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L-FLAMPROP-ISOPROPYL. A VERSATILE WILD OAT HERBICIDE WITH ECONOMIC BENEFITS FOR USE IN WHEAT AND BARLEY

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Summary Field trials were completed in Europe from 1975-78 to evaluate l-flamprop-isopropyl for the control of Avena spp. in barley and wheat. At 0.6 kg a.i./ha, the spikelet reduction in wheat was 95% and comparable to that of benzoylprop-ethyl The 93% spikelet reduction in barley represented a significant improvement over flamprop-isopropyl . In wheat, the 76% control of Alopecurus myosuroides was equivalent to that of flamprop-methyl . Where the broadleaved weed spectrum was suitable, tank mixtures with MCPA K salt gave adequate combined control. Returns on increased yields from crops grown for milling or feed, begin to offset treatment costs at infestations of around 60 Avena panicles/m^2 in spring barley and in wheat. In all wheat and barley crops, treatment of lower infestations is justified, to reduce seed return to the soil. In addition, treatment of seed crops is essential.

Résumé Des essais de plein champ ont été realisés en Europe de 1975-1978 pour evaluer l'action de l-flamprop-isopropyl sur Avena spp. dans les cultures de blé et d'orge. A 0.6 kg m.a./ha, la réduction du nombre d'epillets d'Avena spp. dans les cultures de blé a été de 95% et comparable à celle du benzoylprop-ethyl La réduction de 93% d'epillets d'Avena spp. dans les cultures d'orge a représenté une amélioration significative par rapport à l'activité de flamprop-isopropyl Dans le blé, l'efficacité de 76% sur Alopecurus myosuroides a été équivalente à celle du flamprop-methyl Dans les situations où les dicotyledones présentes étaient sensibles au spectre d'activité du MCPA sel de Potassium, un mélange extemporané a été utilisé et a donné un contrôle combiné adequat. Le seuil de rentabilité du traitement se situe à un niveau d'infestation d'environ 60 epis d'Avena spp. par m^2 pour l'orge de printemps et pour le blé. Même dans les cas d'infestation inférieure, le traitement est justifié dans toutes les cultures de blé et d'orge de facon à réduire l'ensemencement du sol avec les graines d'Avena spp.

INTRODUCTION

In recent years, the increasing occurrence of mixed infestations of Alopecurus myosuroides and Avena spp., particularly in winter cereals, have often necessitated control measures involving separate applications, in addition to the general treatment for broadleaved weeds. A combined application effective against all three weed problems would save both time and money and represent an important advance in cereal weed control. L-flamprop-isopropyl, with its activity against both A. myosuroides and Avena spp. goes some way towards meeting these requirements. The discovery that mixtures with MCPA can give an acceptable combined control of Avena spp. and broadleaved weeds in specific situations is proving to be a further advantage in some areas.

L-flamprop-isopropyl, a chiral form of flamprop-isopropyl, was described by Scott et al (1976). Their work showed that l-flamprop-isopropyl was often twice as active as the commercial racemate against Avena spp., and at 0.6 kg a.i./ha, was consistently superior. This dose showed good selectivity in a wide range of barley varieties when applied between late tillering and the first node stage. Limited work in wheat also demonstrated that at 0.6 kg a.i./ha, l-flamprop-isopropyl gave a performance comparable to that of flamprop-methyl at the same dose.

This paper reviews the results of work from 1975-1978 in Europe, and discusses the benefits of l-flamprop-isopropyl.

METHODS AND MATERIALS

Field trials details

Seventy-two replicated trials were carried out on barley in Europe between 1975 and 1977, and at the time of writing a further fifty replicated trials are due for completion on wheat up to 1978. Treatments were applied at a pressure of 2-4 bars in 250-500 l/ha, using precision plot sprayers or Land Rover sprayers. Plot sizes varied from 20-90m^2. In this work l-flamprop-isopropyl, flamprop-isopropyl and benzoylprop-ethyl were formulated as 20% e.c.s, while flamprop-methyl was formulated as a 15% e.c.

Following exploratory work, doses in the range of 0.5-0.7 kg a.i./ha were decided upon, with 0.6 kg a.i./ha being considered the optimum dose to meet technical and commercial requirements. Applications were made during the period from late tillering to first node in barley, and from late tillering to second node in wheat.

Assessments

Avena spp. counts. Counts of panicles were made using 4-10 x 0.25m^2 quadrats placed at random within the plots but avoiding areas near the edge. In many of the trials an estimate of spikelet reduction was also made by classifying the panicles into one of the three size categories as suggested by Holroyd (1972).

Alopecurus myosuroides counts. Counts of flowering heads were made in quadrats as for Avena spp. (i.e. panicle counts).

Yield. The weight of grain was measured from areas varying between 12.5 and 44m^2, depending on the size of plot treated, and the method of harvesting.

RESULTS

Control of wild oat - Avena spp.

