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CONTROL OF WILD OATS (Avena fatua and A. ludoviciana) IN WINTER WHEAT CROPS

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Summary. In 1968 a series of field trials concerning the control of wild oats has allowed a comparative study of 5 different weed killers in various parts of France. Barban proved to be sufficiently active in the northern half of the country but its action was insufficient in the south; susceptibility of wheat to this chemical seems to have been related to the physiological stage of the plant. Triallate, with low selectivity in wheat was effective when wild oats appeared a short time after sowing. Nitrofen, which is very active in the southern half of France, yielded more irregular results in the northern half. Metoxuron usually gave acceptable control in spite of a certain irregularity of action. β-4-chlorophenyl - α chloropropionic acid methyl ester, which was active in Artois, did not give adequate control in the other parts of France.

INTRODUCTION

Wild oats (Avena fatua L. and A. ludoviciana Dur.) are serious pests in cereal crops in various parts of France.

Both species are fairly susceptible to cold, especially A. fatua L. The emergence of A. ludoviciana generally occurs in the autumn; it proliferates especially in the western and south western regions (Britanny, Vendée, Garonne Valley, etc.) where the winters are mild. The emergence of A. fatua takes place mainly in the spring; that explains why this species is the only one found in areas where the autumn seedlings are destroyed by low winter temperatures (Flanders, Alsace, Normandy, Parisian Basin, etc.).

The control of these grasses is now possible without risks by means of triallate and barban in spring barley (Faivre-Dupaigre, 1963; Rognon, et al., 1963). In winter and spring wheat crops both products have shown variable weed killing efficiency and they have often had a poor margin of selectivity (de Gournay et al., 1963).

The 1968 experimentation was undertaken in order to acquire a better knowledge of the possibilities offered by these two substances and by other more recent chemicals.

METHODS AND MATERIALS

26 behaviour trials were carried out in Artois, Normandy, the Parisian Basin, Vendée, Limagne and the South-West. Treatment applications were made during 4 periods: at the time of wheat sowing ; at the one-leaf stage of the first wild oat seedlings; at the 2-3-leaf stage of the oldest wild oats; at the incipient tillering of the wild oats.

Five weed killers were tested at the following dosages expressed in kg/ha a.i.:

a) Treatment at the time of sowing :

. Triallate (1)	1.2	-	1.8	-	2.4		
. Nitrofen	1.5	-	2	-	3	-	4

b) Treatment at the 1-leaf stage of the wild oats

. Nitrofen	1.5	-	2	-	3	-	4

c) Treatment at the 2 or 3 leaves stage of the wild oats

. Barban	0.25	-	0.375	-	0.5	-	0.75
. N-(chloro-3-methoxy-4-phenyl)N'N' dimethyl urea (metoxuron)	2.4	-	3.2	-	4.8	-	6.4
. β (4-chlorophenyl) α -chloropropionic acid methyl ester (B 57-10)	3.75	-	5	-	7.5	-	10

d) Treatment at the beginning or tillering of the wild oats

. Metoxuron	2.4	-	3.2	-	4.8	-	6.4

(1) applied immediately before sowing and mixed with the soil by means of crosswise harrowing.

The phytotoxicity of barban was measured on winter wheat in two yield trials in wild oat free soil. Treatment was carried out both at the beginning and at the end of tillering of the wheat, the doses applied being 0.375 and 0.750 kg/ha. Triallate was used in two tests of the same type, one on spring wheat and the other on hard wheat (Triticum durum). The product was applied before sowing at 1.4 and 2.8kg/ha and incorporated into the soil to a depth of 5 to 7 cm by means of two harrowing operations.

RESULTS AND DISCUSSION

In the southern part of France wild oats emerged relatively early, between mid-November and mid-January. In the northern half of the country, emergence was far more scattered ; contrary to previous years seedlings at the end of February and beginning of March were relatively rare while the appearance of a very substantial population of wild oats was observed during April. This rather late occurence of the weed explains why the latter could not develop in crops which had already built a large mass of vegetation at that time.

Observations of herbicidal activity were made in 19 behaviour trials out of 26; the 7 other trial crops were free of wild oat at the time of earing.

Triallate : In all trials, triallate caused the disappearance of 10 to 15 % of the wheat seedlings at 1.2 kg/ha, and of 20 to 40 % of the wheat seedlings at 2.4kg/ha. This thinning out was compensated at least in part by a greater tillering of the surviving plants, provided conditions for wheat growth were good at the beginning of spring (especially in Normandy). Elsewhere the cereal yield was seriously checked, as shown by the results of the two tests reproduced in Table II. According to this Table, recovery by a better tillering occurred with Rex wheat, while this phenomenon was not observed on hard wheat (T.durum) Bidi 17.

Triallate was effective against wild oat from 1.2 kg/ha in Normandy and Limagne where emergence occured less than 2 months and a half after application. Its effect was insufficient, even with 2.4 kg/ha, when wild oat made a late appearance.The activity of the product was irregular in the South-West in spite of early germination of the weed.

Table I

Action of barban on yield of winter wheat

Sites	variety	sown	Treatments		Yield % of untreated plot				% C.V.	Yield untreat. pl.q/ha	% l.s.d. 0.05
			1st	2nd	1st		2nd				
					0.375	0.750	0.375	0.750			
Saclay (Essonne)	Capitole	23 Oct 68	26 Mar 68 wheat 1 tiller	12 Sep 68 wheat end till.	100,27	93,32	100,85	99,30	2,05	73,96	2,29
St Aubin (Essonne)	Capitole	18 Oct 68	26 Mar 68 wheat 1 tiller	12 Apr 68 wheat end till.	101,72	96,13	102,15	98,15	5,56	68,16	NS

Table II

Action of triallate on yield of spring wheat

Sites	specie & variety	sown and treated	Number of plants as % of untr.plot				Yield of grains as % of untr.plot			
			dose 1.4	dose 2.8	C.V.	l.s.d. 0.05	dose 1.4	dose 2.8	C.V.	l.s.d. 0.05
Valence d'Agen (T.&.G.)	spring wheat Rex	29 Feb 68	78,41	64,21	3,31	3,44	89,66	70,14	3,12	3,47
Valence d'Agen (T.&.G.)	hard wheat (T.dur.) Bidi 17	29 Feb 68	88,84	75,03	3,10	3,50	88,01	70,65	5,46	6,04

The underlined results are significantly below those obtained in untreated plots, at the probability level of P = 0.05.

Nitrofen : Nitrofen used at the time of sowing was well tolerated by the wheat up to 3 kg/ha. The dosage of 4 kg/ha caused a visual depression estimated at 30 % in May and still visible at the time of harvest in three tests, one on very coarsely prepared soil and the other two on finely worked soil. Applications made after the appearance of wild oat proved to be more damaging to wheat ; however, the latter was only temporarely affected by the normal working dose (2 kg/ha) while the damaging effect of larger quantities was still apparent at the time of harvest in more than half of the tests.

Treatment with nitrofen at the time of sowing, destroyed 80 to 90% of the wild oats at 2 kg/ha, and 85 to 95% at 3 to 4 kg/ha in the southern half of France. The activity was more irregular in the northern half where the destruction rate of wild oats rarely exceeded 60% for doses of 2 or 3 kg/ha and 80% at 4 kg/ha, and where the worst results were observed when sowing and spraying were carried out later than the end of January. Applications made at the 1-leaf stage of the wild oats gave results equivalent to those of treatments at the time of sowing in the southern half of France. Efficacy was in most instances too low in the northern half of the country even at 4 kg/ha.

Barban : In the tests carried out by de Gournay et al. (1963) and by Quidet et al. (1965), barban only showed limited selectivity in wheat. The susceptibility of this cereal was increased when a series of starts and stops of growth was observed immediately after treatment. The incidence of the other factors under study, particularly of the stage of the wheat, was far less obvious. The tests conducted in 1968 on the contrary lead to the assumption that the wheat shows a greater susceptibility at the beginning of its tillering. Table II shows that in one of the tests the double dose (i.e. 0.75 kg/ha) caused a decrease in yield of nearly 7 % when it was applied at the 2-tiller stage of the wheat, while no toxicity occurred following a treatment at the end of tillering. It should be noted that the wheat showed an astonishing ability to recover in both tests as on 22 May, at the swelling stage of the wheat-grain, a visual depression of 10 % at 0.375 kg/ha and of 40 % at 0.750 kg/ha was noted on the plots treated at the beginning of tillering. In the behaviour trials a growth check of 5 to 20 % at the doses of 0.375 kg/ha and of 15 to 40 % at the doses of 0.5 and 0.75 kg/ha respectively was noted in June each time the application was done before the 3-tiller stage of the wheat.

It is, however, not possible to distinguish between the influence of the wheat stage and that of the weather as all the treatment applications involved were carried out in cold periods, in January and February, in the southern half of France. Owing to late emergence of wild oats, trials in the northern part were conducted both at a time when wheat growth conditions were improved (in March and April) and on a crop which had reached the final tillering stage.

The activity of barban was satisfactory at doses of 0.375 kg/ha and upwards, in the northern half of France. It was generally ineffective at any dose in the southern half; that could be due to the fact that wheat checked by the chemical did not have enough competitive action towards wild oat seedlings that were weakened but not totally destroyed by the treatment.

Metoxuron : This herbicide was well tolerated by the wheat at doses of 2.4 and 3.2 kg/ha in the experiments, irrespective of the time of treatment. At 4.8 kg/ha a slight depressive effect (about 10 to 15 %) was observed in June in 5 trials out of 19 for the first period of treatment and in 3 trials for the second period. Visual depression was from 20 to 40 % in nearly half of the experiments for 6.4 kg/ha at both times of spraying.

Treatments carried out when the weeds had 2 or 3 leaves and even those done at the beginning of tillering made it possible to eliminate nearly 80 % of the wild oats from 2.4 kg/ha upwards, and 90 to 99 % at higher doses in 14 tests out of 19. Weed control was not satisfactory at doses of 2.4 and 3.2 kg/ha in two tests and even at 6.4 kg/ha in three other tests. The reason is not known.

B 57-10 : The product B 57-10 was included in 9 trials in the northern half of France and in Limagne. It never injured wheat even at 10 kg/ha a.i. Its activity against wild oats was unsatisfactory at all doses, except in two tests carried out in Artois, where 90 % of the wild oats were destroyed from 3.75 kg/ha in one of the tests, and from 5 kg/ha in the other.

CONCLUSION

Very noticeable differences appeared between the various regions of France regarding the effectiveness against wild oats and the resistance of wheat to all chemicals tested.

Thus, nitrofen was very potent in the southern half of France, and much less active in the northern half, independently of the time-lenght between the spraying and the emergence of the wild oats. In fact, this product, when applied in October in the South-West, sometimes killed wild oats emergin in February, i.e. 4 months after spraying, while it was not sufficiently effective in the Normandy trials where it had been applied at the beginning of March and where emergence occurred in March and April, i.e. less than 2 months later. The activity of this chemical, which is only slightly soluble, obtains only if the superficial layer of the soil is moist, when young parts of the weed seedlings above the ground can absorb it. It would be interesting to check if superficial drying of the soil, which is more frequent in March or April than in January and February, explains the differences in activity observed.

Triallate, on the other hand, seems to have been more effective but above all more selective in the north of France and in Normandy, than in Limagne and in the South-West. This may be derived from the fact that wheat ability to recover is greater in the first two zones than in the others. The destruction of the wheat plants caused by triallate at emergence, makes the use of this herbicide dangerous in any case.

Barban proved to be less damaging to wheat in the North of France than in the South, where treatment applications were carried out during a colder period and at an earlier stage of the wheat. However, it must be recalled that maximum activity of barban on wild oats requires the crop to remain sufficiently dense and strong following the treatment application ; this emphasizes the importance of complete crop-safety in wheat and besides, of meeting the conditions required by the best vegetative development of the cereal.

