MEFLUIDIDE INDUCED CHANGES IN TILLER DEVELOPMENT IN PERENNIAL RYEGRASS

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SUMMARY

Mefluidide, a foliar-applied grass retardant, was translocated to developing tillers in perennial ryegrass (*Lolium perenne*). Development of new tillers was severely retarded (76.6% at 5 weeks after application) at 0.5 kg ai/ha but the reduction was closer to 40% at 0.25 kg ai/ha. The reduced development of new tillers was associated with physical constraints imposed by abnormal sheath development and by inhibition of tiller bud production or development. There was some mefluidide-induced mortality of young tillers.

INTRODUCTION

Mefluidide is used as a turf retardant (Field 1983) and has potential for use in improving the management of pasture grasses (Goold *et al* 1982; Foreman and Field 1987). In both situations the ability of mefluidide to suppress reproductive development is critical and an obvious effect of application. The effect of mefluidide on vegetative tiller production is equally important, particularly in the chemical manipulation of pasture development.

There have been no major investigations into the effect of mefluidide on tiller populations or its mode of action in inducing tiller production changes (Field and Whitford 1982b). This paper describes the effect of mefluidide on the production and survival of vegetative tillers in perennial ryegrass (*Lolium perenne*).

MATERIALS AND METHODS

Single seeds of perennial ryegrass (cv. Grasslands Ruanui) were sown in tubelings in a high fertility potting mix and subsequently transplanted into the same growth medium in 12 cm diameter pots. Plants were grown in a controlled environment cabinet maintained at 18/13 °C with a 16 h photoperiod, a PPFD of 300 $\mu\text{mol}/\text{m}^2/\text{s}$ and a relative humidity of 75%. Plants were treated at the 3-4 tiller stage.

A sample of ^{14}C -mefluidide was converted to the diethanolamine salt and formulated with 0.25% Agral (v/v) as surfactant. Five 1 μl droplets each containing 850 Bq were dispensed onto the upper surface of a single expanded lamina on the oldest tiller. All mefluidide residues on the lamina surface were removed with sequential washes of distilled water and 70% ethanol, and radioactivity extracted from tissue fractions in 70% ethanol, prior to liquid scintillation counting (Field and Whitford 1982a).

In the experiments investigating plant development, mefluidide was applied as a foliar spray. Mefluidide at 0.25 or 0.5 kg ai/ha was formulated with 0.25% Agral (v/v) and applied with a precision sprayer at a water rate of 250 litres/ha.

The development and death of tillers was determined by tagging individual tillers with coloured wire loops at weekly intervals. Some treatments involved making longitudinal cuts in the oldest sheaths on each tiller. This was accomplished by making two 30 mm long incisions in each sheath with a scalpel blade, within 24 h of spraying.

RESULTS

Mefluidide applied to the oldest tiller was translocated to untreated tillers and accumulation increased with time. After 1, 2 and 4 days untreated tillers had accumulated 5.9, 8.5 and 15.7% (s.e. mean=1.5) of foliar absorbed radioactivity, respectively. The roots were the only other major sink and accumulated only 1.9% of absorbed mefluidide after 4 days.

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The development of new tillers was reduced by at least 42% following application of mefluidide (Table 1). The reduction in new tiller development commenced immediately after application and had shown no reversal by 5 weeks. Application of 0.5 kg ai/ha mefluidide was particularly severe on tiller development.

The release and development of new tillers was increased by making the longitudinal cuts in older leaf sheaths (Table 2). The percentage reduction in tiller production brought about by mefluidide was approximately halved when sheaths were cut. In mefluidide treated plants cutting sheaths increased new tiller production by at least 30%. The effect was evident for the 5 weeks of the experiment. By 4 weeks the rate of new tiller production in the mefluidide plus sheath cutting treatment was similar to the untreated control. Sheath cutting did not unduly influence tiller production in non-mefluidide treated plants.

In the experiment reported in Table 1 the tagging of individual tillers allowed measurements of tiller death to be recorded. There was no tiller death in untreated plants but a total of 4.2% and 16.5% mortality in 0.25 and 0.5 kg ai/ha mefluidide treatments respectively. Tiller death rate did not change markedly during the sampling period. There was no significant mortality immediately after application of mefluidide although those tillers that died were mainly those tagged before spraying or at the end of the first week. No assessment on unemerged tillers was possible.