Results are summarised in Tables 1, 2, 3 and 4 according to the density of Avena spp. in the crop as follows:-

low density	=	$<$ 50 panicles/m^2
medium density	=	51-150 panicles/m^2
high density	=	$>$ 150 panicles/m^2

Table 1

Control of Avena spp. in barley. Mean % reduction in total panicles

Year	Density of Avena spp.	No. of trials	Treatment flamprop-isopropyl		l-flamprop-isopropyl	
	Dose in kg a.i./ha:		1.0		0.45-0.5	0.6
1975	Low	5	73.2		72.6	82.7
	Medium	6	65.3		71.5	78.7
	High	4	82.6		80.3	80.8
	Mean		72.6		74.2	80.6
	LSD			15.9		
1976	Low	17	83.9		83.4	92.7
	Medium	14	81.3		84.9	89.3
	High	5	64.6		69.4	77.0
	Mean		80.2		82.0	89.2*
	LSD			7.9		
1977	Low	5	71.6		81.6	85.6
	Medium	13	71.7		76.9	85.3
	High	3	89.3		88.0	87.3
	Mean		74.2		79.6	85.7*
	LSD			10.9		
All 3 years	Overall mean	(72)	76.9		79.7	86.4*
	LSD			5.9		

Table 2

Control of Avena spp. in wheat. Mean % reduction in total panicles

Year	Density of Avena spp.	No. of trials	Treatment benzoylprop-ethyl		l-flamprop-isopropyl	
	Dose in kg a.i./ha:		1.0-1.3		0.5	0.6
1977	Low	10	84.8		89.9	92.6
	Medium	8	70.9		79.8	86.9
	High	3	73.0		74.7	86.6
	Mean		77.8		83.9	89.6*
	LSD			9.4		
1978	Low	3	86.0			95.0
	Medium	3	73.0			38.7
	High	2	90.0			90.5
	Mean		82.1			91.6
	LSD			10.7		
All 2 years	Overall mean	(29)	79.0			90.2*
	LSD			7.4		

N.B. LSD values are applicable only to the annual mean and overall mean differences between l-flamprop-isopropyl and flamprop-isopropyl or benzoylprop-ethyl.

*Difference significant at $P < 0.05$ between l-flamprop-isopropyl and appropriate reference standard (flamprop-isopropyl or benzoylprop-ethyl)

Table 3

Control of Avena spp. in barley. Mean % reduction in total spikelets

Year	Density of Avena spp.	No. of trials	Treatment flamprop-isopropyl		1-flamprop-isopropyl	
	Dose in kg a.i./ha:		1.0		0.45-0.5	0.6
1975	Low	5	73.6		84.0	90.0
	Medium	5	81.0		83.0	87.9
	High	2	74.5		83.0	83.5
	Mean		76.8		83.4	88.0
	LSD			12.5		
1976	Low	8	91.8		92.0	95.8
	Medium	11	91.7		92.7	95.3
	High	3	89.7		90.7	95.7
	Mean		91.4		92.2	95.5
	LSD			4.8		
1977	Low	2	65.0		92.5	86.0
	Medium	2	34.5		81.5	94.5
	High	1	100.0		99.0	100.0
	Mean		59.8		89.4	92.2
	LSD			48.1		
All 3 years	Overall mean	(39)	82.9		89.1*	92.8*
	LSD			5.9		

Table 4

Control of Avena spp. in wheat. Mean % reduction in total spikelets

Year	Density of Avena spp.	No. of trials	Treatment benzoylprop-ethyl		1-flamprop-isopropyl	
	Dose in kg a.i./ha:		1.0-1.3		0.5	0.6
1977	Low	2	97.0		99.0	99.5
	LSD			3.9		
1978	Low	3	91.3			91.7
	LSD			20.6		
All 2 years	Overall mean	(5)	93.6			94.8
	LSD			10.3		

N.B. LSD values are applicable only to the annual mean and overall mean differences between 1-flamprop-isopropyl and flamprop-isopropyl or benzoylprop-ethyl.

*Difference significant at $P < 0.05$ between 1-flamprop-isopropyl and appropriate reference standard (flamprop-isopropyl or benzoylprop-ethyl)

