SOME CONSEQUENCES OF CONTROLLING POA ANNUA IN NEWLY SOWN RYEGRASS LEYS

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Summary The competitive effects of *Poa annua* on ryegrass growth were measured in a box experiment in which ryegrass plants were grown at three densities in the presence or absence of *Poa* at a single density. *Poa* caused a highly significant reduction in ryegrass tillering, although total dry-matter yield from the mixture was greater than the ryegrass monoculture yield. In a field experiment assessments were made of the effect of spraying ethofumesate at 2 kg/ha on ryegrass plants surrounded by different amounts of space, the space being either occupied by *P. annua* or handweeded. When present, *Poa* caused up to a 25% reduction in ryegrass growth. Although the tillering of sprayed ryegrass plants did not reach the same potential as unsprayed plants, yet the value of ethofumesate in preventing early ingress of weeds was demonstrated in terms of improved yields of ryegrass

INTRODUCTION

Poa annua (referred to hereafter as *Poa*) is a major contaminant of establishing swards (Wells, 1974). *Poa* can be selectively controlled in newly sown *Lolium perenne* (abbreviation: ryegrass) leys by ethofumesate (Haggar and Bastian, 1976) but further information is needed on the likely benefits of early removal.

MATERIALS AND METHODS

Experiment 1. Box experiment

To assess the competitive effects of *Poa* on ryegrass growth, a box experiment was carried out in a heated glasshouse, with long-day conditions, during the winter of 1977-78. Each treatment was carried out in a plastic box 28 x 34 x 30 cm deep. *Lolium perenne* c.v. Melle plants were established at three densities, viz, 2, 4 or 8 plants per box (representing 21, 42 and 84 plants /m^2) in the presence or absence of *Poa* at 40 plants per box (420 plants/m^2). The six treatment combinations were replicated three times in a randomized block design.

The boxes contained about 2 cm of gravel to assist drainage and were filled with sterilized sandy loam soil to which fertilizer had been added in the following quantities (g/kg of soil): John Innes Base 4.0, magnesium sulphate 0.75, trace elements 0.1 plus 5% DDT dust. To ensure the requisite number of plants per box, three seeds of ryegrass or *Poa* were sown at each predetermined site and covered with about 5 mm of soil. The boxes were watered daily to field capacity with a fine rose.

After emergence, seedlings were carefully reduced to one per site. Occasional transplanting of *Poa* was necessary. On 15 February 1978 all the boxes were sprayed with thiram for moss control.

Counts of tillers per plant were made at weekly intervals until the 13th week, by which time the shoots were beginning to grow outside the boxes. Plants of the two species were then harvested separately to a stubble height of 4 cm, oven-dried at 100°C for 24 h and weighed. A similar harvest was carried out one month later and a final harvest at soil level, after a further month's regrowth. Ryegrass tillers were counted immediately prior to each harvest.

Experiment 2. Field Experiment

This experiment was designed to assess the competitive effects of the presence of *Poa* on the tillering of individual ryegrass plants in an establishing ley. The effect of spraying ethofumesate on the outcome of competition was also investigated.

The experiment was carried out on a young ley containing several perennial ryegrass varieties, drilled on 14 September 1977 into a conventionally prepared seed bed of sandy loam soil at Begbroke. There were four main plot treatments, viz. sprayed with ethofumesate at 2 kg/ha a.i. or unsprayed, with or without *Poa* ingress. Each main plot was split for five ryegrass densities. Main plot treatments were fully randomized and six replicates were used. Ethofumesate was applied in a single strip at 2 kg/ha in 336 l water, using a tractor mounted sprayer on 17 November 1977; six 5 m long areas were left unsprayed. The main plots were 1 m square and two such plots were randomly selected from each sprayed and unsprayed area. Five ryegrass plants of a similar size were selected from each plot and the area around them was hand-weeded of other ryegrass plants to give gaps of predetermined radii, viz. 2.5, 5, 10, 15 or 20 cm. One of the plots on each area was hand-weeded regularly to remove *Poa* seedlings. On the other plot natural ingress of *Poa* was permitted. All the plots were regularly hand-weeded to remove all broad-leaved weeds, especially *Stellaria media*, and grass species other than ryegrass and *Poa*.

Density of *Poa* seedlings was assessed using 30 cm square quadrats prior to spraying. Tiller counts were carried out on the individually labelled ryegrass plants at monthly intervals between December 1977 and April 1978.

At the end of the experiment, a yield assessment was made by harvesting two ½ m^2 areas from each sprayed and unsprayed plot. The cut material was sorted into the major component species, dried for 24 h at 100°C and weighed.

RESULTS

Experiment 1. Box experiment

In the absence of *Poa* plants, tiller numbers increased exponentially during weeks 8 to 13 (Fig. 1). There was no significant effect of plant spacing during this period. Thereafter, intraspecific competition became progressively greater such that by the 21st week, the high density plants had only 57% of the number of tillers of the low density plants (Fig. 2).