B 57-10, which proved to be active from 3.75 kg/ha in Artois, failed in other regions, even at 10 kg/ha. A link may be assumed between the varying resistance of wild oats to this chemical and the genetic constitution of different types of the weed. Joan M. Thurston (1957) found in fact 13 different types of wild oat within the species *Avena fatua* L., but no-one has yet demonstrated differential susceptibility of wild oat types to any herbicide.

Metoxuron is the most difficult to assess. There was no apparent relation between the rare cases of failure and the region, the nature of the soil, the type and the stage of the wild oats. The study of this product is of great interest because, apart from its action against wild oats, it proved to be quite effective against a number of grass and broadleaf weeds (*Alopecurus myosuroïdes*, *Lolium sp.*, *Poa sp.*, *Matricaria sp.*, *Galium aparine*, etc.).

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PRELIMINARY RESULTS ON CONTROL OF ALOPECURUS MYOSUROIDES HUDS IN WINTER WHEAT WITH METOXURON

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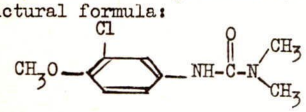
Summary Metoxuron, N'-(3-chloro-4-methoxyphenyl)-N N-dimethyl urea, is a new herbicide developed by Sandoz Ltd. in Switzerland. It has proved specially effective for the control of Alopecurus myosuroides in winter wheat. Thirteen replicated field trials were conducted in 1967-68 to test its use in the U.K. Pre-emergence and early and late post-emergence treatments, with rates of 2.4 - 8.0 lb/ac metoxuron were applied. The early post-emergence treatments (between the two and four leaf stages of growth) proved most effective. Good control of A. myosuroides, other grass weeds, and many annual broad leaved weeds was obtained with rates of 4.0 - 4.8 lb/ac applied pre-emergence, with 2.4 - 3.2 lb/ac applied early, and with 3.2 - 6.4 lb/ac applied late post-emergence. Promise was also shown in the control of Avena spp. with the post-emergence treatments. The winter wheat varieties Cappelle Desprez and Maris Widgeon, and the winter barley Proctor showed a high degree of tolerance to metoxuron; but Mildress winter wheat suffered some severe damage. Yield results show the effect of the treatments on the crop.

INTRODUCTION

Metoxuron is a new substituted urea herbicide, developed by Sandoz Ltd., Basle, Switzerland, with the following chemical and physical properties:
Chemical name: N'-(3-chloro-4-methoxyphenyl)-N N-dimethyl urea.
Structural formula:



Empirical formula: $C_{10}H_{13}Cl\ N_2O_2$
Molecular weight: 228.67
Melting point: 126-127°C

Solubility in water: 678 ppm at 23 - 24°C.
Acute oral LD_{50} for rats: 1600 - 2000 mg/kg.
Metoxuron is formulated as an 80% wettable powder. Originally coded Herbicide 6602, this is now available (in Europe) under the registered trade name of DOSANEX.

Work in Europe over the past three years has shown it to be selective in cereals, especially winter wheat, for the control of Alopecurus myosuroides (black-grass). It has also proved effective against other annual grass weeds, and many annual broad leaved weeds and can be used pre- and post-emergence. (Berg, 1968, - Höhener, et al, 1968.)

Farm Protection Ltd. has tested both the pre- and post-emergence use of metoxuron in the United Kingdom. This paper records preliminary results from the 1967-68 season, on the control of A. myosuroides in winter cereals.

METHOD AND MATERIALS

Thirteen replicated small plot field trials were conducted in the 1967-68 season mainly for the control of A. myosuroides in winter wheat, or winter barley, but also for other weeds especially Avena spp. (wild oats). Sites represented those parts of the country where blackgrass is a serious problem. Soil types were relatively uniform, mainly of a sandy clay, or medium clay loam structure, with a medium or high organic matter content and a fairly high adsorptive capacity. At all the sites, the crop was sown between the beginning of October and the end of November 1967. Standard applications of fertilizer were made and the only deviation from normal husbandry practices was that at some sites the crop was not rolled. Twelve of the trials were on winter wheat and one on winter barley. Metoxuron was applied pre-emergence and at early and late post-emergence stages of crop and weed growth, and compared with other appropriate graminicides. (Tables 1. and 2.)

Pre-emergence application was made between one and nine days after sowing the crop and metoxuron was compared with a standard treatment of terbutryne. No growth had emerged at sites 4 - 6, while at sites 1 and 2 some blackgrass was at the first leaf stage. At site 3 some blackgrass survived after being harrowed onto the surface before drilling. At site 5 no blackgrass or any other grass weeds appeared, but the development of the crop and other weed growth was followed through the season. At site 6 the crop was taken by birds and at site 4 the winter barley failed from the combined effects of frost damage and waterlogging. Even these sites still provided valuable information on the early establishment of the crop after pre-emergence treatment with metoxuron.

At sites 1 - 3 early post-emergence treatments of metoxuron were compared with barban applied about the end of January 1968, between the two and four leaf stages of crop growth. The blackgrass was mostly at an exactly similar stage, with few plants any more advanced than the crop: 6 to >50 plants/sq.ft. gave upto 10% cover. Other weeds, chiefly Stellaria media and Veronica spp., were mainly between the cotyledon and young plant stages of growth at 10 to 20 plants/sq.ft.

The late post-emergence treatments of metoxuron were compared with a standard mixture of methoprotryne + simazine, applied about mid-March 1968 when the crop was at the five leaf stage of growth with two tillers. The blackgrass was at an exactly similar stage. Little new growth or seedling emergence had occurred since the early treatments were applied. Other weed growth had not increased much either. Stellaria media and Veronica spp. were still the most prominent; but some growth of Galium aparine, Lamium purpureum, Lithospermum arvense, Poa annua, Ranunculus sp., Sinapis arvensis and Tripleurospermum maritimum was also recorded. Total weed cover (including A. myosuroides) was upto 20% at this stage.

In the remaining trials (7 - 13), only late treatments were applied. "Standard" treatments were methoprotryne + simazine, and barban if any Avena spp. were present. At application (about mid-March 1968) the crop had 3 - 7 leaves, and 1 - 3 tillers. The blackgrass was usually at the same stage. There were 5 to >30 plants/sq.ft., or 5 to 20% cover. At site 13 wild oats predominated at approx. 16 plants/sq.ft. At site 12 blackgrass, wild oats and shoots of Agrostis stolonifera were about evenly distributed. Other weeds were negligible.

All the trials were of randomised block design, with plots 1/160 or 1/40 acre. Small plot treatments were replicated three or four times and large plots only twice. The treatments were applied either with an Oxford Precision Sprayer or with a Dorman Wheelaway Sprayer, at 40 g/ac.

Visual scores for the control of blackgrass and other weeds, and for crop stand and vigour were made regularly throughout the season. Scoring was based on both plant number and size according to the following scale:

Score	0	1	2	3	4	5	6	7	8	9	10
% Control of A. myosuroides or Other Weeds	0 -10	10 -19	20 -29	30 -39	40 -49	50 -59	60 -69	70 -79	80 -89	90 -99	100%

The scoring for crop stand and vigour was on a similar basis, i.e. 0 = no effect, 10 = complete kill. Only scores above 3 were taken to indicate an obvious reduction in crop stand.

Eight trials were harvested. In trials 1, 2, 3 and 7, the crop was cut by hand from three square yard quadrats in each plot, and the samples threshed separately. In trials 8, 10, 12 and 13, the whole plot was cut by combine harvester. (Table 3.)

RESULTS

Satisfactory control of blackgrass (>70%) was obtained at site 2 with 3.2 lb/ac metoxuron applied pre-emergence and at site 1 with 4.0 lb/ac. However, consistently good control at sites 1 - 3 was only obtained by 4.8 lb/ac and 8.0 lb/ac. Terbutryne at 2.0 lb/ac gave good control at sites 2 and 3, but inadequate control at site 1. (Table 1.)

Table 1.

Control of *Alopecurus myosuroides* (blackgrass), other (broad leaved) weeds, and effect upon crop with treatments of metoxuron

(Taken from assessments made in June 1968)

(Score 0 = no effect, 10 = complete kill)

Trial Reference *		Alopecurus			Other Weeds			Crop		
		1	2	3	1	2	3	1	2	3
PRE-EMERGENCE										
Treatments	Rate/Acre									
Metoxuron	3.2 lb	6	8	5	6	8	7	1	3	2
	4.0 lb	7	9	5	6	8	7	2	3	2
	4.8 lb	8	9	7	7	7	8	0	4	2
	8.0 lb	9	10	7	9	7	7	2	5	2
Terbutryne	2.0 lb	6	9	9	9	8	9	2	2	2
Untreated		0	0	0	0	0	0	3	1	2
EARLY POST-EMERGENCE										
Treatments	Rate/Acre									
Metoxuron	2.4 lb	-	7	-	-	8	-	-	3	-
	3.2 lb	8	-	8	7	-	10	2	-	2
	4.0 lb	-	8	-	-	9	-	-	5	-
	4.8 lb	9	-	10	8	-	10	1	-	2
	6.4 lb	10	-	9	10	-	10	1	-	0
Barban	0.3 lb	2	4	3	0	4	3	2	1	4
LATE POST-EMERGENCE										
Treatments	Rate/Acre									
Metoxuron	2.4 lb	-	6	-	-	8	-	-	3	-
	3.2 lb	6	7	8	7	7	9	1	4	0
	4.0 lb	-	7	-	-	8	-	-	6	-
	6.4 lb	9	10	9	9	9	10	2	8	2
Methoprotryne + Simazine	13.5 oz + 3.0 oz	4	4	3	9	9	10	3	2	2
Untreated		0	0	0	0	0	0	2	1	2

* Winter Wheat varieties, according to trials reference number:

1 - Cappelle, 2 - Mildress, 3 - Cappelle (Table 1.)

4 - Proctor (Winter Barley), 5 and 6 - Cappelle (in text).

At sites 1 - 3, excellent control of blackgrass was obtained by early post-emergence treatment with 2.4 - 4.0 lb/ac metoxuron. Control with 4.8 - 6.4 lb/ac metoxuron was practically complete, and much better than with 0.3 lb/ac barban.

Similarly, control was good with the late post-emergence treatments of 3.2 - 4.0 lb/ac metoxuron, and almost **complete** with 6.4 lb/ac., i.e. considerably better than with methoprotryne + simazine (13.5 + 3.0 oz/ac).

At sites 7 - 13, late post-emergence treatments were less successful; but the control of blackgrass obtained with rates above 2.4 lb/ac metoxuron was markedly better than that given by methoprotryne + simazine, and 50 - 70% control by 4.0 - 6.4 lb/ac metoxuron was considered highly acceptable where the blackgrass was at an advanced stage of growth. (Table 2.)

Table 2.

Control of *Alopecurus myosuroides* and effect on crop with late post-emergence treatments of metoxuron on winter wheat

(Taken from assessments made in June 1968)

(Score 0 = no effect, 10 = complete kill)

Trial Reference *		7	8	9	10	11	Agrostis sp.↓ 12	Avena spp.↓ 13
CONTROL OF ALOPECURUS								
Treatments	Rate/Acre							
Metoxuron	2.4 lb	-	3	3	-	4	-	3
	3.2 lb	7	4	4	4	4	10	3
	4.0 lb	8	5	3	4	6	-	5
	4.8 lb	9	-	-	6	-	10	-
	6.4 lb	-	7	6	-	8	-	8
	8.0 lb	10	-	-	8	-	10	-
Methoprotryne + Simazine	13.5 oz + 3.0 oz	4	3	3	2	1	8	-
Barban	0.3 lb	-	-	-	-	-	2	0
Untreated		0	0	0	0	0	0	0
EFFECT ON CROP								
Treatments	Rate/Acre							
Metoxuron	2.4 lb	-	3	1	-	2	-	2
	3.2 lb	1	2	2	3	2	1	0
	4.0 lb	1	1	1	1	2	-	1
	4.8 lb	1	-	-	1	-	1	-
	6.4 lb	-	2	3	-	1	-	0
	8.0 lb	2	-	-	2	-	2	-
Methoprotryne + Simazine	13.5 oz + 3.0 oz	1	2	3	2	1	2	-
Barban	0.3 lb	-	-	-	-	-	0	0
Untreated		1	3	2	2	2	2	2

↓ Other grass weeds predominant over blackgrass.

