MEFLUIDIDE: A PLANT GROWTH REGULATOR

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Summary

Mefluidide applied at times of active growth suppressed turf grass growth for 6-8 weeks without adverse phytotoxicity. The activity of mefluidide on annual grasses was severe and applied 4-6 weeks prior to seedhead emergence suppressed barley grass *(Hordium* spp) in pasture. There were no long term detrimental effects to sward composition of coarse grass turf or pasture. Broadleaf weeds were not well suppressed by mefluidide but were controlled with 2,4-D and dicamba as tank additives without adverse effects on the activity of either herbicide.

INTRODUCTION

The field of plant growth regulator research has aroused much interest in recent years. Nickell (1978) stated that they were "the most rapidly expanding segment of the agricultural chemical business" and that "several well-informed people predict that the use of plant growth regulators eventually will outstrip that of herbicides".

A principlal area of plant growth regulator research has been in turf grass growth regulation with the aim of reducing mowing requirements by retarding growth and suppressing seedhead formation. The benefits of such a chemical in savings of fuel, labour and machinery maintanance are obvious, as well as the possibility of aesthetically improving many areas by maintaining a freshly cut appearance. A number of chemicals have growth regulatory effects, the principal ones used commercially for regulation of turf grass growth being maleic hydrazide, and chlorflurenol (Freeborg 1979). However, no chemical has yet completely satisfied the requirement of extended growth suppression without causing undesirable effects to the treated sward. Mefluidide was reported by Bushong *et al* (1976) to retard turf growth for up to 8 weeks after application. Other effects reported by Bushong *et al* included the enhancement of sucrose content in sugar cane *(Saccharum officinarum),* selective control of Johnson grass *(Sorghum halepense)* in soya beans *(Glycine max),* sucker control in tobacco *(Nicotiana tabacum)* and growth suppression of woody ornamentals. Mefluidide, formerly known as MBR 12325, first synthesised in 1971 by the 3M Company, is a member of a group of new chemicals based on *N*-ary, 1,1,1,trifluoromethanesulfonamides.

Spectrum of activity

Mefluidide displays a growth regulatory effect on a wide range of grass and broadleaf species, but is most active on annual and fibrous rooted cool season perennial grasses (3M Company, 1977). The activity of mefluidide on annual grasses may be excessive and when applied at the susceptible growth stage of such species, plant mortality generally results.

Mode of action

Mefluidide is a foliar-absorbed chemical which appears to act on cell division and elongation in meristmatic centres of the plant. Truelove *et al* (1977) showed that mefluidide inhibits GA_3-promoted changes which result in cell enlargement and suggests that mefluidide may inhibit the synthesis of lipids which contribute to the increase in membrane elasticity prior to cell elongation. Further support for the assumption that mefluidide affects GA_3 biosynthesis is reported by Truelove's experiments which suggest that mefluidide is able to delay the loss of chlorophyll from senescing corn leaves, a GA_3-influenced process.

Toxicology

Toxicological studies have shown mefluidide to be of low mammalian toxicity having an acute oral LD50 of 1920 mg/kg to rats and a dermal LD50 of ►4000 mg/kg to rabbits. In feeding studies mefluidide did not cause teratogenic or mutagenic effects (3M Company, 1977).

Mefluidide is unstable in soil and will leach when applied to moist soil followed by ample rainfall. Its half life in soil is less than 1 week and the compound is susceptible to photodecomposition in solution but is relatively stable on soil surfaces.

METHODS

Extensive field trials and block evaluations have been carried out in New Zealand to evaluate the suitability of mefluidide as a turf growth regulator and selective barley grass herbicide.

All trials were randomised block designs and, unless stated otherwise in the results, consisted of four replicates and a plot size of 5 x 2.5 m. Treatments were applied with a modified Oxford Precision plot sprayer in water rates from 250 - 320 litres/ha at 200 - 320 kPa. Trials in turf were conducted in spring or autumn during periods of active growth, and were generally applied to recently mown grass.

In commercial evaluations carried out in the spring of 1978 mefluidide was applied by boom in a water rate of 225 - 350 litres/ha and assessments of sward height and appearance carried out at intervals following treatment.

In barley grass trials carried out on pastures in Waikato, Manawatu, Hawkes Bay and Canterbury, mefluidide (0.25 - 0.75 kg/ha) was applied at varying times during the period August to November. Seedhead counts were taken at the green seedhead stage in late December or early January by recording the number of seedheads in 6 or 8, $0.54m^2$ rings per plot.

In both turf and barley grass trials sward production figures were calculated from a mown 4.5 m^2 sample/plot, a 500 g sub-sample was taken from each of these samples for dry weight determination. For herbage dissection hand shears were used to collect 500 g samples/plot at random. Where subjective assessments were made of phytotoxicity, growth suppression or weed control a 0 - 10 scale was used.