The presence of *Poa* plants caused a highly significant reduction in ryegrass tillering (Fig. 1). This reduction increased with time, reaching nearly 80% by the end of the experiment (Fig. 2). Interspecific competition was more damaging than intraspecific competition (Fig. 2) but the two forms of competition were not additive. Mean tiller weight was not influenced significantly by either intra- or interspecific competition.

In the absence of *Poa*, ryegrass yields recorded between weeks 13 and 21 increased linearly with sowing density (Fig. 3) but were reduced by the presence of *Poa* at the highest ryegrass density. However, the *Poa* yield was not influenced by the ryegrass yield so the mixture of the two species was always higher than the monoculture yield.

Experiment 2. Field experiment

Before spraying there were 757 Poa plants present per m^2. When these plants were removed by hand-weeding there was a mean increase of 11% in ryegrass tillering by mid April. The benefits of hand-weeding Poa tended to increase as the 'ryegrass-free' space increased around individual ryegrass plants (Fig. 4).

In the absence of weeds, spraying caused a significant reduction in ryegrass tillering (Fig. 4) that persisted until the end of the experiment. The reduction was least where the 'ryegrass-free' space surrounding individual ryegrass plants was smallest.

Where Poa plants were present, the inhibiting effect of spraying on ryegrass tillering appeared less (Fig. 4) due, presumably, to the removal of competition from the Poa plants. Unfortunately, the fate of individual Poa plants to spraying was not assessed during the experiment. However, yield data recorded at the end of the experiment (table 1) showed that spraying had caused a substantial reduction in both Poa and S. media DM output, which was associated with a 37% increase in the yield of ryegrass.

Table 1

Influence of spraying ethofumesate at 2 kg/ha on the component species of a newly sown ley (DM yield, g/m^2)

	Unsprayed	Sprayed	s.e.
Ryegrass	137.7	188.9	8.8
Poa annua	15.8	2.9	1.7
Stellaria media	9.8	2.0	2.0
Total	163.4	193.8	8.8

DISCUSSION

The level of Poa infestation in the box experiment was less than that found under normal field conditions (see Oswald and Haggar (1976) and results in experiment 2). Even so, the box experiment showed that ryegrass tillering was considerably influenced by the presence of the Poa plants, with interspecific competition being more damaging than intraspecific competition. Thus infestations of Poas are likely to hinder the development of ryegrass ground cover in newly sown crops when low seed rates are used. Conversely, using a selective herbicide to control such infestations of Poas could effectively gain time for the ryegrass to thicken up. So, there appears to be considerable scope for manipulation in the seed rate/herbicide economic equation allowing for the partial replacement of the former by the latter.

Other box experiments have shown that the presence of Poa spp. can reduce ryegrass tillering by between 20 and 30% during the first 6 weeks from emergence (Gibson and Courtney, 1976; Haggar, 1978). This present experiment has shown that even greater differences can be expected with time. In the field experiment, however, removing Poa plants by hand-weeding obviously had a damaging effect on ryegrass growth since removal only resulted in a mean increase of 11% in ryegrass tillering.

Even though the mixture of the two species outyielded the ryegrass monoculture in the box experiment (as has been reported in other competition studies e.g. Wells and Haggar, 1975; Haggar, 1978), the fact that Poa caused such damage to ryegrass tillering during establishment points to the need for early ingress to be controlled if a high tiller density of crop is required for ensuring high and sustained yields during the life of the ley.

Because the tillering of sprayed ryegrass plants did not reach the same potential as the unsprayed plants, at least during the recording period, then more work is needed to investigate the extent of this effect in a weed-free seedbed. Nevertheless, the benefit of using this herbicide to control P. annua and also Stellaria media was demonstrated in the field experiment in terms of a considerable increase in yield of ryegrass (table 1). The results from two other field experiments, yet to be published, have shown annual increases in ryegrass yields of the order of 20 to 30% following the seed-bed use of ethofumesate in newly sown ryegrass leys.

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Fig. 1 Influence of Poa plants on ryegrass tillering
(mean of three densities)