Control of Avena spp. by in-tank mixtures of l-flamprop-isopropyl with MCPA

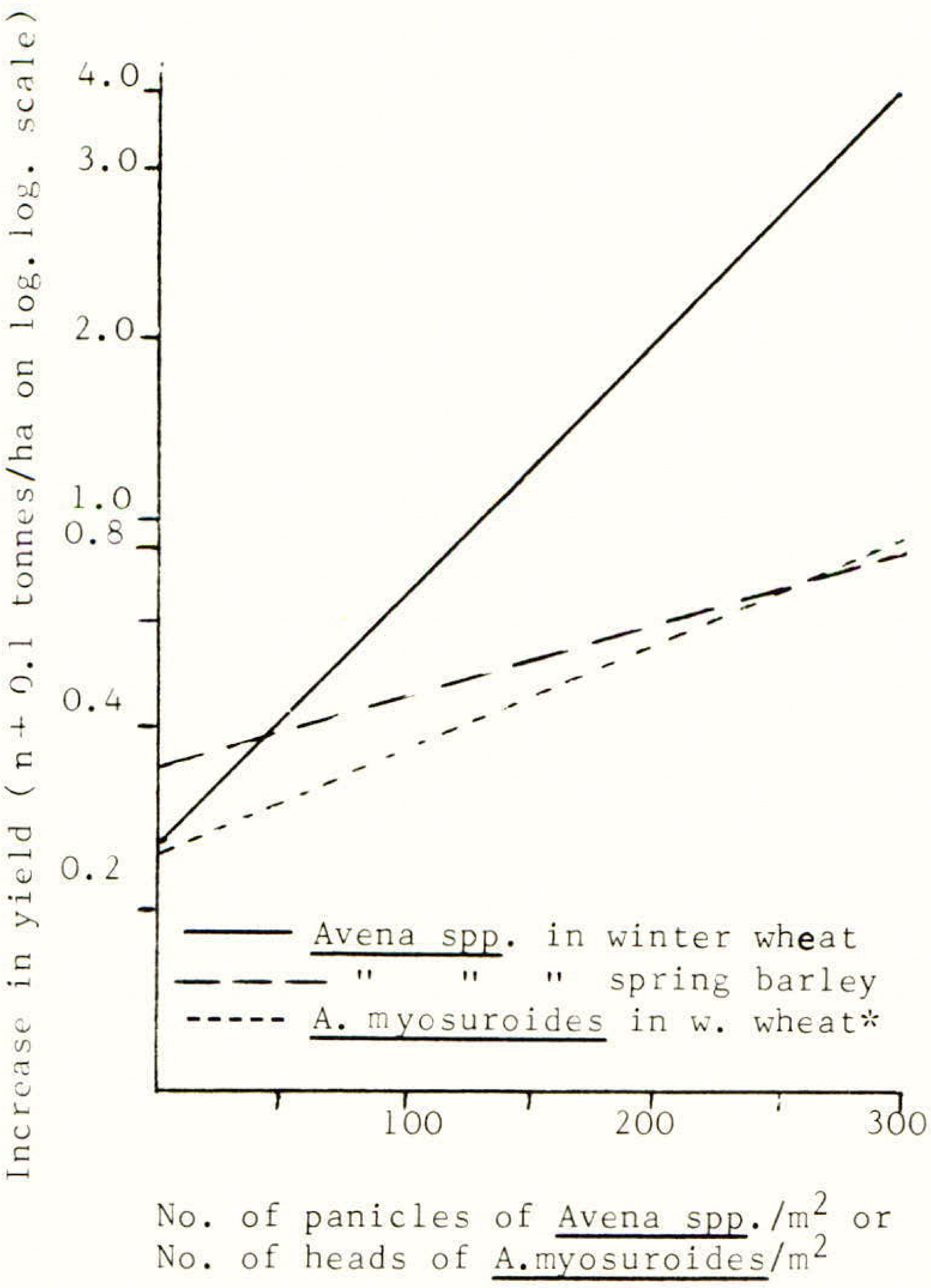
Figure 4 shows the results of two trial series from southern Europe in 1977 comparing l-flamprop-isopropyl alone and in mixture with MCPA K salt.

Yield response to control of Avena spp.

These are set out in Tables 5 and 6, and are summarised below:

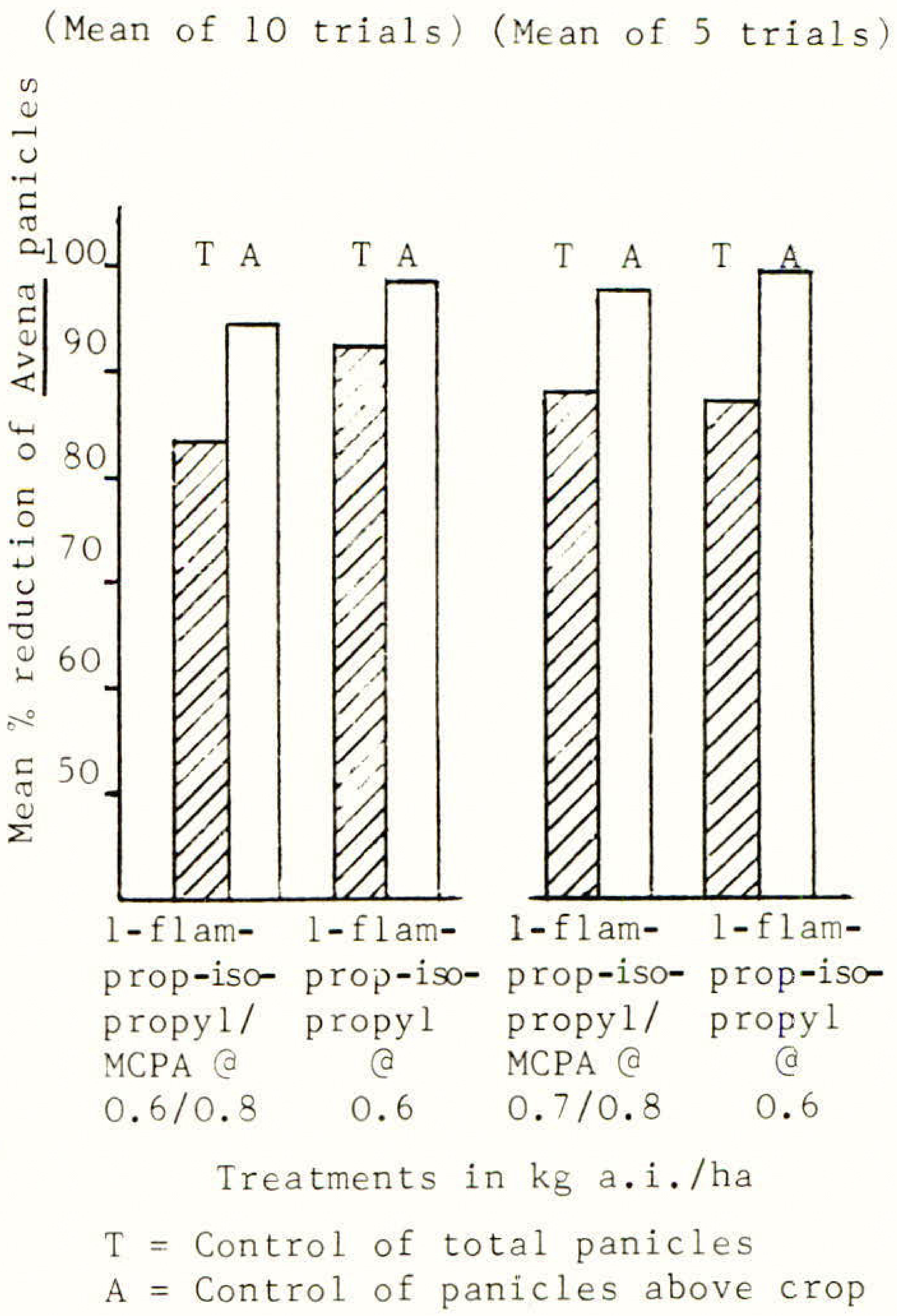
Relationship between density of Avena spp. or A. myosuroides and yield gain following treatment with l-flamprop-isopropyl

Fig. 1



A comparison of the control of Avena spp. by l-flamprop-isopropyl alone and in mixture with MCPA K salt in S. Europe

Fig. 2



Regression equations for increase in yield (log. tonnes/ha) are as follows:-

- 0.6 + [0.4 x density of Avena (100 panicles/m^2)] in winter wheat
- 0.5 + [0.1 x " " " " "] in spring barley
- 0.6 + [0.2 x " " Alopecurus* "] in winter wheat

*in the absence of Avena spp.

Table 5

Mean yields of barley expressed as % of untreated control

Year	Density of Avena spp.	No. of trials	flamprop-isopropyl		l-flamprop-isopropyl	
	Dose in kg a.i./ha:		1.0		0.45-0.5	0.6
1975	Low	6	101.3		102.8	105.2
	Medium	3	103.7		105.7	106.0
	High	2	120.3		137.0	139.5
	Mean		105.4		109.8	111.6
	LSD			16.6		
1976	Low	12	101.3		103.5	101.3
	Medium	5	109.8		111.6	111.8
	High	3	119.0		116.3	120.6
	Mean		106.1		107.4	106.8
	LSD			6.4		
1977	Low	5	102.6		110.8	110.0
	Medium	8	111.5		112.8	114.9
	High	2	112.0		110.5	111.0
	Mean		108.6		111.8	112.7
	LSD			10.8		
All 3 years	Overall mean	46	106.7		109.4	109.9
				5.8		

Table 6

Mean yields of wheat expressed as % of untreated control

Year	Density of Avena spp.	No. of trials	benzoylprop-ethyl		l-flamprop-isopropyl	
	Dose in kg a.i./ha:		1.0-1.3		0.5	0.6
1977	Low	6	105.3		107.6	112.8
	Medium	5	123.8		127.4	128.4
	High	2	125.0		129.5	151.0
	Mean		115.5		118.6	124.7
	LSD			16.1		

At the time of writing yield results for 1978 were as follows:

	Low	2	106.5
	Medium	3	115.3
	High	4	155.3

N.B. LSD values are applicable only to the annual mean and overall mean differences between l-flamprop-isopropyl and flamprop-isopropyl or benzoylprop-ethyl.

