HERBICIDE TOLERANCE AND WEED CONTROL IN MEADOWFOAM (*LIMNANTHES ALBA*)

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SUMMARY

Meadowfoam is a winter annual well adapted to poorly drained sites which has potential as a new oilseed crop for New Zealand. One field trial and two pot trials were conducted during 1992 at Massey University to test the tolerance of meadowfoam to a range of herbicides. Results showed grass weeds can be removed post-emergence using haloxyfop or ethofumesate. Some broad-leaved weeds can be controlled using clopyralid or ethofumesate. Propachlor, alachlor, EPTC and trifluralin showed some potential for pre-emergence weed control. Meadowfoam was severely damaged by propyzamide, chlorpropham, linuron, 2,4-DB, fatty acids, terbutryn, tribenuron and triclopyr.

Keywords: meadowfoam, *Limnanthes alba*, tolerance to herbicides, annual poa, small-flowered buttercup.

INTRODUCTION

Meadowfoam is a herbaceous winter annual species which is grown in Oregon for its unique seed oil (Jolliff *et al.* 1981). It belongs to the Limnanthaceae family and is native to the north-eastern coastal regions of USA. The tolerance of this crop to wet soil conditions and the timing of crop establishment in autumn could make meadowfoam a useful crop to include in New Zealand arable crop rotations. Markets for the oils still need to be established but they have chemical properties useful for many industrial purposes (Nikolava-Damyanova *et al.* 1990).

Information on the herbicide tolerance of this crop is lacking. Of several chemicals tested in Oregon, only diclofop and propachlor were considered by Jolliff *et al.* (1981) to be safe in meadowfoam crops, and information on the other herbicides tested was not provided. Appleby (pers.comm.) has since found asulam, clopyralid and fluazifop to be safe following field trials in Oregon during the 1985-1986 season.

Preliminary unreplicated studies in New Zealand suggested that meadowfoam will not tolerate atrazine, methabenzthiazuron, pendimethalin, metribuzin and ioxynil; has marginal tolerance of trifluralin, alachlor, bentazone and MCPB, but good tolerance of haloxyfop, clopyralid and ethofumesate (Harrington, unpub. data). This paper presents results from later replicated experiments to confirm some of these results and to test other herbicides.

MATERIALS AND METHODS

Post-emergent treatments

A paddock of Tokomaru silt loam in which meadowfoam was grown in the previous year was sprayed with 1.1 kg/ha glyphosate + 0.2 kg/ha clopyralid on 4 March 1992 to remove the resident vegetation. A sward of volunteer meadowfoam plants then established from the soil seed population. Herbicide treatments were applied to 3.0 x 3.5 m plots on 22 May 1992 using a randomised block design for treatment allocation to allow for differences in meadowfoam density. Treatments are listed in Table 1 and were each replicated four times. The herbicides were applied with a gas-powered precision plot sprayer at 200 kPa and a water rate of 250 litres/ha. The soil was moist when herbicides were applied, and 13 mm of rain fell during the following 7 days. The average daily air temperature for the 3 weeks following treatment was 9.4°C.

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Crop tolerance 7 weeks after application, and crop and weed density 26 weeks after application, were assessed in each plot by scoring. An analysis of variance was performed on the probit transformed scores, and means were separated using the Student-Newman-Keuls multiple range test.

A pot trial was conducted at a sheltered outdoor site at the Massey University Plant Growth Unit to evaluate further both these and other post-emergent treatments. A potting mixture comprising equal parts of peat, sand and pumice was placed in 1.5 litre polythene bags, and a slow release fertiliser was added. Three meadowfoam seedlings at the three-leaf stage were transplanted into each pot from the field. Two weeks later on 25 July 1992, 13 herbicide treatments (Table 2) were applied to the seedlings with a pendulum sprayer similar to that described by Wiese (1977) at 200 kPa in 250 litres/ha of water. A completely randomised design was used with five replicates and an untreated control. Overhead irrigation was used to supplement rainfall when necessary. The average air temperature in the 3 weeks following application was 8.9°C. Plants were scored for tolerance 7 weeks after application. All foliage from each pot was removed at ground level 13 weeks after application, dried at 80°C for 16 hours and weighed.

An analysis of variance was performed on the results, with scores analysed after probit transformation, and means were separated by the Student-Newman-Keuls multiple range test.