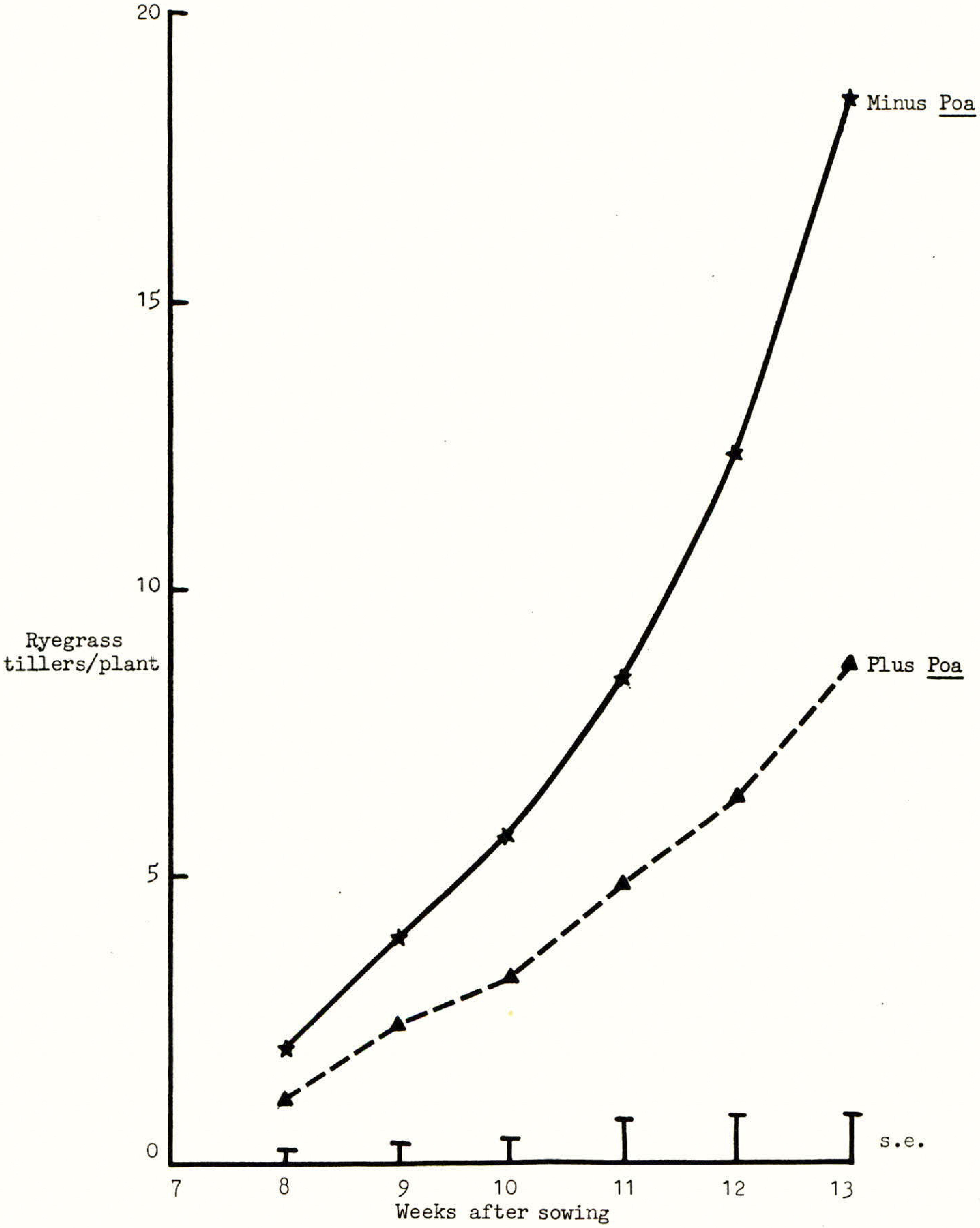


Fig. 2. Effect of ryegrass sowing density, in the presence and absence of *Poa*, on ryegrass tillering measured on three occasions