Performance against blackgrass (Alopecurus myosuroides)

Table 7

Activity against A. myosuroides in wheat. Mean % reduction in total panicles

Year	Density of A. myosuroides	No. of trials	Treatment l-flamprop-isopropyl
	Dose in kg a.i./ha:		0.6
1977-78	Low	5	72
	Medium	8	74
	High	14	66
	Mean	(27)	71

Table 8

Mean of 4 trials on wheat in the absence of Avena spp.
(infestation 270-339 panicles/m^2

Treatment	Dose in kg a.i./ha	% reduction total heads	Yield increase as % of control
l-flamprop-isopropyl	0.6	75.3	120.0
flamprop-methyl	0.525-0.6	68.0	118.5
Mean control yield (tonnes/ha):			5.75

DISCUSSION

The data reported here from trials carried out in wheat and barley, with a range in densities of Avena spp., shows that at 0.6 kg a.i./ha, l-flamprop-isopropyl gives a greater reduction in the numbers of both spikelets and panicles when compared with flamprop-isopropyl or benzoylprop-ethyl. Haddock et al (1974) and Breslin (1974) have shown that the return of wild oat seed to the soil from heavy infestations can amount to 60,000/m^2 (at 2 seeds/spikelet). An improved spikelet control by l-flamprop-isopropyl in barley of around 10% when compared with flamprop-isopropyl, can therefore further reduce the seed returned to the soil by as much as 6,000/m^2, which will result in worthwhile long term benefits. In addition, recent work has shown that treatment results in a reduction of seed dormancy similar to that produced by benzoylprop-ethyl. (Peters, 1978.)

Limited information on the control and suppression of A. myosuroides in wheat by l-flamprop-isopropyl in the absence of Avena spp., demonstrated an activity comparable to that of flamprop-methyl (Table 8). The overall reduction in flowering heads, of around 70%, together with a severe suppression of the remainder, represents an important weed control bonus in crops with mixed infestations. The contribution of this bonus to yield gain is quite marked (Fig. 1).

The trials to evaluate in-tank mixtures of l-flamprop-isopropyl with MCPA K salt in southern Europe (Fig. 2), show a mean reduction of 10% in the level of control of

Avena panicles by 0.6 kg a.i./ha 1-flamprop-isopropyl in mixture with 0.8 kg a.e./ha MCPA. However, performance remained visually good and the reduced control was due mainly to the presence of small panicles with few spikelets at the bottom of the crop. Increasing the dose of the 1-flamprop-isopropyl component from 0.6 to 0.7 kg a.i./ha ensured an overall wild oat control comparable to 1-flamprop-isopropyl alone at 0.6 kg a.i./ha.

At current prices, for wheat and barley sold for milling or feed, an increase in grain production of at least 0.35 tonnes/ha is necessary to offset the cost of treatment. This corresponds to an Avena infestation level of around 60 panicles/m^2 in both crops (Fig. 1). However, the higher prices paid for malting barley justify the treatment of lower densities in this crop. In other cases, treatment of lower infestation levels may be necessary in order to reduce the return of Avena seeds to the soil. Control of low levels of infestation is essential in crops grown for seed because of EEC regulations governing contamination (Pertwee, 1972).

The overall results discussed above show that 1-flamprop-isopropyl applied during its period for optimum Avena control, represents an improvement over flamprop-isopropyl or benzoylprop-ethyl, in terms of its effectiveness and flexibility of use in both wheat and barley. The increase in yield resulting from the control and suppression of blackgrass as well as Avena spp., is of considerable economic importance in those areas where mixed infestations occur, since the use of costly separate treatments is avoided. In those regions where MCPA gives an adequate broadleaved weed control, tank mixtures with 1-flamprop-isopropyl can offer further savings in application cost. The versatility of 1-flamprop-isopropyl can therefore represent very worthwhile economies for the farmer.

Acknowledgements

Thanks are due to all our co-workers who have contributed their results for the production of this report.

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THE EFFECT OF ROTATION AND HERBICIDES ON POPULATIONS OF AVENA FATUA AND AVENA LUDOVICIANA

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Summary Long term studies of populations of Avena spp were conducted in rotations of cereals. Pre-emergence and post-emergence herbicides were applied annually, in alternate years or with alternating chemicals. Untreated controls and continuous hard roguing were included.

On the controls A. fatua did not multiply in an alternating winter wheat - spring barley rotation but A. ludoviciana increased rapidly in winter cereals and declined in spring barley. Annual herbicide use resulted in a rapid decline of Avena spp but 9 years of intensive hand roguing did not eliminate the weed. A. fatua slowly declined when sprayed in alternate years, allowing economies in herbicide use and yields of cereals were unaffected by competition. A. ludoviciana produced large panicles in winter cereals and seed production was not well controlled by herbicides, spraying in alternate years did not contain wild oat populations without loss in yield but economies could be made after a period of spring cropping.