RESULTS

Turf

Table 1 details quantitative results of seedhead incidence and dry matter production from a trial carried out on a Manawatu golf course during spring 1976. Growth suppression became obvious within 1 week of treatment and was accompanied by a slight yellowing of some plant species which persisted for about 3 weeks. The degree of discolouration was related to rate but was considered to be acceptable. Following this initial period of discolouration mefluidide treated plots assumed a darker green appearance than untreated plots.

TABLE 1: Effect of mefluidide on seedhead development and dry matter production 20 Dec. 1976. (LOp = perennial ryegrass, AGt = browntop, ANo = sweet vernal, POa = annual poa)

mefluidide kg/ha	Mean number seedheads/m^2				Dry matter production	
(applied 3 Nov)	LOp	AGt	ANo	POa	kg/ha	% Red.
0	77.0 a	16 a	7.0 a	228 a	587 a	-
0.3	8.0 b	0 b	0.0 b	188 b	473 a	20
0.6	3.0 b	0 b	1.3 b	145 b	414 ab	30
0.9	1.0 b	0.b	0.0 b	159 b	275 bc	53
1.2	1.3 b	0 b	0.0 b	142 b	242 c	59
0.6 + 0.25% wetter	2.5 b	0 b	0.3 b	157 b	286 bc	52
CV%	48	35	44	27	33	

Mefluidide severely retarded seedhead production of perennial ryegrass *(Lolium perenne)*, browntop *(Agrostis tenius)* and sweet vernal *(Anthoxanthum ordoratum)*, while annual poa *(Poa annua)*, which showed reproductive growth at time of treatment was affected to a lesser extent. Mefluidide 0.9 and 1.2 kg/ha provided a significant reduction in dry matter production while the addition of 0.25% v/v wetter markedly enhanced the effect of mefluidide 0.6 kg/ha. A further cut 16 weeks following that detailed in Table 1 showed there were no significant differences in dry matter production.

The results of two trials, trial A on a road verge and trial B on parkland carried out in Southland during Spring 1977 are presented in Table 2.

TABLE 2: Assessment of mefluidide-induced growth suppression, grass height and dry matter production

mefluidide kg/ha all plus 0.25% v/v wetter	Trial A + - treated 11 Oct			Trial B ° - treated 5 Oct	
	% growth supression			Mean height (cm)	kg DM/ha % reduction
	week 3	week 6	week 9	week 9	week 9
Pre-mown					(3540 kg/ha)
0	-	-	-	32	-
0.4	-	-	-	14	59
0.6	-	-	-	11	64
0.8	-	-	-	8	75
Post-mown					(3580 kg/ha)
0	0	0	0	26	-
0.4	70	80	57	14	57
0.6	85	93	56	14	57
0.8	85	95	71	11	71

\+ trial A mown 5 days following treatment to a height of 6 cm
° trial B pre-mown - mown to 3 cm 2 days prior to treatment
post-mown - mown to 3 cm 2 days post-treatment

Fig. 1 Sward height following mefluidide treatment

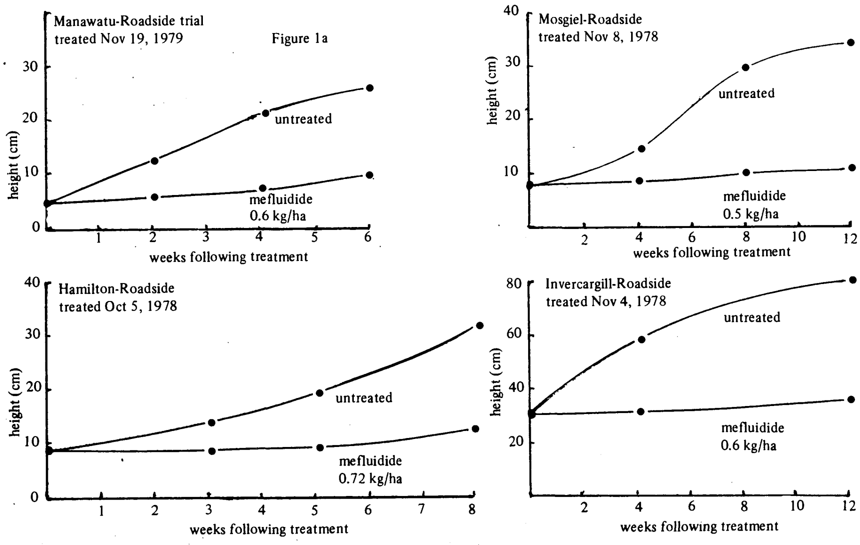

Table 2 shows that mefluidide provided effective growth suppression during moist spring conditions in Southland, and that 0.8 kg/ha provided more consistent and uniform growth suppression than 0.4 kg/ha. In trial B the reduction in height and dry matter production was marked and increased with increasing rate of chemical. Resultant growth suppression from mowing 2 days before or 2 days following application was similar, however, observations showed there was a greater emergence of weeds on the pre-mown plots. The retreatment of trial A 10 weeks following the initial application caused no undesirable effects other than a slight yellowing.