TABLE 1: Weekly changes in mefluidide-induced production of new tillers/plant and tiller death.

Mefluidide kg ai/ha	Weeks after treatment				
	1	2	3	4	5
0	5.0	10.4	11.8	23.6	21.4
0.25	2.8	4.4	5.8	10.4	12.4
0.50	1.6	1.2	1.6	3.8	5.0
s.e. mean	0.48	0.81	0.87	2.53	1.56
dead tillers/plant					
0	0	0	0	0	0
0.25	0	0.2	0.6	0.8	0
0.50	0	1.0	0.6	1.0	0

TABLE 2: The effect of mefluidide and longitudinal cuts in leaf sheaths on the production of new tillers/plant.

Mefluidide kg ai/ha	Sheaths cut	Weeks after treatments				
		1	2	3	4	5
0	—	2.3	4.7	6.8	11.3	17.3
0	+	2.0	5.0	5.5	11.0	18.0
0.25	—	1.2	2.8	4.2	7.8	11.7
0.25	+	1.7	3.8	5.7	10.2	15.8
s.e. mean		0.4	0.6	0.7	1.6	2.2

DISCUSSION

Young tillers may receive mefluidide either by direct interception of spray droplets or by translocation from other tillers. Mefluidide is phloem translocated and accumulated in plant tissue largely as the parent molecule (Field and Whitford 1982a), which has been shown to possess the growth retardant properties (Field and Whitford 1982b). The increasing accumulation of mefluidide in existing and newly formed tillers can be reasonably linked to the effects of mefluidide on morphological development.

At high application rates (≥ 0.5 kg ai/ha) mefluidide retarded grass development by suppressing new tiller production and inducing tiller death (Table 1). These events are major factors in the mode of action of mefluidide when used for turf retardation (Field and Whitford 1982b; Field 1983) and may account for the reduced density of swards, contributing to turf damage, in high wear areas, (Field 1983). Mefluidide-induced tiller mortality was short-lived and by 5 weeks after treatment there was normal

tiller longevity (Table 1). This is of some significance in the long term maintenance of mefluidide treated turf swards.

Of significant interest was the pattern of tiller population change at the lower use rate (0.25 kg ai/ha) which may be used in pasture growth manipulation (Foreman and Field 1987). The production of new tillers initially was reduced significantly (Table 1 and 2) but had resumed by 6-8 weeks after treatment (Field and Whitford 1982b). At low application rates there may be a considerable flush of new tiller development at this time. The reduced production of new tillers, their retention in a vegetative state and the low tiller death (Table 1), contribute to the beneficial effect of mefluidide on pasture quality (Field and Whitford 1982b; Foreman and Field 1987).

Although mefluidide has been in use for a number of years there is no clear understanding of the mechanism of its retardant action. It has been implicated in suppression of cell division and cell extension (K.J. Tautvydas pers. comm.), the latter no doubt contributing to reduced lamina expansion (Field and Whitford 1982b) while the former may influence both the initiation and development of vegetative and reproductive apices. The mefluidide-induced reduction in tiller production (Table 1 and 2) may have a meristematic basis. Additionally, there are changes in sheath structure involving reduction in length, changes in chemical composition and increased rigidity (Field and Whitford 1982b). The removal of physical constraints imposed by the sheath, by making a series of longitudinal cuts, did not significantly change tiller production in untreated plants, but resulted in increased tillering in mefluidide treated plants (Table 2). This suggests that the physical constraints imposed by sheaths in mefluidide-treated plants differ from those in untreated plants and interfere with the normal release of developing tillers. That the longitudinal cuts did not completely compensate for the loss in tiller production suggests that interference with meristematic activity is also a principle mechanism of mefluidide action.

The effects of mefluidide on tiller development must be considered alongside grass productivity measurements in turf (Field and Whitford 1983) and pastures (Foreman and Field 1987). The influence of mefluidide in minimising seedhead development may be of greater importance than temporary reductions in vegetative tiller populations. The plants used in this study were young and possessed only 3-4 tillers at treatment. It is reasonable to assume that damaging effects of mefluidide would be greater on these than on field-grown plants, which would include a proportion of tillers that are older than those treated in the present study (Field and Whitford 1982b).

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