The economic significance of the results is discussed.

INTRODUCTION

Wild oats are a serious problem in many areas of the UK; clean fields are vulnerable to contamination and prolonged survival of buried seed makes eradication doubtful in the short term.

The economics of chemical and cultural practices which influence wild oat populations are of concern to the farmer. Populations vary with factors affecting mortality and addition of new seed to the soil. Loss of seed under leys is usually insufficient to prevent reinfestation (Thurston 1966, Forbes 1963). On the other hand seed production by Avena spp is adversely affected by vigorous crop competition, seedling root growth is less rapid than in cereals (Chancellor and Peters 1970) and older seed and seed at increasing depth emerges later (Thurston 1966). Wild oats emerging 2 to 3 weeks after spring cereals have low seed production (Holroyd, 1972) whereas in early sown winter cereals much seed can be produced and shed before harvest unless remedial action is taken.

It is not possible to stimulate germination of wild oat seeds in the soil by cultural means (Wilson and Cussans 1975) but Wilson (1972) found that over 75% of seed on the soil surface of undisturbed stubble died by December and loss of dormancy of exposed seed was over 70% compared to 10% in buried seed. Cultivation of stubble soon after harvest produced two to three times more seedlings in the spring, while cultivation plus mouldboard ploughing produced fewer seedlings but more seed was conserved. Straw burning accounted for 20% of seed mortality, particularly in the swath.

Specific wild oat herbicides enable the farmer to make a more direct attack on the problem. Breslin (1974) with repeated applications of benzoylprop-ethyl to winter wheat over three years reduced an emerging seedling population of _A. fatua_ from 108/m^2 to 12/m^2. Similarly Roebuck and Hughes (1972) showed that a 95% level of control of panicles by herbicides in spring barley combined with straw burning and no early stubble cultivation, reduced a severe infestation of _A. fatua_ to roguable levels in 5 years. In this report the untreated crop areas showed a gradual decline in emerging wild oats over 6 years after a large increase in the first year. But in similar work at Boxworth wild oats in continuous winter wheat multiplied annually by a factor of 3.4 after ploughing and by 6.5 after cultivations and early drilling. Annual herbicide application did not reduce wild oats unless followed by later drilling in November. In this situation cultivations were better than ploughing because fewer seeds were conserved (Oliphant 1977).

The two trials described here studied the population trends of wild oats in cereal crops with various treatments applied to the same areas each year.

METHODS AND MATERIALS

At two farms a field in cereal rotation was selected and treatments for wild oat control were applied on an annual basis to large plots of 0.1 to 0.3 ha with two-fold replication. _A. fatua_ was studied at a chalkland site in East Sussex and _A. ludoviciana_ at a site in Bucks on Upper Greensand. Choice of crop and husbandry was at the discretion of the farmer. Basic treatments were as follows:

1. Pre-emergence herbicide applied
   - a. annually
   - b. alternate years only
   - c. alternate years with post-emergence herbicide (Bucks site only)

2. Post-emergence herbicides applied
   - a. annually
   - b. alternate years only
   - c. alternate years with pre-emergence herbicide (Bucks site only)

3. Hand rogued each year (Bucks site only)

4. Control areas not sprayed (2 to 3 per trial)

Sprays were applied across the cereal rows and grain yields were obtained by combine harvester. Counts of emerging wild oats, panicles and spikelets were obtained to measure changes in population.

At Church Farm, Edlesborough, Bucks, the straw was generally burnt but the stubble was not cultivated before ploughing. As general farm practice the ploughed land was sprayed with paraquat to kill winter germinating weeds prior to seedbed preparation for spring cereals.

At Coombe Farm, Saltdean, E. Sussex, straw of the preceding crop was burnt or, if baled, the stubble was subsequently burnt. The plots were tine cultivated soon after straw disposal and mouldboard ploughed in preparation for drilling. For spring crops ploughing generally took place in December.

Table 1

Details of Sites

1. Avena ludoviciana
(Church Farm, Edlesborough, Bucks)

Year	1972	1973	1974	1975	1976	1977	1978
Crop	W. Wheat	S. Barley	S. Barley	S. Barley	W. Beans	W. Wheat	W. Wheat
Cultivar	Cappelle Desprez	Lofa Abed	Lofa Abed	Maris Mink	Throws MS	Flinor	Kinsman
Sown	13 October	19 March	28 March	23 April	5 November	12 October	15 October
Pre-emergence	Triallate	Triallate	Triallate	Triallate	Triallate	Triallate	Triallate
herbicide	13 October	19 March	27 March	22 April	5 November	12 October	15 October
Post-emergence	Barban	Barban	Barban	Barban	Barban	Flamprop-methyl	Flamprop-methyl
herbicide	21 March	9 May	17 May	6 May	22 April	13 May	10 May
Wild Oats stage	3 leaf	2 leaf	1-2 leaf	2 leaf	2½-3 leaf	Tillered	Tillered
Alternate years	-	+	-	+	-	+	-

In addition paraquat at 2.7 litre/ha product applied to ploughed furrow before seedbed preparation for spring cereals to whole trial area.