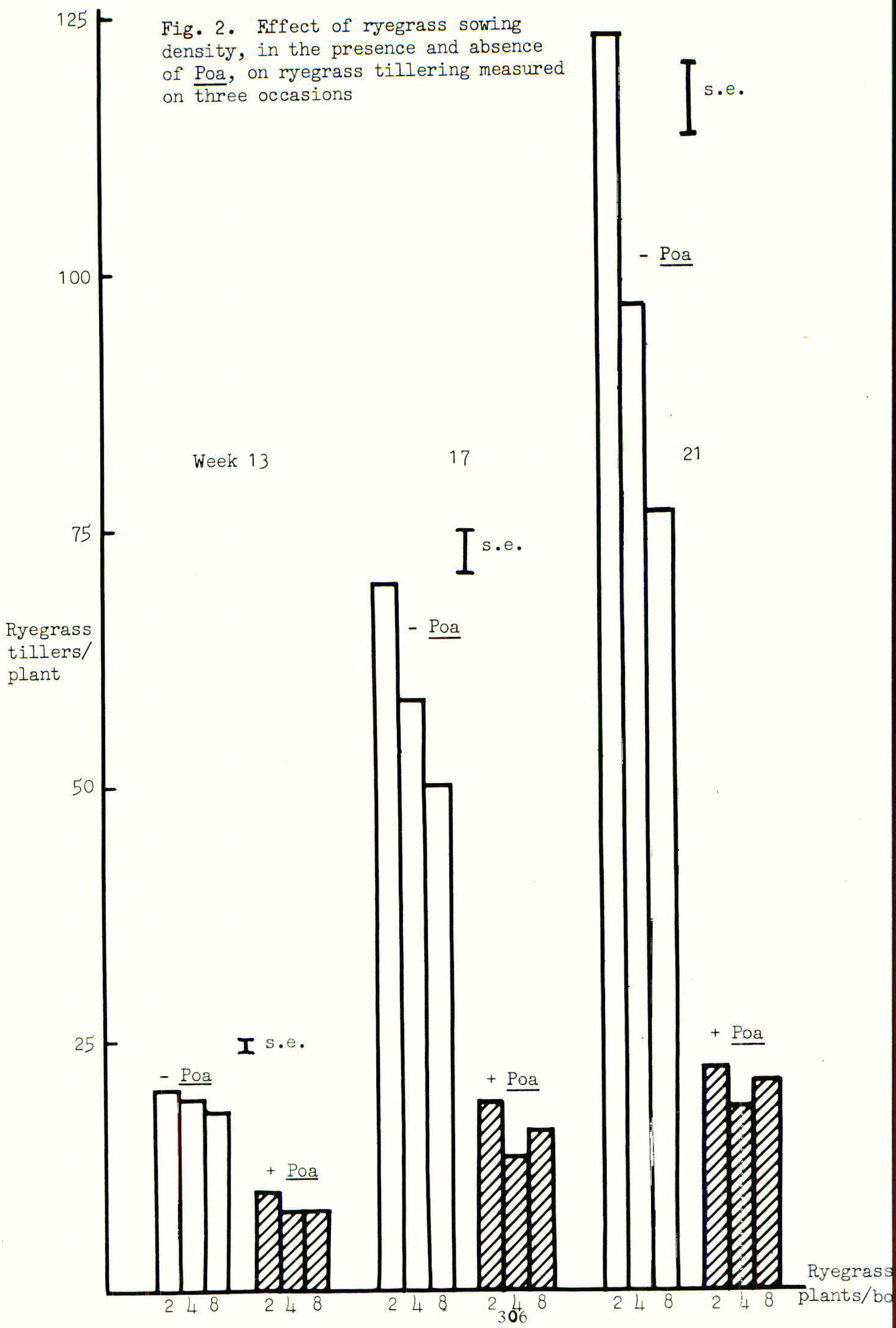


Fig. 3. Yield of ryegrass in monoculture and mixture with *Poa*, as influenced by ryegrass sowing density (total of three harvests)