* Winter Wheat varieties, according to trials reference number:

7 to 10, 12 and 13 - Cappelle, 11 - Maris Widgeon.

Metoxuron performed best in the early post-emergence treatments. Here, control of blackgrass (at about the three leaf stage of growth) and of other weeds was the most complete. Pre-emergence activity was less pronounced except at the higher rates of application when residual activity was sufficient to control any spring-germinating blackgrass. In the late post-emergence applications of metoxuron, where growth of blackgrass was advanced, a complete kill was not always obtained; but flowering was prevented. Provisional harvest data indicate, however, that significant increases in yield may be obtained from incomplete control of blackgrass by late post-emergence treatments with metoxuron.

The winter wheat Cappelle Desprez proved highly tolerant to both pre- and post-emergence treatment upto 8.0 lb/ac metoxuron. Mild chlorosis often followed pre- and post-emergence treatments with metoxuron above 4.0 lb/ac., as with terbutryne and methoprotryne + simazine. The crop usually recovered quickly; but sometimes the effects of barban lasted longer. So far as could be judged, in the circumstances of poor crop growth, Proctor barley tolerated pre-emergence treatments with metoxuron and Maris Widgeon winter wheat post-emergence treatments. Damage was recorded on Mildress winter wheat by 3.2 lb/ac metoxuron pre-emergence and by 2.4 lb/ac both early and late post-emergence. Severe damage entailing an appreciable reduction in stand and retarded growth was caused at 4.8 lb/ac and above, applied pre-emergence and 3.2 lb/ac applied post-emergence; but where damage occurred there was some compensatory growth of the surviving crop.

The yield results show considerable increases from most treatments over the untreated controls and confirm the high degree of tolerance of metoxuron by winter wheats, even in the variety Mildress where the damage was less than first supposed. However, no advantage was shown for application of the treatments at any particular growth stage of crop or blackgrass. (Table 3.)

Good control of other grass weeds (Poa annua and Agrostis spp., including A. stolonifera) was recorded with both pre- and post-emergence treatments of metoxuron and control of Avena spp. was promising, especially with the post-emergence treatments of 4.0 - 6.4 lb/ac; but time and stage of growth are probably critical. Good control was obtained with rates between 3.2 - 4.8 lb/ac metoxuron of the annual dicotyledons Chenopodium album, Galium aparine, Geranium sp., Lamium purpureum, Lithospermum arvense, Matricaria matricarioides, Myosotis arvensis, Polygonum convolvulus, Sinapis arvensis, Stellaria media, Tripleurospermum maritimum and Viola arvensis, especially at the early stages of growth. The main resistant weeds appear to be the Veronica spp. (speedwells) and, to a lesser extent, Polygonum aviculare. The perennial broad leaved weeds and Agropyron repens are not controlled.

DISCUSSION

In these trials, Alopecurus myosuroides, other grass weeds especially Avena spp., and many annual broad leaved weeds have been well controlled by both pre- and post-emergence treatment with metoxuron; but the post-emergence treatments have proved slightly more effective. Thus to obtain adequate control of A. myosuroides and other weeds 4.0 - 4.8 lb/ac metoxuron was necessary pre-emergence; but only 2.4 - 3.2 lb/ac early post-emergence, or 3.2 - 6.4 lb/ac at a later stage (depending upon stage of growth). The advantage is that the chemical can be applied over such a period of time.

The results given in Table 3 suggest that there is nothing to be gained from applying a relatively high rate of metoxuron pre-emergence; but it is still felt that timing is an important factor in the use of the chemical. It is anticipated that further trials work will establish the best rate and time of application of metoxuron to suit particular conditions. Also, considering the damage that was caused to Mildress winter wheat, work will need to be done on varietal susceptibility of the crop. Nevertheless, it is confidently felt that metoxuron will provide a useful treatment, especially for the control of Alopecurus myosuroides in most varieties of winter wheat.

Table 3.

Yield results from control of *Alopecurus myosuroides* with metoxuron in winter cereals

Mean yield cwt/acre @ 15% moisture

Trial Reference		PRE-EMERGENCE 1	2	3	EARLY POST-EMERGENCE 1	2	3
Treatments	Rate/Acre						
Metoxuron	2.4 lb	-	-	-	-	24.73	-
	3.2 lb	25.22	25.88	32.52	26.13	-	31.57
	4.0 lb	25.22	22.91	29.69	-	24.73	-
	4.8 lb	26.21	25.36	33.05	25.41	-	32.04
	6.4 lb	-	-	-	27.10	-	28.28
	8.0 lb	24.48	24.14	32.34	-	-	-
Terbutryne	2.0 lb	24.48	27.63	32.52	-	-	-
Barban	0.3 lb	-	-	-	21.05	21.89	25.68
Untreated		18.73	25.23	28.71	14.84	23.49	25.29
L.S.D. (P = 0.05)		6.46	4.09	4.58	5.55	4.54	3.89

Trial Reference		LATE POST-EMERGENCE 1	2	3	7	8	10	12	13
Metoxuron	2.4 lb	-	23.53	-	-	17.97	-	-	32.65
	3.2 lb	26.65	24.02	31.34	36.04	16.36	20.34	36.72	40.06
	4.0 lb	-	21.75	-	35.34	20.22	26.91	-	36.17
	4.8 lb	-	-	-	40.08	-	26.34	34.14	-
	6.4 lb	25.65	14.45	30.40	-	21.64	-	-	37.69
	8.0 lb	-	-	-	40.96	-	24.51	32.26	-
Methoprotryne + Simazine	13.5 oz + 3.0 oz	22.63	24.34	30.40	37.10	16.87	19.96	33.67	-
Barban	0.3 lb	-	-	-	-	-	-	34.40	34.54
Untreated		14.84	23.49	25.29	34.29	14.02	18.13	35.28	33.81
L.S.D. (P = 0.05)		5.55	4.54	3.89	7.04	5.10	7.92	2.78	10.53

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EXPERIMENTS ON THE CONTROL OF WILD OATS (AVENA FATUA L) IN SWEDEN

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Summary High humus content in the soil diminished the effect of triallate on wild oats. Triallate gave better control than barban and 2-chloro-3-(4-chlorophenyl) propionic acid methylester (Bayer 70533). The effect on yield from chemical wild oat control depends on the wild oat density. Triallate improved the yield more than barban. Triallate was more effective against wild oats when incorporated at 5 cm than at 2-3 cm. Delayed sowing had somewhat less effect on wild oats than chemical wild oat control.

INTRODUCTION

Wild oats (*Avena fatua* L) have become very troublesome in Sweden. They are most frequent on the plains in the middle and south of the country. In these areas many farmers run their farms without cattle, and cereals are the main crop. *Avena ludoviciana* does not occur as a weed in Sweden because most cereals are spring-sown. In northern Sweden, where leys are the main crops, wild oats are not a problem.

Most chemical wild oat control is carried out in barley. Barley is much more resistant to triallate than to diallate. For this reason diallate is not sold in Sweden today.

Trials in Sweden have demonstrated the effect of chemicals on wild oats. The effect of different incorporation depths of triallate has been examined. Delayed sowing has been tried in comparison with chemical wild oat control.

METHODS AND MATERIALS

The trials have been performed with 4 replications. The plot size has been 50 m^2. The trials have been conducted on farms with severe wild oat infestation in south and middle Sweden. Delayed sowing means 2 weeks later sowing than in comparable plots. Deep incorporation means that the harrowing depth has been 5 cm and shallow 2-3 cm. The treatments with triallate were performed pre-sowing. The sowing depth of barley (varietres Ingrid and Arla) was 2-3 cm. Results from trials with triallate, barban and 2-chloro-3-(4-chlorophenyl) propionic acid methylester (Bayer 70533) are presented in this paper.

RESULTS AND DISCUSSION

Table 1 shows the effect of triallate and barban on wild oats in trials conducted in 1964 and 1965. The trials were divided into groups according to the organic matter content in the soil.

Table 1.

Number of wild oat plant on soils with different humus contents after treatment with triallate and barban

Treatment	Relative number of wild oat plants 6 % humus (20 trials)	6-12 % humus (13 trials)	12-20 % humus (5 trials)
Untreated	100	100	100
0,8 kg/ha triallate	40	49	56
1,6 " "	25	28	44
2,4 " "	20	24	43
3,2 " "	16	23	43
0,25 " barban	72	64	78
0,5 " "	63	61	65

The effect of triallate was best on soils with a low organic matter content. Triallate gave better wild oat control than barban.

In table 2 the effect of triallate and barban on the yield is shown. The trials have been arranged in groups according to the wild oat density in the untreated plots.

Table 2.

The effect of triallate and barban on the yield at different wild oat densities. (Relative yield)

Treatment	<20 wild oat plants/m^2 (13 trials)	20-50 wild oat plants/m^2 (5 trials)	50-100 wild oat plants/m^2 (6 trials)	>100 wild oat plants/m^2 (11 trials)
Untreated	100	100	100	100
0,8 kg/ha triallate	100	107	114	124
1,6 " "	102	105	118	128
2,4 " "	100	110	123	139
3,2 " "	102	108	123	141
0,25 " barban	102	105	106	111
0,5 " "	102	108	109	113

The increase in yield after treatment with chemicals depended on the wild oat density. The yield improvement was less from barban than from triallate.

The first trial with different incorporation depths was conducted in 1965 at Ultuna. The spring of that year was very dry. No rain fell between sowing and emergence. The effect on wild oats from triallate was much better when it was deeply incorporated. The results are shown in table 3.

Table 3.

The effect of different incorporation depths on the effect of triallate

Treatment Dose of triallate and depth of incorporation	Relative number of wild oat plants	Relative weight of wild oat plants
Untreated	100	100
1,6 kg/ha triallate 2-3 cm	66	32
1,6 " " 5 cm	22	16
3,2 " " 2-3 cm	42	29
3,2 " " 5 cm	14	12

In 1966 and 1967 trials were carried out in south and middle Sweden with triallate at different incorporation depths. The mean result is shown in table 4.

Table 4.

Yield and wild oat control after treatment with triallate at different incorporation depths

Treatment Dose of triallate and depth of incorporation	Barley kg/ha (23 trials)	Wild oats Relative number of plants (26 trials)	Wild oats Relative weight of plants (26 trials)
Untreated	2780	100	100
1,6 kg/ha 2-3 cm	3000	41	43
1,6 " 5 cm	3010	32	34
2,4 " 2-3 cm	3090	36	38
2,4 " 5 cm	3060	21	24
3,2 " 2-3 cm	3030	25	29
3,2 " 5 cm	3050	23	26

The deeper incorporation of triallate gave, on an average, a better wild oat control than the shallow one. The barley was not damaged, as can be seen from the yield figures. The yield was about the same for the two incorporation depths.

In 1968 triallate, barban and methachlorphenprop were compared in a number of trials. Neither methachlorphenprop nor barban gave as good control of wild oats as triallate. The results from the trials are shown in table 5. Bayer 70533 controlled wild oats somewhat better than barban.

Table 5.

The effect of triallate, Bayer 70533 and barban on wild oats in 1968

Treatment	Relative number of wild oats plants (6 trials)	Relative weight of wild oats plants (6 trials)
Untreated	100	100
1,6 kg/ha triallate	37	34
3,2 " "	21	20
0,5 " barban	59	51
4,0 " Bayer 70533	49	43

Owing to the short growing season in Sweden delayed sowing will, on an average, cause a lower yield. Therefore delayed sowing is recommended only when the wild oat infestation is severe. In trials it has been shown that the sowing must be delayed at least two weeks in order to get a satisfactory wild oat control. Table 6 shows result from trials in 1968 with delayed sowing in comparison with chemical wild oat control. The wild oat control from delayed sowing was not as good as from chemical treatment. However, the best control was obtained from a combination of delayed sowing and chamical wild oat control. Triallate was sprayed and incorporated in early spring and sowing was carried out two weeks later. The result is shown in table 6.