Table 1
Continued

Details of Sites

2. Avena fatua
(Coombe Farm, Saltdean, Brighton)

Year	1973	1974	1975	1976	1977	1978
Crop	S. Barley	W. Wheat	S. Barley	W. Wheat	S. Barley	W. Wheat
Cultivar	Vada	Capelle Desprez	Vada	Maris Huntsman	Abacus	Maris Huntsman
Sown	15 March	26 October	12 April	20 October	3 March	14 October
Pre-emergence herbicide	Triallate granules 20 March	Triallate granules 30 October	Triallate granules 10 May	Difenzoquat 20 April	Difenzoquat 12 May	Flamprop-methyl 19 April
Post-emergence Herbicide I	Barban 25 April	Barban 20 March	Chlorfenprop-methyl 19 May	Benzoylprop-ethyl 20 April	Difenzoquat 12 May	Flamprop-methyl 19 April
Post-emergence herbicide II	Chlorfenprop-methyl 8 May	Benzoylprop-ethyl 9 May	Difenzoquat 29 May	Difenzoquat 20 April	Difenzoquat 12 May	Flamprop-methyl 19 April
Alternate years	+	-	+	-	+	-

RESULTS

The effects of treatment on seedling emergence and panicle and spikelet production are shown in tables 2 and 3.

Table 2

A. ludoviciana (Edlesborough) Counts per m²

Year/Crop		1972 (WW)	1973 (SB)	1974 (SB)	1975 (SB)	1976 (W. Beans)	1977 (WW)	1978 (WW)	Total Spikelets m² 1972-78
Treatment									
Pre-emergence									
Annual	S	9	44	35	3	0	0	-	
	SP	628	0	0	13	14	364	15	1034
Alternate years (nil 1972)	S	84	102	101	8	9	0	-	
	SP	3940	17	165	22	278	135	258	4815
Alternate pre/ post (post in 1972)	S	80	54	19	5	0	0	-	
	SP	42	0	0	11	0	0	192	245
Post-emergence									
Annual	S	75	33	18	3	0	0	-	
	SP	7	44	18	76	8	30	23	206
Alternate years (nil 1972)	S	70	83	99	16	5	2	-	
	SP	4569	20	185	69	488	20	421	5772
Alternate pre/ post(pre in 1972)	S	7	40	24	4	0	1	-	
	SP	430	2	18	39	22	0	249	760
Hand rogued since 1968	S	7	5	7	1	7	1	-	
	SP	11	93*	60*	0	0	1	110*	-
Controls	S	79	72	77	9	1	3	-	
	SP	2736	314	293	135	216	1004	1915	6613

S = seedling wild oats per m² in winter crops or on furrow before spring crops

SP = spikelets per m²

* before roguing

Table 3

A. fatua (Saltdean) Counts per m^2

Year/Crop		1973 (SB)	1974 (WW)	1975 (SB)	1976 (WW)	1977 (SB)	1978 (WW)
Treatment							
Pre-emergence							
Annual	S	0	0.5	0	1	0.5	0
	P	1	1	1	0	0	0
Alternate years (nil 1974)	S	0	2	1	4	1	0.2
	P	1	4	2	1	0	0
Post-emergence I							
Annual	S	17	3	5	2	1	0.2
	P	5	2	1	0	0	0
Alternate years (nil 1974)	S	17	3	7	10	3	1.4
	P	5	5	6	1	0	0
Post-emergence II							
Annual	S	15	4	4	2	1	0
	P	1	2	0.5	0	0	0
Alternate years (nil 1974)	S	15	4	4	5	1	1
	P	1	2	0.5	0.5	0	0
Controls	S	8	5	9	14	8	2
	P	13	8	10	1	5	0.5

S = seedling wild oats in crop per m^2

P = panicles per m^2

At the Saltdean site there were differences in vigour of wild oats where blocks were situated on thin chalk compared to the more fertile lower lying deeper downwash as shown in table 4.

Table 4

A. fatua populations (m^2) (Saltdean)

	Year	Crop	Herbicide Annually		Herbicide Alternate Years		Control	
Fertile soil	block		S	P	S	P	S	P
	1973	SB	22	4	22	4	18	25
	1974	WW	5	2	4	6	8	15
	1975	SB	7	1	7	1	16	15
	1976	WW	4	0	7	0.5	22	3
	1977	SB	1	0	2	0	14	7
Less fertile	block							
	1973	SB	8	1	8	1	7	4
	1974	WW	2	1	2	3	2	4
	1975	SB	1	0.5	2	1	3	6
	1976	WW	1	0	5	0.5	8	1
	1977	SB	0.5	0	1	0	2	2

Where possible combine yields of grain were taken and the mean of two replicates are shown in table 5.