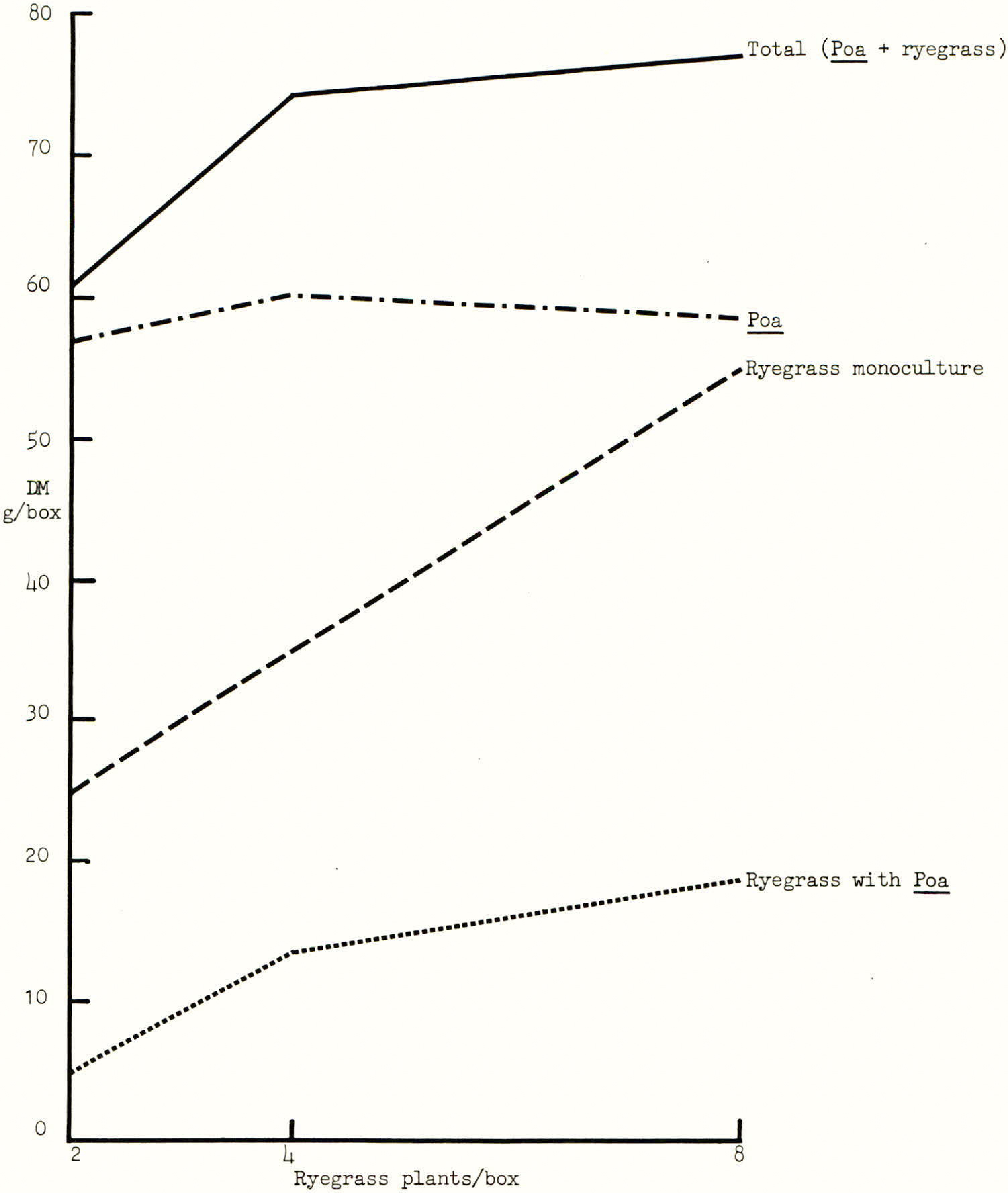
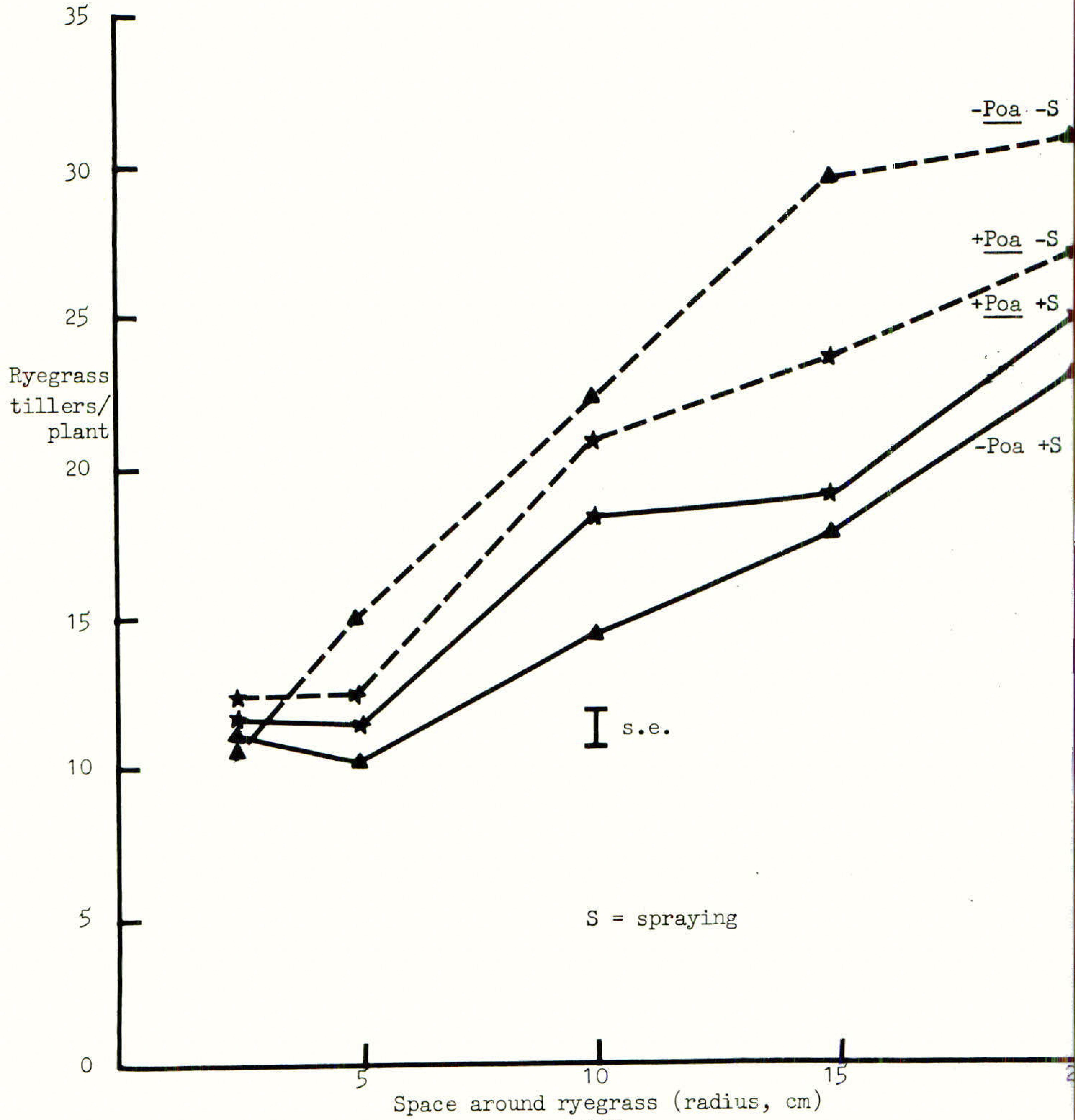