Table 6.

The effect on wild oat of different doses of triallate and of delayed sowing

Treatment Dose of triallate and depth of incorporation	Relative number of wild oat plants (6 trials)	Relative weight of wild oat plants (6 trials)
Untreated	100	100
Delayed sowing	28	48
1,6 kg/ha triallate 5 cm + delayed sowing	6	12
1,6 kg/ha triallate 2-3 cm	27	29
1,6 kg/ha triallate 5 cm	25	24
2,4 kg/ha triallate 2-3 cm	32	31
2,4 kg/ha triallate 5 cm	17	16

The wild oat plants which were not killed by the late harrowing on the delayed-sowing treatment became very big, because of the low competition effect from the crop.

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THE CONTROL OF ANNUAL GRASS WEEDS IN CEREALS WITH N',N-DIMETHYL-N'(2-BENZTHIAZOLYL)-UREA (BAYER 74283)

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Summary The results of numerous experiments, carried out in Belgium, Holland and Germany are explained from a graphical diagram, showing the different reactions of Alopecurus myosuroides, Apera spica-venti and Poa annua to Bayer 74283 as well as the dependence of the degree of control of these grass weeds upon the stage of their development.

Only Alopecurus myosuroides outgrows rapidly the sensitive stage and can only be effectively controlled up to the 3-leaf stage. Therefore, the space of time during which effective control of Alopecurus myosuroides can be achieved is relatively short.

As a pre-emergence treatment, Bayer 74283 shows favourable crop tolerance with all kinds of cereals, whereas only wheat tolerates considerable amounts of the preparation as a post-emergence application-up to 6 kg/ha (70% preparation). Recommendations for practical application are given.

INTRODUCTION

Early experiments with Bayer 74283 for the chemical control of weeds in cereals suggested that the individual species of annual grass weeds react differently to Bayer 74283. It also seemed that with Alopecurus myosuroides (blackgrass), Apera spica-venti (silky bent grass) and Poa annua (annual meadow grass) the success of the control depended on the stage of development (1).

In order to obtain more exact information about these conditions, a larger number of experiments were carried out. The results of these trials conducted in Belgium, Holland and Germany in the years 1967 and 1968 and the conclusions derived from these about the successful application of Bayer 74283 against grass weeds in cereals are reported here.

METHOD AND MATERIALS

For these experiments Bayer 74283 was applied as 70% w.p. (5653) with 3 kg/ha at as many times as possible beginning with application immediately after planting the cereals up to the main tillering period of the grass weeds. We recorded the predominant stage of development of the grasses at the time of application. Here we followed the BBA leaflet 27 (2). The evaluation of the degree of grass control was either made by counting the respective grass weeds or by visual assessment, the success always being related to the untreated check. Each value, therefore, represents an "average" of four replicates, the individual values not having been available. From the assessments the average for the individual stages of growth and the deviation were calculated. The result is shown in the graphical diagram, figure 1.

RESULTS

Reaction of the various grass weeds

A comparison of the individual grass weeds shows that Alopecurus myosuroides, when grown beyond the 3-leaf stage (D), becomes insensitive to Bayer 74283, whereas Apera spica-venti can still be controlled with Bayer 74283 up to stage F (main tillering stage) and the control of Poa annua depends even less on the stage of development. The reason for the smaller number of experiments (Σn) against Apera spica-venti and Poa annua is that the main concern of the experiments was the control of Alopecurus myosuroides with Bayer 74283. As Apera spica-venti and Poa annua are very easily controlled with 3kg/ha Bayer 74283 (70%) over a prolonged period of their development, the only real problem remains to ensure the removal of Alopecurus myosuroides.

The special behaviour of Alopecurus myosuroides

On the average the pre-emergence application of Bayer 74283 (70%) is somewhat less successful than post-emergence application at earlier stages of growth, connected with a greater deviation of the single values. This greater deviation is explained by the well known fact that with pre-emergence application the effectiveness of the preparation depends to a much greater extent on the type of soil, the moisture in the soil and the subsequent rainfall than with post-emergence application. The more moist the soil and the more maritime the climate, the more effective will be the control by pre-emergence application. An exception to this is soil containing a considerable amount of humus; here the effectiveness against Alopecurus myosuroides is lessened by the high absorption of the active ingredient. Another reason for the greater deviation and less successful control with Bayer 74283 (70%) used in pre-emergence application, is that after fall application the residual effect of 3 kg/ha is not always sufficient to ensure the control of the new Alopecurus myosuroides germinating in spring.

The curve for post-emergence application shows that Alopecurus myosuroides can only be effectively controlled with 3 kg/ha Bayer 74283 (70%) in the earliest stages of growth. At the later stages of development the average success is significantly lower and the deviation higher. Also with this type of application the degree of control is to a greater extent determined by climate and soil conditions in these advanced stages of development. Thus, under favourable conditions, like high assimilation at elevated temperatures (20° - 25°C) and moist soil, Alopecurus myosuroides can still be effectively controlled with 3 kg/ha Bayer 74283 (70%).

CROP TOLERANCE

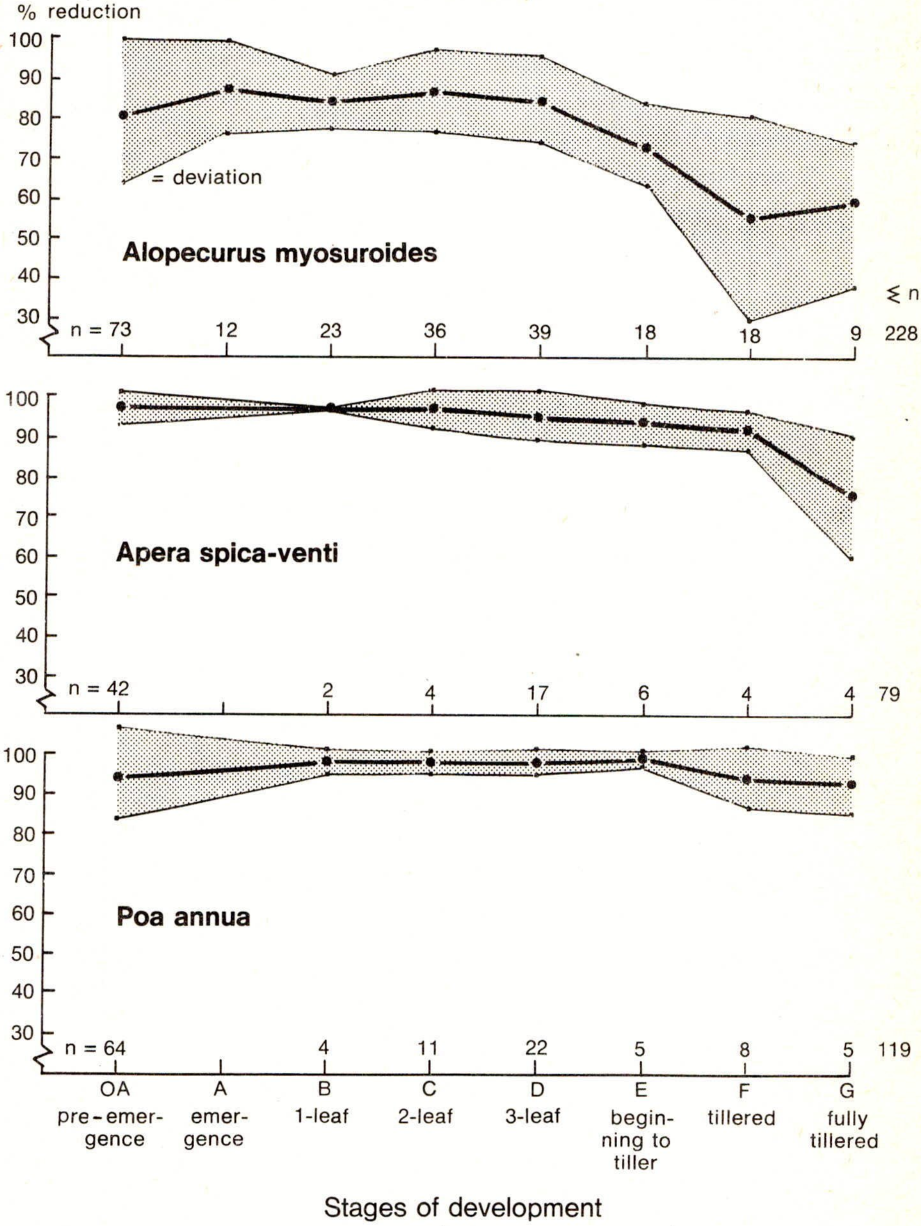
At the same time these extensive experiments carried out under very varying conditions give information about the tolerance of the various species of cereals to Bayer 74283 (70%). In general it can be said that the cereals can suffer more damage with post-emergence application than with pre-emergence application.

With a normal dose of 3 kg/ha Bayer 74283 (70%) as pre-emergence treatment, no damage whatever occurs to any kind of cereal and even double the normal dose only leads to isolated cases of temporary damage.

The experiments under consideration, where the post-emergence application was after the 3-4 leaf stage of the cereal confirm the very good crop tolerance of

Figure 1

Control of Alopecurus myosuroides, Apera spica-venti and Poa annua with 3 kg/ha of Bayer 74283 (70%) at different stages of development



this preparation in winter and spring wheat observed in earlier experiments (1). Even considerable overdoses, up to 7.5 kg/ha Bayer 74283 (70%) applied after the emergence of winter wheat do not cause any significant damage.

Applications around the time of frost periods are an exception. Timed experiments showed applications made 10 to 14 days before heavy frost (-6° - $14^{\circ}C$) to lead to the most severe damage, whereas applications during frost periods clearly cause less damage.

Spring wheat is generally somewhat more sensitive; however it still tolerates 5 to 6 kg/ha Bayer 74283 (70%). Next to winter and spring wheat the following crop rank with decreasing tolerance: winter rye, winter barley, summer barley and oats. As the varieties of each individual cereal species react differently the rank order of the cereal species can often be less sharply defined. More exact information on these results is reserved for later publication.

DISCUSSION AND CONCLUSIONS

The particular problem in controlling Alopecurus myosuroides is that in practice it is not always possible to make a post-emergence application at the optimal date. Alopecurus myosuroides has two main periods of germination - autumn and early spring - which, however, more and more overlap under maritime conditions, with the result that throughout the winter months there is continuous emergence of Alopecurus myosuroides together with delayed development. Post-emergence application is often impossible at the optimal time in autumn in early sown winter cereals (mostly barley and rye), because by then the fields have become impassable. Delay until spring allows the Alopecurus myosuroides to grow too strong, especially in mild winters, so that spring application is not very successful. On the other hand, for late sown winter cereals (mostly wheat) if the winter is not too mild, a spring application will be early enough to hit Alopecurus myosuroides at its sensitive stage of development.

Where post-emergence application after the winter is too late for Alopecurus myosuroides, a pre-emergence application will, therefore, yield better results. The disadvantage that weeds germinating in spring will then not be controlled with certainty can be overcome by a second application in spring at a lower dosage. This leads to splitting up the dosage into two applications, one in autumn and one in spring, which Strykers and Van Himme (1968) also recommend as a result of their experiments (3). The amount of Bayer 74283 (70%) applied depends on the local conditions and should be between 2.5 and 3 kg/ha for the pre-emergence application and between 1.5 and 2 kg/ha for the subsequent post-emergence application.

Considering the crop tolerance of the different species of cereals, pre-emergence application is particularly suitable with rye and barley. In more severe infestations with Alopecurus myosuroides, the dosage of Bayer 74283 (70%) should either be raised to 4 kg/ha or divided into two applications as suggested above. It depends on the local climate which method will produce best results in each individual case.

