides that were tested, except fenoxaprop-P-ethyl, significantly reduced yield, compared to metribuzin alone (Table 4). In 1988, metribuzin mixed with fenoxaprop-P-ethyl, clethodim and fluazifop-P-butyl reduced yield. No significant effects were shown in 1989. The metribuzin vs metribuzin + graminicide contrast, for combined 1988 and 1989 data, was not significant and neither was its interaction with year. The mixtures showed a trend towards lower yields when compared to the graminicides alone, but contrast analysis for the combined data for 1988 and 1989 indicated that the difference was not significant. In addition, contrasts to test graminicides and the graminicide x metribuzin interaction were not significant.

In 1987, no treatment significantly increased yield compared to the weedy check (Table 4). In 1988, metribuzin alone and sethoxydim alone increased yield over the check, as did fluazifop-P-butyl alone and mixed with metribuzin in 1989.

Victoria Seed Yield

In 1987, metribuzin mixtures with sethoxydim and haloxyfop significantly reduced yield compared to metribuzin alone (Table 5). In 1988, the mixture of clethodim and metribuzin also reduced yield. Mixture had no significant effect compared to metribuzin alone in 1989. The metribuzin vs metribuzin + graminicide contrast for combined 1988 and 1989 data was not significant, but there was a significant interaction with year. Mixtures of graminicides and metribuzin had significantly lower yields when compared to the graminicides alone, as shown by contrast analysis from the combined years 1988 and 1989. Contrasts to test among graminicides and the graminicide x metribuzin interaction were not significant.

In 1987, sethoxydim alone significantly increased yield compared to the weedy check (Table 5). There were no increses in 1988, but the clethodim-metribuzin mixture significantly reduced yield. In 1989, the higher rate of clethodim, clethodim-metribuzin mixture, fluazifop-P-butyl alone, and haloxyfop alone significantly increased yield compared to the weedy check.

Discussion

Graminicide efficacy was generally reduced in mixtures, but metribuzin efficacy was not. Yield data confirm the crop vigor assessments from both cultivars that tank mixing of graminicides with metribuzin causes some injury which can lead to yield reductions. Victoria is more sensitive to the mixtures compared to the graminicides alone. When mixtures are compared to

Table 4. Effect of herbicide treatments on seed yields of Trapper field peas at Melfort

Treatment	Rate kg a.i. ha^{-1}	Seed yield 1987	1988	1989	Mean
		kg ha^{-1}			
Metribuzin	0.21	2090	1480*	1940	1840
Sethoxydim + Assist + Ammonium sulphate	0.25 + 1% + 4%	2170	1480*	1790	1810
Metribuzin + Sethoxydim + Assist + Ammonium Sulphate	0.21 + 0.25 + 1% + 4%	1650*	1310	1900	1620
Fenoxaprop-P-ethyl	0.11	2010	1210	1880	1700
Fenoxaprop-P-ethyl + Metribuzin	0.11 + 0.21	1950	1190	1890	1680
Clethodim + Crop Oil Concentrate[1]	0.12 + 1%	-	1350	1850	1600
Clethodim + Crop Oil Concentrate[1]	0.24 + 1%	-	1320	2040	1680
Clethodim + Metribuzin + Crop Oil Concentrate[1]	0.12 + 0.21 + 1%	-	1160	1840	1500
Fluazifop-P-butyl[2] + Superior Oil Concentrate	0.12 + 1%	2020	1260	2270*	1850
Fluazifop-P-butyl[2] + Superior Oil Concentrate	0.25 + 1%	-	1180	1930	1560
Fluazifop-P-butyl[2] + Metribuzin + Superior Oil Concentrate	0.12 + 0.21 + 1%	1730*	950*	2210*	1630
Fluazifop-P-butyl (TF 1195)	0.12	-	1260	1980	1620
Haloxyfop + Canplus	0.15 + 1%	1930	1250	2160	1780
Haloxyfop + Canplus + Metribuzin	0.15 + 1% + 0.21	1780	1290	1910	1660
Check	-	1940	1230	1860	1680
LSD (0.05)		205	230	340	NS

*Significantly different from check at $P \leq 0.05$.
[1] In 1989 CC 16255 was used.
[2] ICIA 0005 DF

Table 5. Effect of herbicide treatments on seed yields of Victoria field peas at Melfort

Treatment	Rate kg a.i. ha^{-1}	Seed yield 1987	1988	1989	Mean
		kg ha^{-1}			
Metribuzin	0.21	2280	1620	1420	1770
Sethoxydim + Assist + Ammonium sulphate	0.25 + 1% + 4%	2470*	1810	1570	1950
Metribuzin + Sethoxydim + Assist + Ammonium Sulphate	0.21 + 0.25 + 1% + 4%	2010	1380	1480	1620
Fenoxaprop-P-ethyl	0.11	2240	1640	1700	1860
Fenoxaprop-P-ethyl + Metribuzin	0.11 + 0.21	2060	1480	1350	1630
Clethodim + Crop Oil Concentrate[1]	0.12 + 1%	–	1490	1560	1520
Clethodim + Crop Oil Concentrate[1]	0.24 + 1%	–	1870	1830*	1850
Clethodim + Metribuzin + Crop Oil Concentrate[1]	0.12 + 0.21 + 1%	–	1240*	1820*	1530
Fluazifop-P-butyl[2] + Superior Oil Concentrate	0.12 + 1%	2240	1570	1820*	1880
Fluazifop-P-butyl[2] + Superior Oil Concentrate	0.25 + 1%	–	1200*	1850*	1520
Fluazifop-P-butyl[2] + Metribuzin + Superior Oil Concentrate	0.12 + 0.21 + 1%	2130	1360	1660	1720
Fluazifop-P-butyl (TF 1195)	0.12	–	1440	1850*	1640
Haloxyfop + Canplus	0.15 + 1%	2230	1650	1910*	1930
Haloxyfop + Canplus + Metribuzin	0.15 + 1% + 0.21	1990	1470	1800	1750
Check	–	2100	1620	1380	1700
LSD (0.05)		260	340	430	NS

*Significantly different from check at $P \leq 0.05$.
[1] In 1989 CC 16255 was used.
[2] ICIA 0005 DF

metribuzin alone, all graminicides tended to reduce yield, but in many cases the reduction was not significant.

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LITERATURE CITED

Ali-Khan, S.T. and Zimmer, R.C. 1989. Production of field peas in Canada. Agric. Canada Publ. 1710/E. 21 p.

Friesen, G.H. 1988. Weed control in field peas. Agric. Can. Res. Stn., Morden, Manitoba.

Germida, J.J. 1990. Effect of herbicides on nitrogen fixation of pea and lentil. Sask. Pulse Crop Dev. Board Newsletter. 6(6):6.

Malik, N. 1988. Herbicide tolerance of field peas in northeastern Saskatchewan. Proc. Canadian Soc. Pest Manag., Calgary, Aug. 22-25.

Nelson, D.C., and Nylund, R.E. 1962. Competition between peas grown for processing and weeds. Weeds. 10:224-229.

Wright, A.T. 1990a. Yield effect of pulses on subsequent cereal crops in the northern prairies. Can. J. Plant Sci. 70:1023-1032.

Wright, A.T. 1990b. Quality effects of pulses on subsequent cereal crops in the northern prairies. Can. J. Plant Sci. 70:1013-1022.