Fig. 4. Effect of removal of Poa (by hand-weeding) and ethofumesate (S) on tillering of ryegrass plants surrounded by different areas of 'ryegrass-free' space



WEED CONTROL IN NEW LEYS AND ESTABLISHED PASTURES WITH ETHOFUMESATE

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Summary Data is presented from the first harvest year of 10 replicated trials on autumn-sown new leys and 10 trials on established pastures, sprayed with ethofumesate at 2.0 kg a.i./ha. Application early post-emergence on new leys controlled Stellaria media, Poa spp, Alopecurus myosuroides and volunteer barley. This resulted in highly significant increases in ryegrass dry matter yield (125% of untreated) on both 1st and 2nd cuts and a highly significant increase in total yield on the latter. On established pastures the situation is more complex, but the data show clearly that where swards contain a high proportion of preferred species, well distributed, ethofumesate highly significantly increased yield of the preferred species. Moreover there is a clear case for the use of this chemical to control unpalatable grasses e.g. Hordeum murinum and Bromus mollis.

INTRODUCTION

Because sown and indigenous grasses can be utilised by animals, the distinction between weed and desirable grasses is hard to define. Nevertheless, ryegrasses, together with smaller quantities of timothy, cocksfoot and fescues completely dominate the grass seeds farmers sow in the U.K. For the purpose of this paper therefore, we have designated these as preferred species and all other non-sown species as weeds.

The majority of broad-leaved weeds can be well controlled by hormones and, apart from Stellaria media, will not be discussed in this paper.

Weeds which germinate with the newly sown crop, especially Stellaria media and Poa spp limit the development of the sown species, with adverse effects on output in the first and subsequent years (Haggar 1976). This initial ingress of weeds is almost ubiquitous and begins the process of sward change, a survey of which has shown that, on average in the U.K., a sward consists of only 50% of sown species within 5 years of sowing. (Morrison & Idle 1972). Although research techniques have frequently failed to show any loss in animal output from such changes in botanical composition, many intensive grass farmers are prepared to re-seed regularly despite the high costs involved.

There appears to be a clear case for removal of grass weeds which the grazing animal finds unpalatable or, which lower the quality of conserved crops e.g. Hordeum murinum and Bromus spp. The case for removing other grass species is less precise and will only be of benefit if the space vacated can be taken up by preferred species.

Ethofumesate has shown unique safety to most preferred pasture grasses and especially to ryegrasses. It has been marketed for the control of Hordeum spp in New Zealand since 1974 (Minter 1974, Hartley 1974) and is also used for control of annual grasses in herbage seed crops in Europe and the USA (Hammond et al 1976; Lee 1977). A logical development, therefore, was to examine its potential for reducing weed competition during the establishment phase of new leys and for increasing the proportion of preferred species in estasblished pastures.

Preliminary work by Fisons in 1976/77 (Griffiths and Hammond 1978a) and by the Weed Research Organisation (Haggar 1978) indicated highly encouraging increases in total output and especially of preferred species, from application of ethofumesate to new leys. More work was therefore initiated by Fisons in 1977/78 involving 10 replicated trials on new leys and 10 trials on established pastures. This programme was backed up by a series of large scale farmer trials throughout the UK, on which visual observations were made. The results obtained in the first harvest year of a continuing programme, are reported in this paper.

METHODS AND MATERIALS

Ten replicated trials were laid down on autumn sown leys (dominantly ryegrasses) within 200 miles of Chesterford Park. Plots measured 10 m x 2 m in a randomised block design. Ethofumesate (20% E.C. formulation available as NORTRON) was applied at 2.0 kg a.i./ha after the crop had reached the 2-3 leaf stage (Nov./Dec. 1977). Application was by knapsack sprayer operating at a volume of 200 l/ha and a pressure of 1.8 bars. After the basic fertiliser given by the farmer, 500 kg/ha of a 29-5-5 fertiliser was applied in spring, followed by375 kg/ha after each of the first 2 cuts. Botanical composition was assessed using 100 points/plot of a ten point quadrat (i.e. 400 points/treatment) in March/April 1978. Harvesting was carried out twice during the season using a Sheen cutter and fresh weights recorded. From 12 representative handfuls of grass from each plot, total DM yield/ha of each species was calculated.