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THE CONTROL OF ALOPECURUS MYOSUROIDES (BLACKGRASS) IN WINTER WHEAT

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Summary In a series of 5 experiments, 22 herbicides, and certain mixtures thereof, were examined for selective control of *Alopecurus myosuroides* in winter cereals. Terbutryne, methoprotryne + simazine, nitrofen and fluometuron were the most promising herbicides.

INTRODUCTION

In recent years a large number of herbicides have been proposed for the control of *Alopecurus myosuroides*. As a continuation of the work to evaluate such herbicides which was reported at the last conference (Holroyd, 1966), a further five field experiments were laid down during 1966, 1967 and 1968 on winter cereal crops containing this weed. The herbicide treatments were again chosen as a result of suggestions from manufacturers and the results of greenhouse experiments at W.R.O.

METHOD AND MATERIALS

All five experiments were in winter cereal crops (four wheat and one barley) where infestations of blackgrass were visible or expected. The soil on all the sites was heavy.

Three types of application were used in the 3 experiments begun in 1966: (1) pre-emergence to the soil surface (no crop or weed plants visible); (2) early post-emergence (all crop plants visible, some of weed plants visible); (3) late post-emergence (all crop and weed plants visible).

In the 1967 experiment all the treatments were applied pre-emergence and in the 1968 experiment all the treatments were applied at the late post-emergence stage. Treatments were applied with a Fisons Mini Logarithmic Sprayer, at a volume rate of 28 gal/ac, using a matched pair of Teejets (No. 6503) and a pressure of 40 p.s.i. The half dose distance was 5.5 yd and each plot was 22 x 1 yd. The experimental design was a randomised block, replicated twice with a 1 yd untreated path between each plot.

The herbicides used in these experiments and their formulation are listed below. All doses quoted in this paper are in terms of active ingredient.

GS 13528	(2-chloro-4-ethylamino-6-sec-butylamino-1,3,5-triazine)	50% w.p.
GS 13529	(2-chloro-4-ethylamino-6-t-butylamino-1,3,5-triazine)	50% w.p.
GS 16065	(2-ethylthio-4-ethylamino-6-isopropylamino-1,3,5-triazine)	25% w.p.
Metoxymarc	(N-(4-methoxybenzoyl)-N-(3,4-dichlorophenyl)-N',N'-dimethylurea)	25% w.p.
CP 31675	(2-chloro-N-(2-methyl-6t-butylphenyl)acetamide)	12% e.c.
CP 50144	(2-chloro-N-2,6-diethylphenyl-N-methoxymethylacetamide)	48% e.c.

terbutryne - 50% w.p.; methoprotryne - 25% w.p.; metoxuron - 80% w.p.; fluometuron - 80% w.p.; monolinuron - 50% w.p.; linuron - 50% w.p.; noruron - 80% w.p.; bromacil - 80% w.p.; mecoprop (potassium salt) - 32%, dichlobenil - 50% w.p.; ioxynil (sodium salt) 85%; nitrofen - 24% e.c.

The details of the site, date of treatment, stage of growth of the crop and weed, and the weed density are given in the Table. Assessments of weed control

Table

Details of sites, and stage of growth of A. myosuroides (blackgrass) and crop at the time of treatment

Site and Crop	Date of Spraying	Stage of growth (no. leaves on main shoot)		Weed density (plants/ft^2)
		Crop	Weed	
Bledington, Oxon	2-11-1966	pre-emergence	-	-
winter wheat	6- 2-1967	2.5-3.5	2.0-4.0	10-15
var. Maris Widgeon	21- 3-1967	4.0-5.5 (0-3 tillers)	3.5-6.0 (well tillered)	10-15
Kingham, Oxon	7-11-1966	pre-emergence	-	-
winter wheat	8- 2-1967	2.5-4.5	2.0-4.0	5- 8
var. Champlein	21- 3-1967	4.5-6.0 (1-2 tillers)	* 2.5-3.5 and (well tillered)	7-10
Gt. Missenden, Bucks	4-11-1966	pre-emergence	-	-
winter wheat	7- 2-1967	3.0-4.5 (0-1 tillers)	2.0-3.5	uneven
var. Champlein	22- 3-1967	5.0-6.0 (0-3 tillers)	2.5-5.0 (0-3 tillers)	uneven
Bledington, Oxon	22-11-1967	pre-emergence	-	-
winter wheat var. Maris Widgeon				
Kingston Blount, Oxon	24- 3-1968	2.0-7.0 (well tillered)	(well tillered)	numerous
winter barley var. Otter				

* much spring germination at this site

were made after the blackgrass had set seed, by scoring on a scale of 0-10 (0 = no inflorescences present, 10 = indistinguishable from the adjacent paths) every 2.75 yd along each plot. The distance at which the crop appeared to be normal was also noted at the same time.

RESULTS

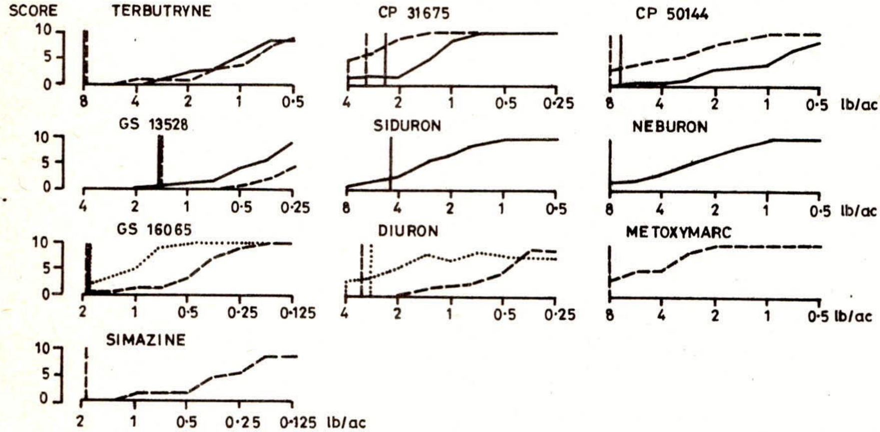
Figs. 1, 2 and 3 show the scores for the densities of blackgrass inflorescences at the various doses along the plots in the three 1966 experiments. The continuous line shows the scores for the plots treated pre-emergence, the broken line for those treated early post-emergence and the dotted line for those treated late post-emergence. Fig. 4 and 5 show the scores for the plots in the 1967 and 1968 experiments.

Each graph in Fig. 1, 2, 3 and 4 is a mean of two replicates; in the 1968 experiment however the scores for the different replicates of the same treatments sometimes varied greatly, so that both are given - as continuous and dashed lines. In all Figs. the dose below which the crop was apparently unaffected is shown as a single vertical line on each graph.

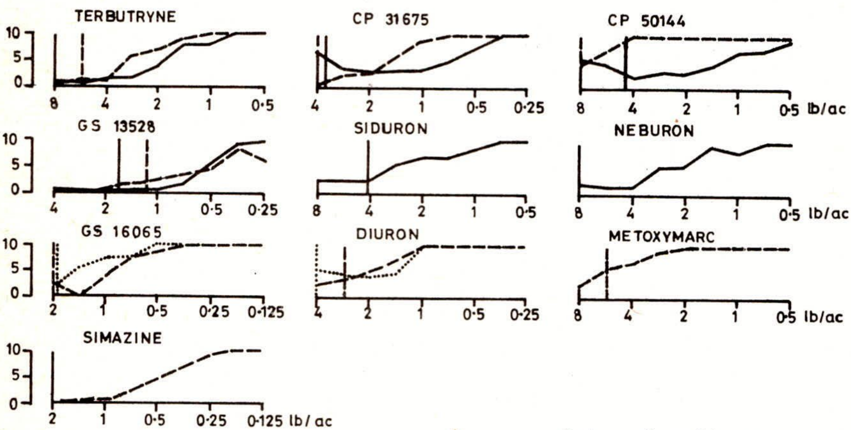
In all three of the 1966 experiments terbutryne applied pre-emergence consis-

Fig. 1 Control of Alopecurus myosuroides in winter wheat on plots treated with 'log' reducing doses at different growth stages
(Scores for no. of inflorescences - 0 = none; 10 = as control)

(a) Site - Bledington, Oxon. Wheat var.- Maris Widgeon



(b) Site - Kingham, Oxon. Wheat var. - Champlein

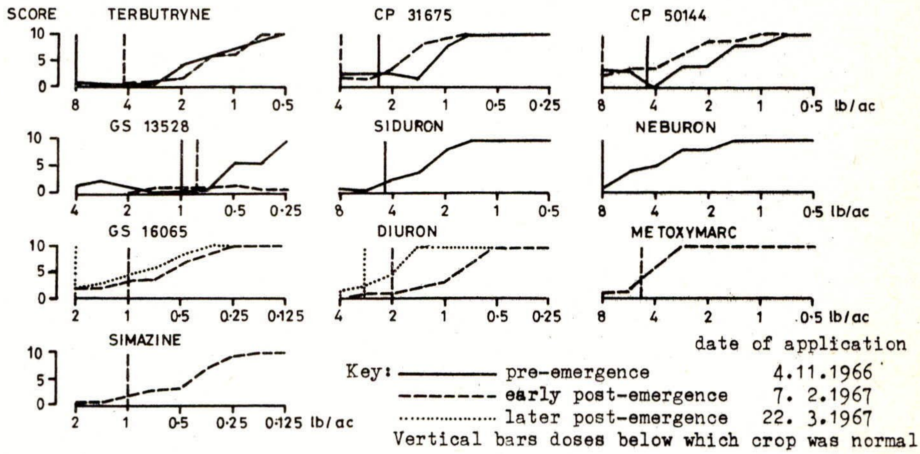


Key:		Dates of application (a)	(b)
————	pre-emergence	2.11.1966	7.11.1966
– – – –	early post-emergence	6.2.1967	8. 2.1967
········	later post-emergence	21.3.1967	21. 3.1967

Vertical bars - doses below which crop was normal

Fig. 1 (Continued)

(c) <u>Site</u> - Gt. Missenden, Bucks. <u>Wheat var</u>.- Champlein



tently gave good control of blackgrass at a dose of 3 lb/ac and no obvious crop damage at doses below 8 lb/ac. Treatments applied after emergence were more toxic to the crop and selectivity was reduced. Simazine was very much more toxic to the blackgrass than terbutryne and doses between 0.5 and 1.0 lb/ac gave good control but crop toxicity was also evident down to 1 lb/ac at Great Missenden. The other triazines tested were if anything less selective.

Neburon was the most selective of the ureas but its general level of activity was low and for adequate blackgrass control doses of more than 4 lb/ac appeared necessary. Both CP 31675 and CP 50144, like the ureas other than neburon, had insufficient selectivity.

In the 1967 experiment (Fig. 4) terbutryne again gave good selective control at a dose of 3 lb/ac and in addition fluometuron at 2 lb/ac and nitrofen at 3 lb/ac were very effective treatments. The mixtures of terbutryne with GS 13528 and GS 13529 although very much more toxic to the blackgrass did not show any improvement in selectivity. The mixture of methoprotryne and simazine however gave quite good selective control. All the other treatments were either not sufficiently selective or not effective on the blackgrass.