Fig. 1a depicts the results from a Manawatu roadside trial where mefluidide provided effective growth suppression for a 6 week period. Seed-head suppression of clover *(Trifolium repens)*, ryegrass, Yorkshire fog *(Holcus lanatus)*, and cocksfoot *(Dactylis glomerata)* were pronounced and lasted for 9 weeks.

The results from commercial applicaltions depicted in Fig. 1 show that mefluidide effectively suppressed grass growth for an 8 - 12 week period. In no case was undue phytotoxicity recorded, however, some weeds such as dandelion *(Taraxacum officinale)* and plantain *(Plantago* spp) seedheads became prominent in treated areas.

Table 3 details results which showed mefluidide to be compatible with 2,4-D and dicamba and the additives to provide near complete control of a heavy infestation of plantains and dandelion, in a predominantly ryegrass sports turf.

TABLE 3: Compatibility of mefluidide with 2,4-D and dicamba - autumn application on a Manawatu park. (Treated 6 April 1979)

Treatment	kg/ha	% growth suppression 19 Apr	2 May	11 May	phytotoxicity* 19 Apr	2 May	11 May	% weed control 11 May
untreated	0	0	0	0		0	0	0
mefluidide	0.72	70	88	63	1.5	2.3	0.5	0
mefluidide	0.72							
+ 2,4-D	1.80	70	83	63	1	1.9	0.5	85
mefluidide	0.72							
+ 2,4-D	0.50							
+ dicamba	.37	78	88	63	1	1.9	0.5	90

* 0 = no effect; 10 = complete effect

Table 4 details the results of assessments of species composition following mefluidide treatment in Christchurch (treated 5 October 1976, 12 January 1977) and Manawatu (treated 10 October 1977)

TABLE 4: Species composition of mown turf areas following mefluidide treatment. (LOp = perennial ryegrass, HOl = Yorkshire fog, AGt = browntop, TRr = white clover, ACm = yarrow, FEr = chewings fescue, weeds = plantains and hawkbit)

mefluidide kg/ha	kg DM/ha	Christchurch - 4 October 1977 % species composition + LOp	Hol	AGt	TRr	ACm	Manawatu - 9 May 1978 % species incidence* FEr	HOl	LOp	TRr	Weeds
0	5160	54 a	14 a	11 a	16 a	5 a	71	8	3	8	12
0.4	2700	44 a	21 a	7 ab	20 a	8 a					
0.5							69	3	3	5	11
0.6	2030	46 a	19 a	7 ab	19 a	9 a					
0.75							55	0	4	15	26
0.8	2250	54 a	9 a	6 ab	24 a	7 a					
1.0	2800	49 a	27 a	5 b	15 a	4 a					

\+ Assessed by herbage dissection
* Assessed by point analysis, (100 points per plot) - plot size 25 x 34 m, 1 replicate

TABLE 5: Percentage barley grass control - Effect of time of application, location, and rate of mefluidide

Time of application	mefluidide kg/ha	Waikato 1977	Waikato 1977	Hawkes Bay 1976–77	Hawkes Bay 1977	Hawkes Bay 1978	Rangitikei 1977	Manawatu 1978	Canterbury 1976-77
September	0	(4266)a	-	-	(20)a	(1104)a	(144)a	(294)a	(139)[1]
	0.25	75b	-	-	87b	34b	77b	-	66
	0.375	-	-	-	-	38b	–	80b	-
	0.5	88b	-	-	89b	79c	81b	-	42
	0.75	82b	-	-	89b	-	94b	-	43
CV %		50	-	-	100	31	38	51	-
early October	0	(1798)a	(331)a	visual	(58)a	(1012)a	(31)a	-	(116)[2]
	0.25	89b	98.8b	-	98b	54ab	77b	-	–
	0.375	-	-	–	–	49+ab	-	-	64
	0.5	94b	100b	93	99b	86b	80b	-	-
	0.75	95b	100b	97.6	99b	-	92b	-	-
CV %		74	25	-	34	58	38	-	-
late October	0	(754)a	-	(1403)a*	-	-	(71)a	(248)a	(122)[3]
	0.25	81b	-	85b	-	-	97b	-	0
	0.375	-	-	88b	-	-	-	88b	-
	0.5	91b	-	86b	-	-	99b	-	63
	0.75	89b	-	94b	-	-	99.5b	-	71
CV %		74	-	50	-	-	14	84	-
November	0	(1842)a	-	visual	(54)a	(1159)a	(59)a	(410)a	-
	0.25	89b	-	-	75b	87b	95b	64b	-
	0.375	-	-	-	-	88b	-	90c	-
	0.5	94b	-	0	89b	92b	98b	99c	-
	0.75	99b	-	0	88b	-	99b	-	-
CV %		67	-	-	56	43	69	65	-

NB Figures in brackets represent actual seedhead no /m².
* 1977 results same site.
\+ Rain affected result.