Pre-emergent treatments

In another pot experiment, ten residual herbicide treatments (Table 3) were applied to 1.5 litre polythene bags of Ohakea silt loam soil, with five replications of each treatment arranged in a completely randomised design. Herbicides were applied on 20 June 1992 using the same sprayer and water rate as in the other pot trial. Ten meadowfoam seeds were sown 4 mm deep in the pots either just before application, or immediately after herbicide had been mixed into the soil in the case of the EPTC and trifluralin treatments. The pots were placed beside those used in the other trial. The average air temperature in the 3 weeks following treatment for this trial was 8.0°C. Seedlings emerged 15 days after sowing, they were scored for herbicide tolerance 8 weeks after application, and their dry weight was measured 15 weeks after application. Results were analysed as for the other pot trial.

RESULTS AND DISCUSSION

Although clopyralid caused some minor leaf distortion in meadowfoam plants soon after application, no significant effect on crop appearance was detected 7 weeks after application in either the field trial (Table 1) or the pot trial (Table 2). However, the 37% reduction in dry weight of meadowfoam foliage measured 13 weeks after application of 0.45 kg/ha clopyralid (Table 2), although not significantly different from untreated plants, suggests that clopyralid should not be applied in excess of 0.3 kg/ha.

Haloxyfop at 0.25 kg/ha was also tolerated well by meadowfoam, as was a combination of this herbicide and 0.15 kg/ha of clopyralid. Weeds controlled by this mixture included annual poa (*Poa annua*), white clover (*Trifolium repens*) and groundsel (*Senecio vulgaris*). However the rather narrow range of species controlled by these two herbicides allowed many weed species to survive, including scrambling speedwell (*Veronica persica*), spurrey (*Spergula arvensis*), toad rush (*Juncus bufonius*), chickweed (*Stellaria media*) and twin cress (*Coronopus didymus*).

As annual poa was the main weed species in the field trial, successful control of this weed made a large impact on the weed density score 26 weeks after application. Although haloxyfop controlled annual poa, new plants soon re-established in sprayed plots because of the non-persistent nature of this herbicide. The addition of propachlor to the haloxyfop/clopyralid mixture prevented further annual poa plants from establishing until the meadowfoam canopy became dense enough to outcompete new seedlings.

TABLE 1: Effect of herbicide treatments applied to field populations of 2 month-old meadowfoam seedlings on crop tolerance (7 weeks after application) and crop and weed density (26 weeks after application).

Treatment[1]	Rate (kg ai/ha)	Crop tolerance score[2] (7 weeks)	Crop density score[3] (26 weeks)	Weed density score[3] (26 weeks)
clopyralid	0.15	3.1 a[4]	6.0 b	4.0 a
clopyralid	0.45	3.0 a	3.0 b	6.5 a
haloxyfop	0.25	3.0 a	6.0 ab	4.0 ab
clopyralid + haloxyfop	0.15 + 0.25	2.9 a	6.3 ab	3.5 ab
clopyralid + haloxyfop + propachlor	0.15 + 0.25+ 6.5	3.0 a	8.8 a	1.5 b
propyzamide	1.25	1.0 b	4.3 b	5.5 a
ethofumesate	2.0	2.7 a	7.5 ab	4.0 ab
untreated	-	3.6 a	3.8 b	6.3 a

[1]clopyralid (Versatill), ethofumesate (Nortron 500 SC), haloxyfop (Gallant), propachlor (Ramrod Flowable), propyzamide (Kerb Flo).
[2]crop tolerance score of 1 = poor tolerance, 4 = excellent tolerance.
[3]density score of 1 = few plants, 10 = high density.
[4]mean values sharing the same letter within a column are not significantly different (P=0.05).

TABLE 2: The effect of post-emergence herbicide treatments on tolerance score (7 weeks after application) and foliage dry weight (13 weeks after application) on potted meadowfoam plants.

Treatment[1]	Rate (kg ai/ha)	Tolerance score[2] (7 weeks)	Foliage dry weight (g) (13 weeks)
clopyralid	0.15	2.6 cdef[3]	11.1 abc
clopyralid	0.30	2.9 def	12.5 ab
clopyralid	0.45	2.6 cdef	8.5 abc
haloxyfop	0.25	3.1 ef	13.7 a
clopyralid + haloxyfop	0.5 + 0.25	3.3 f	12.5 ab
clopyralid + haloxyfop + propachlor	0.5 + 0.25 + 6.5	2.4 cdef	9.7 abc
propyzamide	1.25	1.7 bcde	9.0 abc
ethofumesate	2.0	2.8 edf	11.9 ab
2,4-DB	2.4	1.2 abcd	6.1 c
fatty acids	39	0.6 ab	1.4 d
terbutryn	0.38	1.4 abcd	5.8 c
tribenuron	0.015	1.0 abc	7.3 bc
triclopyr	1.2	0.0 a	0.0 d
untreated	-	3.4 f	13.7 a

[1]2,4-DB (DowElanco 2,4-DB), fatty acids (Topgun), terbutryn (Igran), tribenuron (Granstar), triclopyr (Grazon).
[2]score of 0 = plants dead, 4 = plants appear unaffected.
[3]mean values sharing the same letter within a column are not significantly different (P=0.05).