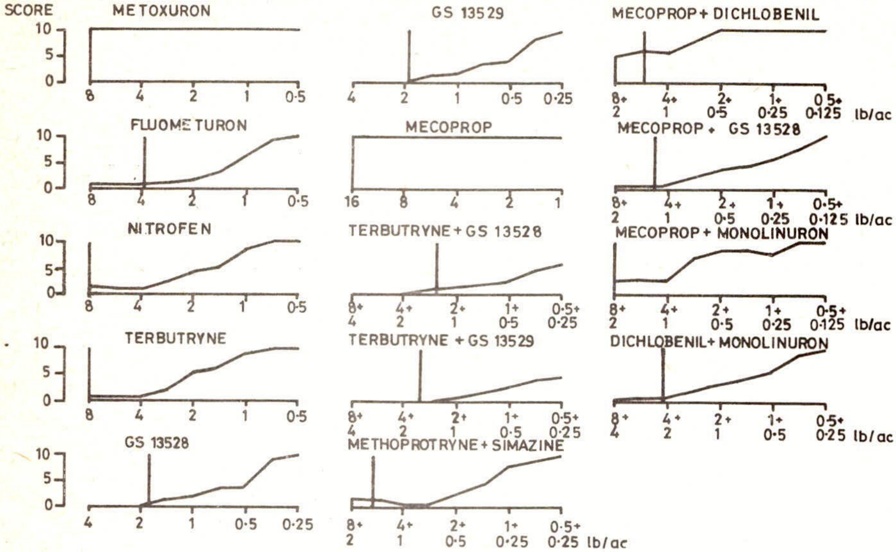
Most of the treatments in the 1968 experiment (Fig. 5) were either insufficiently selective or ineffective on the blackgrass. Noruron at 2-3 lb/ac was the most satisfactory treatment but selectivity was still very marginal. In this experiment some of the treatments showed major differences in effectiveness between each of the replicates; metoxuron showed the greatest variation.

DISCUSSION

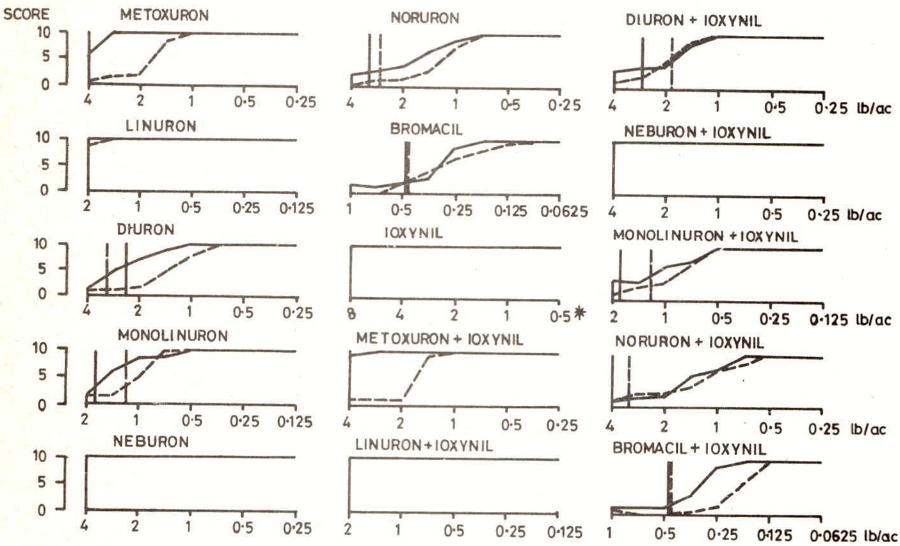
Terbutryne applied pre-emergence as reported in the earlier paper (Holroyd,1966) was again the most selective treatment, but unfortunately the 3 lb/ac dose required for maximum effect is expensive and above the dose recommended commercially. At doses below 3 lb/ac its effectiveness on the blackgrass tended to fall off relatively

Fig. 1 (Continued)

(d) Site - Bledington, Oxon. Wheat var. - Maris Widgeon
Pre-emergence applications only on 28.11.1967



(e) Site - Kingston Blount, Oxon. Barley var. - Otter
Post-emergence applications only on 24.3.1968



* oz/ac
The ioxynil used in mixtures is a constant 8 oz/ac
Vertical bars - doses below which crop was normal

Key: ———— Rep. I
- - - - - - Rep. II

rapidly. Mixtures of terbutryne with other triazines did not show any clear-cut advantage.

In France both nitrofen and neburon have been particularly successful for the control of blackgrass (Rognon 1966). In the present work nitrofen was only tested in one experiment but the promising result indicated that this herbicide should be investigated further in Britain. In contrast neburon showed a lower level of activity under British conditions although still selective.

Fluometuron was another herbicide which was only tested in one experiment, but its high activity and reasonable selectivity merit further investigation.

In the 1968 experiment, ioxynil was included in various mixtures but the results were disappointing and there was no useful interaction. In this experiment there was a very marked difference in the activity of some of the compounds between the two replicates; this might be explicable in terms of a difference in soil type or conditions between the two blocks, thus influencing the activity through the soil.

Acknowledgments

Thanks are due to Messrs. M. E. Thornton and J. A. Bailey and Miss J. L. Laughton for carrying out most of the experimental work, the commercial firms for supplying the herbicides and the farmers on whose crops these experiments were sited.

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Proc. 9th Brit. Weed Control Conf. (1968)

TRI-ALLATE GRANULES FOR THE POST-EMERGENCE CONTROL OF AVENA FATUA IN WINTER AND SPRING CEREALS

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Summary Three field experiments (one in winter wheat, two in spring barley) are described, in which post-emergence applications of tri-allate at doses of 1.0-2.0 lb/ac in a granular formulation, without incorporation, gave good control of Avena fatua at growth stages between one leaf and tillering. There was no visible damage to the crops. A normal emulsifiable concentrate formulation applied as a conventional spray was, by comparison, very much less effective. The implications of these results are discussed.

INTRODUCTION

Tri-allate has been used to control Avena spp. in wheat and barley crops for a number of years. Past recommendations specify application of the herbicide to the soil surface either before or soon after drilling the crop, followed by immediate mixing with the soil by suitable cultivation because of the volatility of the herbicide (Fryer and Evans, 1968).

In winter crops spring germinating Avena fatua is difficult to control. Treatments applied at the time of drilling in the autumn often do not have sufficient residual activity, and subsequent treatments cannot be mixed with the soil because of the presence of the crop. A granular formulation which is less liable to vapour loss than the normal application of an emulsifiable concentrate provides a possible solution. Early in 1968 the manufacturers made such a granular formulation available to the Weed Research Organization for testing.

At the beginning of April, an experiment to test the effectiveness of this granular formulation on spring germinating A. fatua in a winter wheat crop was begun. A considerable number of plants of A. fatua had already emerged at the time of treatment and some of these were colour coded according to their stage of growth. Two to three weeks later these plants and others were seen to be severely affected by the tri-allate treatments. Two further experiments were therefore laid down on crops of spring barley containing A. fatua to investigate this post-emergence activity further. This paper reports the results of these three experiments.

METHOD AND MATERIALS

The first experiment was on winter wheat and the other two were on spring barley. All contained moderate to heavy infestations of A. fatua. Details of the sites, dates of treatment and stage of growth of crop and weed are given in Table 1.

In the experiments at Drayton and Chipping Norton two formulations of tri-allate were compared - (a 40% emulsifiable concentrate and a 5% granular formulation on 24/48 mesh attapulgite) at the doses shown in Fig. 1. The emulsion was applied with an Oxford Precision Sprayer fitted with Allman '00' jets. The volume rate was 20 gal/ac and the pressure 28 lb/in^2. The granules at all three sites were applied from a small hand-held shaker on the 'pepper pot' principle. At Chipping Norton, barban (12% e.c.) was also applied (similarly to the tri-allate emulsion) at the recommended rate of 5 oz/ac, for comparison. At Stonesfield only the granular formulation was applied. The experimental design was a randomised block replicated

Table 1

Details of sites and stages of growth of crops and *A. fatua* at the time of treatment

Site and Crop	Soil type & condition	Date of treatment	Stage of growth (presence of tillers and no. of leaves on main shoot) Crop	Weed
Drayton, Berks winter wheat var. Capelle sown 20.11.1967	Thames Valley silt dry	4.4.1968	5.5–6.5 (2–3 tillers)	0–tillering mostly 0–2
Stonesfield, Oxon spring barley var. Zephyr sown 20.3.1968	clay over limestone brash moist	20.5.1968	5.0–6.0 (1–3 tillers)	0–tillering mostly 2–3.5
Chipping Norton, Oxon spring barley var. Impala sown 22.4.1968	sandy loam wet	14.5.1968	1.5–2.0	0–2.5 mostly 1–1.5
	wet	27.5.1968	3.5–4.0	0–tillering mostly 2–3

twice. At Drayton 3 replicates were treated initially but one became severely lodged and had to be discarded. Plot size was 6 x 2 yd with an untreated strip 1 yd between each pair of plots.

At Drayton variable numbers of *A. fatua* plants were colour coded according to their specific stage of growth at the time of treatment, but only on some of the plots in one replicate. On the other two experiments 10 plants (if available) of each growth stage were colour coded on each plot.

Assessments were made by counting the numbers of panicles present in three quadrats of 1 yd^2 on each plot when the majority of panicles were fully emerged. The panicles were graded into three categories according to size (A = 0 - 10 spikelets, B = 11 - 40 spikelets and C = 40+ spikelets). The fate of colour coded plants was also recorded and their panicles sized on the same scale. At Chipping Norton and Stonesfield the spikelets on 100 panicles of each of the three sizes were counted and the means calculated. These were as follows: Chipping Norton, A = 5.9, B = 27, and C = 60 spikelets/panicle; Stonesfield, A = 5.7, B = 26, and C = 74 spikelets/panicle. These figures were used to calculate total numbers of spikelets per yd^2 from the panicle counts.

RESULTS

Tri-allate had a very characteristic effect on the *A. fatua* plants which had emerged at the time of treatment. It was somewhat similar to the effects of barban. Development of new leaves on affected plants stopped. Leaves which had already emerged soon ceased longitudinal growth but continued to develop in width so that on larger plants, a small rosette was formed. Leaf colour became darker and cuticular wax failed to form. Plants remained in this inhibited state of growth for about six weeks. Occasionally the main shoot or a tiller resumed normal growth eventually but was then at a severe competitive disadvantage because of the advanced crop development. Others died in due course.

The effects of the various treatments on panicle size and the numbers of spikelets produced by the *A. fatua* are shown in Figs. 1 and 2. No visible crop damage due to the tri-allate treatments was seen in any of the experiments. At Drayton all doses of the granules except the lowest (0.5 lb/ac) gave good control. The emulsion formulation had much less effect although the 2 lb/ac treatment gave approx. 80% control. The colour coding showed that the two higher doses of the granules were killing an appreciable number of the largest plants which had more than 2 leaves at the time of treatment.

Although many of the A. fatua plants at Stonesfield had begun to tiller at the time of treatment all the treatments (granules only) gave good control. Barban applied on the same day in a separate but adjacent experiment, gave very poor control. At Chipping Norton the granules were again much more effective than the spray. A little surprisingly the treatments applied later were more effective than those applied earlier, for the weather conditions after both sets of treatments were very similar. At this site only the 2 lb/ac treatments gave satisfactory control. Barban, which was applied for comparison, gave satisfactory control at the earlier date. The crop, which was a variety susceptible to barban, was quite severely checked.

At both Stonesfield and Chipping Norton the colour coding showed that, although the susceptibility of the A. fatua decreased with age, many of the more advanced plants (three leaves + tillers) were killed, particularly by the higher doses of tri-allate granules.

DISCUSSION

Banting (1967) showed that if the top 5 cm of soil was removed from around A. fatua plants in the 1.0 - 1.5 leaf stage and replaced with soil treated with tri-allate, growth ceased almost immediately, but he also found that susceptibility was very much reduced at the 2.0 - 2.5 leaf stage. By contrast, in the experiments described in this paper a surface layer of tri-allate, resulting from application of granules and probably relatively concentrated, killed many plants which had already begun to tiller. The period of susceptibility was therefore much extended and in the presence of crop competition mortality was relatively high even at fairly advanced stages of growth. In the experiment at Chipping Norton excavation of ten A. fatua plants of each of six growth stages (1-6 leaves) showed that plants in the 1-3 leaf stage came from depths of 1.0-4.5 in. (mean 2.6 in.) whereas those in the 4-6 leaf stage came from 0.5-2.75 in. (mean 1.15 in.). This suggests that although more developed plants may be basically more resistant this is counterbalanced by the shallower location of their growing points which may have exposed them more readily to the concentration of herbicide at the soil surface.