Details of trials on established pastures are as given for new leys, with the following differences. Ethofumesate was applied at 2.0 kg a.i./ha by the farmer's own machine as a single strip across the field on 10 sites. Four steel cages each 2 m x 1 m were set up at random in the treated and untreated areas and formed the basis of subsequent observations. In early spring 250 kg/ha of a 29-5-5 fertiliser was applied followed by the same dose after each cut. Sward composition was assessed in March/April using 50 points/cage (i.e. 200 points/treatment). An area of 1.5 m x 0.75 m was harvested from the middle of each cage.

RESULTS

1. Botanical analysis

The mean botanical composition of treated and untreated areas, assessed in March/April, on leys and established pastures is given in table 1. Clover occurred on two sites and was killed or severely checked by ethofumesate.

Table 1

Mean botanical composition (%) of treated (T) and untreated (UT) areas in trials on new leys and established pastures, March/April, 1978.

		New Leys			Established Pastures	
		T	UT		T	UT
ryegrass	(10)	53	47 **	(10)	72	57 **
timothy				(7)	7	7 NS
cocksfoot				(6)	0	1 NS
Stellaria media	(9)	0	7 **	(4)	0	4 **
Poa spp+	(9)	1	13 **	(9)	11	23 **
Alopecurus myosuroides	(2)	2	35 **			
Bromus mollis				(4)	1	9 **
Hordeum murinum				(1)	0	5 NS
Volunteer barley	(5)	0	8 **			

() = number of sites occurring
\+ = almost entirely *Poa annua* on new leys
** = significant difference between treated and untreated at the 1% level
NS = no significant difference between treated and untreated at the 5% level

On both new leys and established pasture, the high tolerance of preferred pasture grasses to ethofumesate was confirmed. The proportion of ryegrass in both sward types was highly significantly increased after treatment.

Good control of *Poa* spp, *Alopecurus myosuroides* and volunteer barley was obtained in new leys and of *Bromus mollis* and *Hordeum murinum* in established pastures. *Stellaria media* was almost completely controlled in both situations. *Poa* spp were not separated in these trials. The lower level of control of *Poa* spp. shown in established pastures reflects the higher proportion of *Poa trivialis*, which is less susceptible to ethofumesate, when well established.

2. Yields

Full details of 1st and 2nd cuts taken on new leys in 1978 have already been reported (Griffiths and Hammond 1978 b) and are repeated in summary form only in Table 2. Yield data from the first 2 cuts on established pasture are given in Table 3.

Table 2

Mean yield in kg DM/ha from 1st and 2nd cuts on treated (T) and untreated (UT) areas - new leys, 1978

	1st cut (10 trials)				2nd cut (8 trials)			
	yield		significance	SE/plot	yield		significance	SE/plot
	T	UT			T	UT		
total	4513	4731	NS	537	4547	4068	**	526
ryegrass	4276	3410	**	548	4477	3582	**	543
timothy	391	442	NS	191	100	117	NS	48
Poa spp	24	327	**	98	23	293	**	72
Stellaria media	0	216	**	69	0	9	*	9
Alopecurus myosuroides	427	2155	**	692	4	584	**	195
V.barley	2	459	**	203	0	19	NS	32

Yield data from the first 2 cuts on established pastures are given in table 3. Hordeum murinum occurred on one site only (Oxon) and is therefore not included in the table. Ethofumesate gave excellent control of H. murinum reducing its yield over the first two cuts from 423 kg DM/ha to zero.

A wide range of typical pasture weeds was noted in these trials, with considerable variation in the level of importance between sites. The most frequently occurring species are listed in table 3, "others" include Agropyron repens, Agrostis spp, Cynosurus cristatus, Festuca rubra, Holcus lanatus, Hordeum secalinum, Ranunculus spp, Rumex spp, Taraxacum officinale.

Table 3

Yield in kg DM/ha from first 2 cuts on treated (T) and untreated (UT) areas established pastures, 1978.

Site	Total		Preferred + species		*Poa* spp		*Stellaria media*		*Bromus mollis*		Others	
	T	UT	T	UT	T	UT	T	UT	T	UT	T	UT
1 Oxon	6681	6892	4166	2767	1094	1497	-	-	133	847	1288	1782
2 Lincs(x)	5829	5816	3032	2393	286	692	-	-	-	-	251	290
3 Leics	5624	6551	5544	5841	61	633	0	12	0	8	20	58
4 Northants	7522	7288	6267	4036	1160	2174	0	185	-	-	94	892
5 Salop	7409	7140	not separated									
6 Suffolk	5208	4989	5028	4458	19	41	0	283	0	2	161	205
7 Cambs	3436	4137	2893	2501	366	482	-	-	16	957	160	198
8 Somerset	5045	5493	4652	4533	373	923	-	-	-	-	20	37
9 Glos	6936	6679	6574	5267	277	1278	0	13	-	-	85	121
10 Kent	6031	6080	3402	1885	902	1002	-	-	-	-	1726	3193
Mean yield	5972	6107	4816	3911	532	1004	0	123	37	454	444	811
significance	NS		**		**		*		**			
S.E./plot	734		860		482		151		410			