The other main weed species in the field trial was small-flowered buttercup (*Ranunculus parviflorus*). This species had increased dramatically in numbers at the site in the previous two seasons presumably because it has a life cycle and growth habit similar to meadowfoam, which had been cultivated in the paddock for several years in succession. Clopyralid controlled this species only at the high application rate.

Ethofumesate was another herbicide identified as being safe during these trials (Tables 1 and 2), and this herbicide controlled annual poa and severely suppressed the growth of small-flowered buttercup. Ethofumesate also has residual activity which prevented rapid re-establishment of annual poa. Weeds not controlled well by ethofumesate included scrambling speedwell, toad rush, perennial ryegrass (*Lolium perenne*), broad-leaved dock (*Rumex obtusifolius*), hawksbeard (*Crepis capillaris*), groundsel and daisy (*Bellis perennis*).

Propyzamide was severely damaging to meadowfoam in the field trial and cannot be recommended for use in this crop despite some recovery of the crop plants in subsequent months. Other herbicides identified in the pot trials as being unsuitable for selective weed control in meadowfoam were chlorpropham, linuron, 2,4-DB, the fatty acid mixture, terbutryn, tribenuron and triclopyr.

Appleby (pers. comm.) has found that pre-emergence applications of propachlor begin reducing meadowfoam yields under Oregon conditions once rates exceed 2.2 kg/ha. Damage caused by higher rates of propachlor was confirmed in the pot trial (Table 3). However when propachlor was applied at pre-emergence to an establishing paddock of meadowfoam at 2.2 kg/ha in the 1993 season, very poor control of annual poa and all other weed species was obtained (Harrington, unpub. data).

TABLE 3: The effect of pre-emergence herbicide treatments on tolerance score (8 weeks after application) and foliage dry weight (15 weeks after application) on potted meadowfoam plants.

Treatment[1]	Rate (kg ai/ha)	Tolerance score[2] (8 weeks)	Foliage dry weight (g) (15 weeks)
alachlor	1.4	3.0 c[3]	1.06 ab
chlorpropham	1.2	1.0 e	0.00 d
EPTC	5.0	3.7 a	0.95 abc
linuron	1.0	0.0 f	0.00 d
propachlor	2.2	3.4 b	0.81 abc
propachlor	3.4	2.8 c	0.69 bc
propachlor	4.5	2.6 c	0.55 c
propachlor	5.5	2.0 d	0.54 c
propachlor	6.5	2.0 d	0.58 c
trifluralin	0.8	3.8 a	1.18 a
untreated	-	3.9 a	1.18 a

[1]alachlor (Lasso Microtech), chlorpropham (Chloro-IPC), EPTC (Eradicane Super), linuron (Linuron 50), trifluralin (Treflan).
[2]score of 0 = all plants dead, 4 = plants unaffected.
[3]mean values sharing the same letter within a column are not significantly different (P=0.05).

Alachlor, which is closely related to propachlor, caused noticeable distortion to meadowfoam seedlings when applied in an earlier trial in 1991 at 2.4 kg/ha. At 1.4 kg/ha, a small but significant effect was detected on seedlings in the pot trial, though this effect was no longer detectable 15 weeks after application (Table 3). However this application rate would probably be too low to give useful weed control.

Trifluralin and EPTC also appeared to be tolerated in the pot trial (Table 3). There was some difficulty incorporating these herbicides into the soil because of its wetness

when treated, so these treatments need to be tested again. Incorporation difficulties may be a problem if these herbicides were to be used in autumn in soils prone to wetness, conditions under which meadowfoam grows well. Trifluralin caused some stunting of growth when applied to meadowfoam at 1.2 kg/ha in an earlier field trial, a higher rate than the 0.8 kg/ha used in the pot trial.

Ethofumesate, clopyralid and haloxyfop should allow production of reasonably weed-free crops of meadowfoam if used in conjunction with sound crop establishment techniques such as good seedbed preparation, crop rotation, high sowing rate, good drilling techniques and correct timing of sowing. This will allow research into the potential of meadowfoam as a new cash crop for New Zealand to proceed. However cheaper herbicide recommendations would be desirable if this crop was to be grown commercially in New Zealand.

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