The route of effective entry into plant must be elucidated before the factors governing the reliability of this form of treatment can be determined. It has been deduced that with this type of herbicide, entry through the root system of the young seedling of Avena spp. is unimportant (Parker, 1963). Leaf uptake seems unlikely, even in the vapour phase, for no granules were retained by plants in the early growth stages and relatively few by those which were tillering; furthermore, over-all spray application as an emulsion was less effective. Uptake into the shoot at around ground level would seem to be implicated. Currently, greenhouse experimentation is in progress to elucidate this and other aspects of this remarkable and potentially useful post-emergence activity.

Environmental factors could influence this activity. Weather and soil conditions at both Stonesfield and Chipping Norton were probably ideal for the activity of a granular herbicide, as the soil surface was moist at the time of treatment and rain followed soon afterwards. However at Drayton, earlier in the season, the soil surface was dry and little or no rain fell for the next nine days. At this time of the year, during the early morning, cereal crops become very moist near the soil surface, due to guttation and dew, and this moisture may have been sufficient to activate the granules.

The present work imparts a new dimension to the use of tri-allate for the control

Fig. 1

Effect of treatments on proportions of panicles of Avena fatua of various sizes

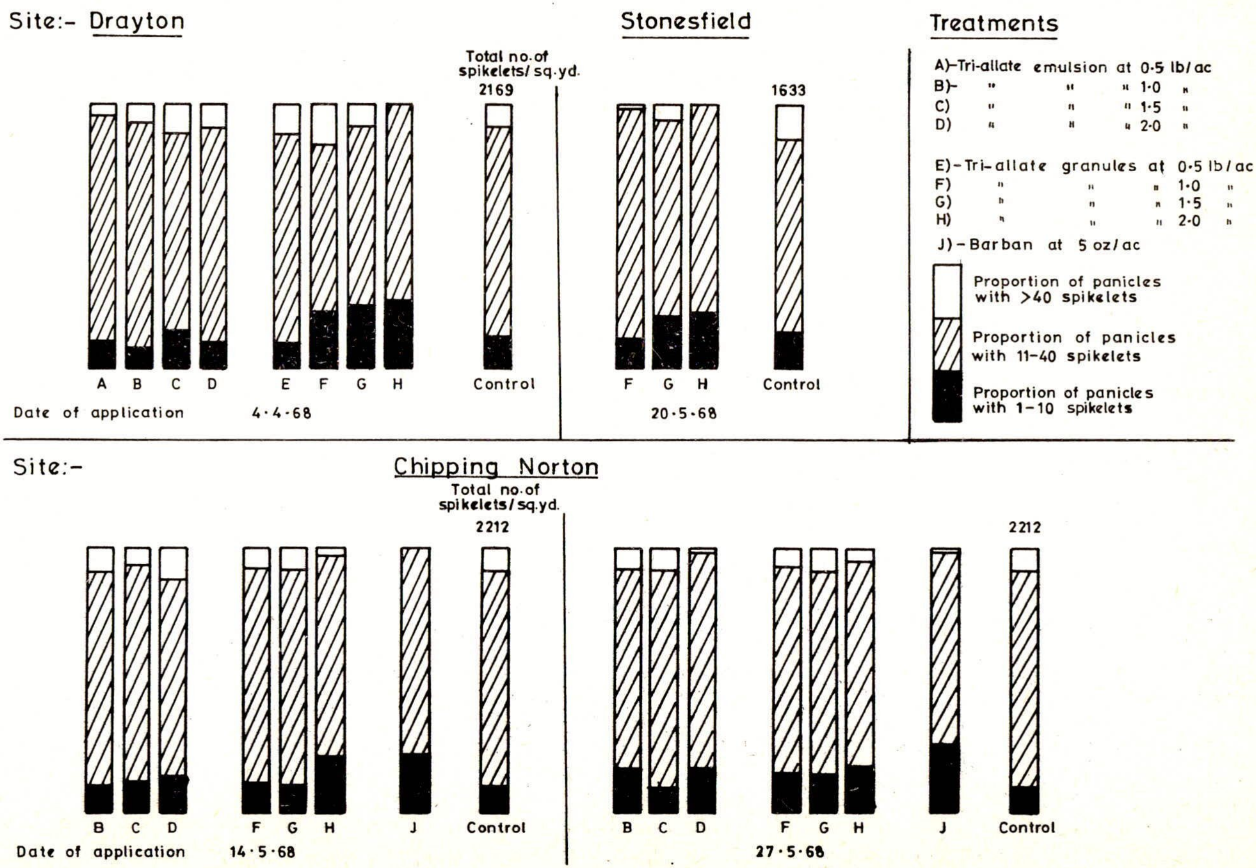
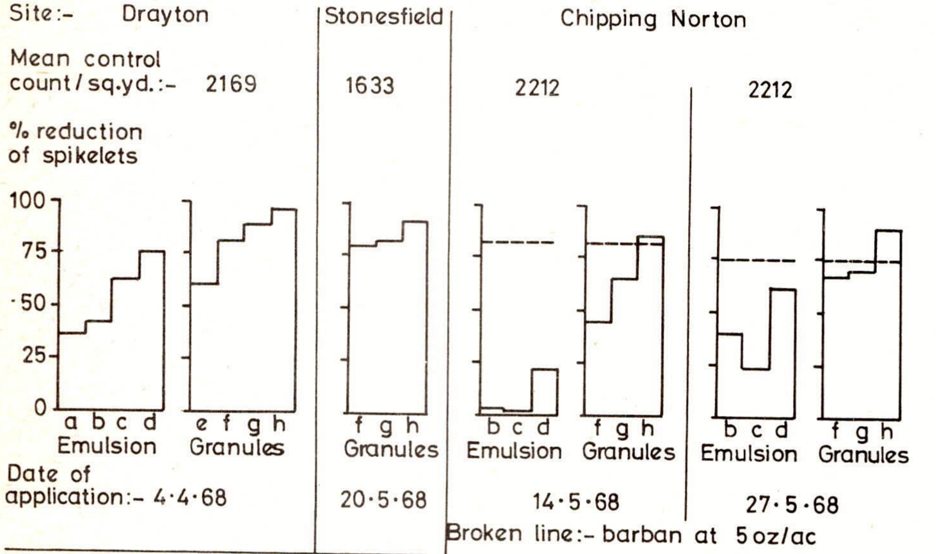


Fig. 2

Effect of post-emergence treatments with tri-allate on the production of spikelets by Avena fatua



Treatments

a) = tri-allate emulsion at 0·5 lb/ac
b) " " " 1·0 "
c) " " " 1·5 "
d) " " " 2·0 "

e) = tri-allate granules at 0·5 lb/ac
f) " " " 1·0 "
g) " " " 1·5 "
h) " " " 2·0 "

of Avena spp. in cereals. The period of weed susceptibility is extended, the need for incorporation in what are often difficult soil conditions is eliminated, spring germinating plants can be controlled and the decision to treat can be made when the weed infestation is visible. Conditions for use would be particularly favourable in winter crops where treatment could be combined with the spring application of fertiliser and the presence of sufficient moisture can be guaranteed. Ideally the fertiliser might be used as the granular carrier for the herbicide.

In spring crops environmental factors may be of crucial importance. The effect of temperature and soil moisture regime needs to be investigated in detail. Coupled with this is a need for information on the release of tri-allate from the granule and its subsequent distribution and persistence in the soil. The response of seedlings of different ages and arising from different depths in the soil must be investigated in more detail. Likewise the safety of the common varieties of cereal crop under all conditions must be verified. In the longer term, the possibility of adding another herbicide to the granule to control broad-leaved weeds should be considered. Some of the experimentation to elucidate these and other points is already in progress.

Acknowledgements

Thanks are due to Dr. K. Holly for help and advice, Messrs. M.E. Thornton and J.A. Bailey and Miss J.M. Laughton for carrying out much of the experimental work, the farmers who provided the experimental sites and the manufacturers for supplying the materials.

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THE CONTROL OF AVENA FATUA IN SPRING BARLEY WITH 2-CHLORO-3-(4-CHLOROPHENYL) PROPIONIC ACID METHYL ESTER

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Summary A population of *Avena fatua* in a spring barley crop was treated with doses of 2, 4 and 8 lb of 2-chloro-3-(4-chlorophenyl) propionic acid methyl ester (Bayer 70533) and a standard dose (5 oz/ac) of barban at three different stages of growth of the crop. The results indicated that at doses of 4 - 8 lb/ac 70533 compared favourably with barban. Treatments were most effective at the earliest time of application. Colour coding showed that *A. fatua* plants were susceptible up to the 4 leaf stage, but most susceptible at the 1.5-2.5 leaf stage.

INTRODUCTION

The herbicide currently recommended for the post-emergence control of *Avena fatua* in spring cereals is barban. This suffers from two particular drawbacks: firstly some barley varieties have very little tolerance; secondly the period of susceptibility of *A. fatua* is relatively brief (1-2.5 leaves). Recent work in Europe has shown that a new herbicide, 2-chloro-3-(4-chlorophenyl)propionic acid methyl ester (Bayer 70533) will selectively control *A. fatua* post-emergence in spring cereals (Eue 1968, Kampe 1968). The experiment here described was designed to compare the performance of 70533 with barban at various stages of growth of the weed.

METHOD AND MATERIALS

The experiment was in a commercial crop of spring barley var. Zephyr sown on 20.3.1968 and heavily infested with *A. fatua*. The soil was a heavy clay over limestone brash.

70533 was formulated as a 53.5% w/v emulsifiable concentrate and barban as a 12.5% w/v emulsifiable concentrate. They were applied with an Oxford Precision Sprayer fitted with Allman '00' jets. The volume rate was 21 gal/ac and the pressure 30 lb/in^2. Details of the stages of growth of the crop and the weed are given in Table 1. The doses used are shown in Table 2. At the time of treatment 10 *A. fatua* plants (if available) of each growth stage were colour coded i.e. identified by placing a piece of suitably coloured wire in the soil beside the selected plant, on each plot.

The experimental design was 3 replicates in randomised blocks. The plot size was 8 x 2 yd with an untreated strip of 1 yd between each pair of plots. Assessment was by counting the numbers of panicles present in three quadrats of 1 yd^2 on each plot when the majority of panicles were fully emerged. The panicles were graded into three categories according to size (A = 0 - 10 spikelets, B = 11 - 40 spikelets and C = 40+ spikelets). The fate of the colour coded plants was also recorded and their panicles classified on the same scale.

The number of spikelets in one hundred panicles of each of the three sizes was counted and the means calculated. These were as follows: A = 5.7, B = 26 and C = 74 spikelets/panicle. These figures were used to calculate total numbers of spikelets/yd^2 from the panicle counts.

Table 1

Details of stage of growth of crop and weed at the time of treatment

Date of Treatment	Crop height (in.)	Stage of growth (nc. of leaves on main shoot, presence of tillers) Crop	Weed	Colour coding
25.4.1968	5.0 - 5.5	3.0 - 3.5 just tillering	0.5 - 3.0 majority 1.0 - 1.5	0.5, 1.0, 1.5, 2.0 & 2.5 leaves, 10 plants each, 3 leaves as available
20.5.1968	7.0 -10.0	5.0 - 6.0 1-3 tillers	1.0 to tillering majority 3-4	2, 3, 4, 5 + leaves and tillering, 10 plants each. 1 leaf as available
5.6.1968	11.0 -16.0	5.0 - 7.5 1-3 tillers	4.0 upwards majority 6+ and tillering	4, 5 & 6 leaves most tillering

RESULTS

The symptom of damage from 70533 on A. fatua was necrosis which developed on the exposed leaves and gradually extended to the whole plant. The action seemed to be primarily by contact but with a suggestion of translocation. Less severely affected plants recovered by the regrowth of tillers. Treatment with the highest dose at the first date caused a limited amount of leaf necrosis on the crop but this did not extend. Recovery subsequently seemed to be complete. The results from the assessment of the panicles and spikelets on the general population are given in Table 2, and those from the assessment of the colour coded plants in Table 3.