\+ = ryegrass + cockfoot + timothy

(x) = figures other than total yields are from the second cut only on this site

DISCUSSION

1. General

Results presented in this paper confirm the high tolerance of preferred pasture grasses to ethofumesate. Clover however is very susceptible and ethofumesate should not be used where clover is an important constituent of the sward.

The high level of weed control obtained in these trials agrees closely with experience in 1976 and 1977 and does not appear to be influenced by the organic matter status of the soils (up to 20.6%).

Several farmers involved in the large scale trials noted that cattle and sheep preferentially grazed the ethofumesate treated areas. D-value analysis of treated and untreated samples failed to show significant differences and the reasons for this preference have not yet been identified.

2. New leys

The competitive effect of grass weeds on cereals, also a graminaceous crop, has been well established. Morphological and physiological similarities between weed grasses and preferred species is even closer and it would be surprising if competition did not occur. The uniquely selective properties of ethofumesate have allowed such assessment to be made and, as shown in Table 2, highly significant increases in the output of ryegrass (125% of untreated areas) have been obtained following treatment.

Poa annua and Stellaria media are the most commonly occurring weeds during the germination of autumn-sown leys in the U.K. (Infestations of Stellaria media did not, however, develop as expected in our trials.) The competitive effect of these weeds is particularly severe where the preferred species are slow to establish. Their timely removal by ethofumesate not only improves establishment, but has a very positive effect on the yield of the preferred species. Stellaria media is particularly susceptible to ethofumesate and results not reported here have shown excellent control at rates down to 1.0 kg a.i./ha. An additional advantage is its activity during cold periods of the year, when hormone herbicides tend to lose reliability. Ethofumesate also gives residual control of germinating chickweed and other susceptible weeds for up to 12 weeks after application of 2.0 kg a.i./ha.

The significance of "arable grass weeds" during the establishment of a new ley is also highlighted in the results presented. Alopecurus myosuroides proved to be very competitive to ryegrass and we believe that heavy infestations of volunteer cereals are also more competitive than previously considered. Avena spp are also controlled by ethofumesate, but did not occur in these trials. They are equally likely to be competitive to the sown species at establishment. The ability to control these arable weeds and Bromus sterilis in short term leys in an arable rotation is an important additional bonus.

3. Established pastures

Research on the control of annual grass weeds in established pastures with ethofumesate is less advanced than in new leys and hence the potential benefits are less well defined. The situation is further complicated by the enormous variation between fields, not only in botanical composition, but also in management practices.

In spite of this, there appears to be a firm case for controlling weeds which are unpalatable, or which markedly reduce the quality of conserved fodder. Amongst these, Hordeum murinum and Bromus mollis are of particular interest.

Hordeum murinum has become more apparent in the U.K. following the dry winter of 1975/76, and the dry summers before and after, but has been recognised as a problem on some farms for over 20 years. In extreme cases contamination by this weed has necessitated burning of the hay crop (Fulton, 1978). The rejection by animals, once this grass has approached the green head stage, has resulted in many farmer enquiries for control. Ethofumesate has been very effective in meeting this need.

Bromus mollis also tends to run to head very quickly with little vegetative production. Moreover, the small awn can cause considerable irritation to stock. It occurred in significant quantities on 2 sites reported here (sites 1 and 7) and in 8 farmer trials. This weed is well controlled by ethofumesate provided application occurs at or soon after, germination. Our experience suggests that for most of England the period October to December is optimum. For Scotland the germination period appears to be different and spraying should take place in late winter or early spring.

Poa spp. normally precede Agrostis spp in the botanical succession of a sward. Preventing the establishment of Poa spp by ethofumesate and encouraging the preferred species could prevent, or significantly slow down, the succession to Agrostis. The effect of ethofumesate on Agrostis and other perennial grasses in established pasture is the subject of continuing investigation.

No herbicide alone can maintain the productivity of a sward. For optimum benefit management should be aimed at encouraging maximum competition by the preferred species to subsequent weed invasion. This is most likely to occur under intensive dairying conditions where high rates of nitrogen are used.

Following the results reported in this paper and work by collaborators, ethofumesate is now recommended for use during the establishment phase of leys at 2.0 kg a.i./ha post-emergence on most preferred species, or at 1.4 kg a.i./ha pre-emergence on ryegrass and tall fescue. It is also recommended for the control of specific weeds in established pastures.

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