Table 5

Yields of grain (tonne/ha)

	1972 (WW)	1973 (SB)	1974 (SB)	1975 (SB)	1976 (W. Beans)	1977 (WW)	1978 (WW)
A. ludoviciana (Edlesborough)							
Pre-emergence							
Annual	5.0	4.6	5.6	2.3	3.5	6.4	6.2
Alternate years (nil 1972)	2.8	4.6	5.7	2.3	3.4	6.4	6.1
Alternate pre/post (post in 1972)	4.8	4.5	5.6	2.3	3.2	6.3	5.9
Post-emergence							
Annual	4.8	4.5	5.5	2.5	3.4	6.4	6.1
Alternate years (nil 1972)	2.8	4.6	5.5	2.4	3.5	6.1	5.0
Alternate pre/post (pre in 1972)	5.1	4.5	5.6	2.6	3.5	6.4	6.2
Hand rogued since 1968	4.8	4.2	5.4	2.4	3.5	6.2	5.7
Controls	3.3	4.6	5.6	2.5	3.1	6.2	4.9
A. fatua (Saltdean)							
Pre-emergence		(SB)	(WW)	(SB)	(WW)	(SB)	
Annual		5.0	5.7	4.7	no yields taken	5.2	
Alternate years (nil 1974)		5.0	5.6	4.6		4.9	
Post-emergence I							
Annual		5.4	5.6	5.0		5.2	
Alternate years (nil 1974)		5.4	5.9	4.8		5.9	
Post-emergence II							
Annual		5.5	5.6	5.9		5.2	
Alternate years (nil 1974)		5.5	6.3	5.4		5.3	
Controls		4.8	5.8	5.0		5.1	

DISCUSSION

In the cereal rotation at Edlesborough with 70-80 plants m^2 of A. ludoviciana emerging in 1972, annual application of herbcide led to a reduced seedling emergence after three to four years. In contrast, omission of herbicide in the first alternate year treatment in winter wheat allowed a large seed return and 3-4 times more seedlings than in the annually treated plots emerged in the following spring barley crops. Most of these were removed by spraying paraquat before sowing and there was little further germination. Consequently A. ludoviciana was not competitive in the spring cereals and there was no response in yield to herbicide. Total seed return over the 7 year rotation was least with the annual post-emergence treatment because survivors after the pre-emergence treatment (triallate) had larger panicles. Herbicides were less effective in controlling seed return in winter cereals and alternate year spraying was ineffective because of the high seed return in winter crops.

The prospects for eradication of wild oats appear to be poor as 9 years of intensive hand roguing did not prevent the continued emergence of A. ludoviciana at Edlesborough.

At Saltdean after two years of pre-emergence treatment A. fatua seedlings were reduced by 80% and by 60% where herbicide had been omitted in the alternate year. In 1975 the post-emergence herbicides applied annually reduced crop yield because of damage, and lower levels of control led to more emergence of A. fatua in the following year compared to treatment with triallate. On the controls there was no evidence of a build up of A. fatua in the cropping sequence of alternating winter wheat with spring barley. This did not confirm the annual multiplication rate of 3.05 at Boxworth over 6 years (Selman 1970) and was surprising, as early stubble cultivation and ploughing as at this site has been shown to conserve wild oat seed (Wilson 1972).

At Edlesborough the yield response over 6 years to annual herbicide application was 0.3 tonne/ha/annum. At £80 per tonne of grain the extra return of £24/ha was sufficient to cover the cost of wild oat control. With the alternate year treatments the total yield over 6 years was similar to the controls because of the effect of omitting herbicide in the winter cereals. Chemical control of A. ludoviciana should be concentrated on the winter sown crops because wild oat seed return and yield response is likely to be high on infested fields. Economies in pesticide use may then be possible in subsequent spring cereals particularly when winter germinating A. ludoviciana can be cheaply eradicated prior to drilling.

Over 5 years at Saltdean the response in yield to controlling A. fatua was also 0.3 tonne/ha/annum, which was sufficient to cover herbicide costs. Annual or alternate year use gave similar results because the annual post-emergence herbicides reduced crop yield in one year (1975). Alternate year spraying at this site provided an economic policy for containment of A. fatua. It is also possible that alternating winter and spring cropping provided an unfavourable environment for survival of A. fatua, which did not multiply on the control plots.

The trials suggest that a policy of containment of Avena spp. in cereal enterprises allows economies to be made in pesticide use provided chemical and cultural practices are concentrated on vulnerable sections of the rotation. However, maintenance of quality and avoidance of wild oat contamination in the harvested grain should not be neglected as a result of such economies.

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