[1] Lincoln – 1977.
[2] Christchurch airport – 1977.
[3] Christchurch airport – 1976.

The results of the Christchurch trial (Table 4) show that, following a dry summer and wet winter, there was a marked suppression in dry matter production as a result of mefluidide application. The proportion of each species in the sward was not altered apart from browntop which was significantly reduced by the high rate of mefluidide (1.0 kg/ha). The Manawatu trial, carried out on a fine grass recreational turf, showed an increase in broadleaf weeds and a reduction in Chewings fescue and Yorkshire fog.

Barley grass control

The results in Table 5 show that mefluidide (0.25 - 0.75 kg/ha) provided significant control of barley grass, with the late September to October treatment being optimal. In Waikato, Hawkes Bay, Manawatu and Rangitikei trials the higher rates (0.5 - 0.75 kg/ha) consistently provided higher levels of control than lower rates, however, poor control was achieved in Canterbury from all rates. In the 1976 Hawkes Bay trial no control was achieved when mefluidide was applied at the green seedhead stage.

The addition of wetting agent 0.5% v/v provided a significant enhancement in barley grass control from mefluidide 0.25 kg/ha on one site, whilst the addition of TCA and 2,2-DPA was generally antagonistic.

Although mefluidide at all rates induced growth suppression for 4 - 8 weeks, phytotoxicity to pasture species other than annual grasses was limited.

TABLE 6: Long term effect of mefluidide on pasture species following early October 1977 treatment.

Species	% species composition							
	Hawkes Bay 27.9.78			Waikato 17.7.78*				
mefluidide kg/ha	0	0.25	0.5	0	0.25	0.5	0.75	CV%
LOp	25	40	64	50	61	62	67	44
HOm	56	37	15	-	-	-	-	-
OG	6	13	8	42	35	33	26	91
clover	4	4	2	6	3	4	6	62
weeds	0	1	0	2	1	1	1	22
litter	11	5	11	-	-	-	-	-

(LOp = perennial ryegrass, HOm = barley grass, OG = other grasses)

Other grasses - include bromus mollis *(Bromus mollis),* browntop, poa annua and, in Waikato trial, barley grass.

* No significant effect of rates

Table 6 shows that in Hawkes Bay mefluidide increased the proportion of perennial ryegrass in the sward while barley grass diminished. In Waikato the proportion of ryegrass was not significantly affected. The clover component was not affected; and neither was there an ingress of weed species.

DISCUSSION

The trials reported have shown that mefluidide provides considerable potential for the chemical regulation of grass growth by suppressing growth and seedhead development for an average 6-8 week period and up to 12 weeks on some sites. At optimum rates (0.5 - 0.75 kg/ha) no undesirable phytotoxicity was observed providing application was made during periods of active growth, at which time the chemical is obviously of greatest turf management benefit. Whilst on some sites there was a temporary discolouration following mefluidide application, the appearance of treated grass later assumed a darker green colour. According to Truelove *et al* (1977) the initial yellowing is probably a result of a reduction in the chlorophyll b content of basal tillers whilst the darker green colour which follows may be associated with delaying the loss of chlorophyll from senescing leaves.

Annual grasses were found to be more susceptible to mefluidide than perennial grasses, and fine turf species were affected to a greater extent than coarse-bladed perennial grasses. The effect on annual grasses may be excessive and extend beyond growth regulation when applied at the most susceptible growth stage. For the control of barley grass the susceptible stage occurs during a 4 - 6 week period immediately prior to seedhead emergence which suggests that the herbicidal effect is associated with reproductive physiology. The effect on barley grass was much greater in the North Island than the South Island, a difference which cannot be explained at present.

Mefluidide has very little effect on broadleaf weeds, but there is no evidence to suggest that the number of broadleaf weeds increases after application in other than fine turf swards. However, they may become more prominent during the period of growth suppression but can be controlled with 2,4-D and dicamba which are compatible with mefluidide.

To attain the desired sward height, a mowing regime prior to or following application is required. Whilst a trial in Southland mown 2 days prior and 2 days following treatment showed no differences from either regime, general experience has shown that some new growth is required prior to applying mefluidide and 6 days is considered desirable before mowing to allow chemical absorption.

A further plant growth regulatory feature of mefluidide is that it enhances the *in vitro* nutritive value of forage (Glenn *et al* 1980) and significant weight gains have been recorded from animals feeding on treated pastures (Jagusch and Goold pers comm).

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