The treatments applied at the earliest date were the most effective; at this time 70533 at 4 lb/ac decreased the number of spikelets produced by 71% and at 8 lb/ac by 89%. A month later, at the second date, 8 lb/ac gave only 75% reduction and at the last date, 8 lb/ac gave only 40% reduction of the A. fatua spikelets. Barban gave 55% reduction at the earliest date and had relatively little effect at the two subsequent dates.

Nearly all the treatments reduced the number of large panicles present, and there was a general shift in the panicle sizes from the larger to the smaller, which was particularly noticeable as a result of treatment with the higher doses of 70533, at the earliest date.

The results in Table 3 show the mortality of A. fatua plants as a result of treatment at the different stages of growth, but give no indication of effects on panicle size. However they show very clearly the increase in resistance with age. Plants beyond the 4.0 leaf stage were rarely killed by 70533; the maximum effect was on plants having 1.5 - 2.5 leaves.

Table 2

Effect of treatments on proportion of panicles of *A. fatua* of various sizes, and on number of spikelets produced

panicle sizes, A = 0-10, B = 11-40, C = 40+ spikelets

	Treatment		% of panicles in each size grade A	B	C	Spikelets number/yd^2	% of control
Date I 25.4.68	70533	2 lb/ac	16	70	14	1431	86
	"	4 lb/ac	35	60	5	490	29
	"	8 lb/ac	48	50	2	182	11
	barban	5 oz/ac	28	69	3	751	45
Date II 20.5.68	70533	2 lb/ac	18	73	9	1253	75
	"	4 lb/ac	24	71	5	718	43
	"	8 lb/ac	29	65	6	415	25
	barban	5 oz/ac	16	81	3	1368	82
Date III 5.6.68	70533	2 lb/ac	18	66	16	1586	85
	"	4 lb/ac	19	69	12	1086	65
	"	8 lb/ac	18	76	6	1005	60
	barban	5 oz/ac	15	67	18	1991	119
	Control		13	71	16	1667	100
Control mean of 6 replicates		S.E.	treatments			± 209	
			control			± 93	

DISCUSSION

The results from this experiment indicate that 70533 is a moderately effective herbicide for the control of *A. fatua* in spring barley at doses between 4 and 8 lb/ac, and compares favourably with barban. Relatively early treatment soon after the emergence of the *A. fatua* would seem to be the best, although there was some indication, from the colour coded plants, that mortality due to the treatments at Date I was slightly less at the 0.5 and 1.0 leaf stages than at the 1.5 - 3.0 leaf stages. Interpretation is a little difficult because of the high mortality of the plants at the early leaf stages on the control plots, particularly after the second date. This was presumably due to severe competition from the crop. The amount of spray retained by plants at these early stages could be expected to be considerably less than at the later stages because of the orientation of the leaves.

Investigation of the influence of different types of spray application such as angled jets, higher pressures and lower volume rates to reduce drop size, etc. or changes in formulation would appear warranted. Satisfactory cover of the *A. fatua* foliage with this herbicide is probably necessary because of the primarily contact nature of the action of 70533.

Table 3

Mortality of A. fatua plants treated at different stages of growth

(date from colour-coded plants)
Dead plants as % of number relocated*

	Treatment	Leaf stage at time of treatment						tillering		
		0.5	1.0	1.5	2.0	1.5	3.0	4.0	5.0	6.0
Date I 25.4.68	70533 2 lb/ac	43	17	13	26	17	6	-	-	-
	" 4 lb/ac	59	22	74	52	84	56	-	-	-
	" 8 lb/ac	75	56	80	92	54	69	-	-	-
	barban 5 oz/ac	42	30	9	0	31	14	-	-	-
	control	31	7	0	0	0	0	-	-	-
Date II 20.5.68	70533 2 lb/ac	-	67	-	43	-	21	10	0	0
	" 4 lb/ac	-	97	-	86	-	76	39	24	0
	" 8 lb/ac	-	85	-	80	-	69	62	36	0
	barban 5 oz/ac	-	68	-	27	-	9	10	0	0
	control	-	58	-	32	-	0	0	0	0
Date III 5.6.68	70533 2 lb/ac	-	-	-	-	-	-	14	13	0
	" 4 lb/ac	-	-	-	-	-	-	26	7	0
	" 8 lb/ac	-	-	-	-	-	-	27	10	0
	barban 5 oz/ac	-	-	-	-	-	-	6	0	0
	control	-	-	-	-	-	-	15	0	0

* A small number of the colour coded plants could not be found at the time of assessment

Acknowledgments

Thanks are due to Dr. K. Holly for help and advice, Messrs. M.E. Thornton and J.A. Bailey and Miss J.M. Laughton for doing the experimental work and the manufacturers for supplying the materials.

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CONTROL OF ALOPECURUS MYOSUROIDES (BLACKGRASS) IN CEREALS

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Summary A comparison was made of current commercial herbicides and some recent introductions for control of Alopecurus myosuroides (blackgrass) in three experiments in winter wheat and one in spring barley. Moderate to high densities of blackgrass greatly decreased yield of grain per acre as measured by the response to control by herbicides. However, control even by the most efficient herbicides was not complete and allowed a considerable return of weed seed to the soil. None of the new herbicides tested proved more effective than the current commercial recommendations in cereals for control of blackgrass.

INTRODUCTION

Triallate, barban and GS 14260 are now being used for the control of blackgrass in winter wheat. On heavy soils in the South East Region some spring sown cereals are severely infested by blackgrass and require treatment by herbicide. In winter cereals there is difficulty in applying barban because the soil can be too wet for equipment when the weeds are at the optimum stage of growth. Seedbed application of triallate adds to the work load at drilling and on heavy soils there is difficulty with cloddy tilths and inefficient incorporation. GS 14260 has the advantage in not requiring incorporation, and has shown good crop selectivity in manufacturers' trials. On the advice of commercial firms the chemicals diuron, neburon and simazine/methoprotryne mixture were included for comparison with the above chemicals. Simazine/methoprotryne is recommended for spring application in winter cereals when blackgrass is beyond the optimum stage for barban ($1\frac{1}{2}$ leaves).

METHODS AND MATERIALS

Three of the experiments in winter wheat were on heavy land farms intensively cropped with winter wheat and one site was in spring barley on Oxford clay.

Treatments applied were as follows:

1. Pre-sowing
   24 oz a.i./ac triallate incorporated into the soil by harrows.

2. Post-sowing pre-emergence to soil surface
   24 oz a.i./ac triallate incorporated by harrows.
   8 oz a.i./ac diuron.
   16 oz a.i./ac diuron.
   32 oz a.i./ac GS 14260 (4-ethylamino-2-methylthio-6-t-butylamino-1,3,5-triazine). = **terbutryne.**
   40 oz a.i./ac neburon.

3. Post-emergence of crop and weeds
   $16\frac{1}{2}$ oz a.i./ac simazine + methoprotryne (blackgrass at 3-4 leaves)
   16 oz a.i./ac diuron) (blackgrass at $1\frac{1}{2}$ leaves)
   5 oz a.i./ac barban)

In the three yield trials two control plots were included, one of which was wheeled at stage three (post-emergence) spray application.

A Land Rover mounted sprayer unit was used on the yield trials spraying an area of 5 yd x 44 yd to allow a combine cut up the centre of each plot. Low volume fan nozzles were used at 18 in. (height above ground or above main crop density) and 40 lb. p.s.i. applying 20 gal/ac. At one winter wheat site the Oxford Precision Sprayer was used at 30 gal/ac. on plots 6 ft x 30 ft. Spraying was carried out across the cereal drills. The experimental design was randomised blocks, replicated three times.

Details of site, date of treatment, stage of growth of crop and weed and density of weeds are given in Table 1.

Table 1

Details of Sites

Site	Crop		Weed		
	Date of spraying	Stage of growth	No. of leaves	Height (in)	Density Plants /ft^2
Chesham	25.10.66	Pre-sowing	-	-	none
Bucks	25.10.66	Pre-emergence	-	-	none
Var. Champlein	10. 2.67	3-4 leaves	3	2	9-14
Sown 25.10.66					
Bledlow	18.11.66	Pre-emergence	-	-	none
Bucks	14. 2.67	2.5-3 leaves	2-2.5	1.5	5.6
Var. Cappelle					
Sown 12.11.66					
Bledlow	18.11.66	Pre-emergence	-	-	none
Bucks	9. 2.67	2.5-3 leaves	2-2.5	1.5	2-3
Var. Cappelle	12. 4.67	3-4 leaves	4-5	3	5-6
Sown 12.11.66					
O.P.S. trial					
Elsfield	29. 3.67	Pre-emergence	-	-	patchy
Oxon	28. 4.67	1.5 leaves	1-1.5	0.5-1	47
Var. Impala	3. 6.67				
Sown 27.3.67					

RESULTS

Blackgrass and crop plant density scores were made in early spring to assess the effects of pre-emergence treatments (Table 2). Assessments of blackgrass density were made in June on a scale 0 = no inflorescences seen, 10 = control treatment (Table 3). The results from the two control plots were meaned as wheeling had no significant effect on crop density or yield.

Table 2

Control of A. myosuroides by pre-emergence herbicides

(Score for blackgrass plants, 0 = none, 10 = untreated)
(Score for crop plants, 0 = none, 10 = untreated)

Site and date of count	Chesham 24.4.67		Bledlow 24.2.67		Bledlow O.P.S. 24.2.67		Elsfield 24.5.67	
Treatment	Weed	Crop	Weed	Crop	Weed	Crop	Weed	Crop
Pre-sowing triallate	2.8	8.3	-	-	-	-	-	-
Pre-emergence triallate	3.0	9.0	2.0	5.5	4.0	7.0	1.0	8.0
Diuron 8 oz	4.7	7.0	-	-	6.0	6.5	-	-
Diuron 16 oz	4.3	7.7	-	-	4.5	6.0	6.0	8.0
GS 14260	2.7	7.0	2.0	6.0	3.0	7.0	2.0	9.0
Neburon	5.3	7.7	-	-	8.0	6.0	7.0	8.0
Untreated (mean of 2 plots) thousands/acre	546	674	235	759	105	736	2,043	767

Table 3

Control of *A. myosuroides* by herbicides applied at various times

(Score for number of inflorescences per unit area in June, 0 = none, 10 = untreated)

Site / Treatment	Chesham	Bledlow	Bledlow O.P.S.	Elsfield
Pre-sowing triallate	2.7	-	-	-
Pre-emergence triallate	5.0	4.5	4.5	1.0
Diuron 8 oz	6.3	-	5.0	-
Diuron 16 oz	6.0	-	3.0	5.0
GS 14260	4.0	5.7	4.0	2.5
Neburon	7.0	-	7.0	6.0
Post-emergence simazine/methoprotryne	1.3	-	6.3	7.0
Diuron 16 oz	2.7	-	5.0	4.0
Barban	-	3.5	1.7	-
Untreated (inflorescences/ft^2)	43.0	25.5	25.0	58.0

Combine yields were obtained from three trials (Table 4); the Bledlow O.P.S. plots were not sampled for yield.

Table 4

Effect on crop yield of herbicides applied for the control of *A. myosuroides*

Site Treatment	Chesham Winter wheat	Bledlow Winter wheat	Elsfield Spring barley
Pre-sowing triallate	117	-	-
Pre-emergence triallate	108	115	135
Diuron 8 oz	99	-	-
Diuron 16 oz	109	-	109
GS 14260	105	114	132
Neburon	101	-	119
Post-emergence simazine/methoprotryne	116	-	77
Diuron 16 oz	114	-	74
Barban	-	122	-
Untreated (mean of 2 plots)	(43.3 cwt/ac)	(27.1 cwt/ac)	(19.7 cwt/ac)
S.E. means (%)	± 3.69	± 5.57	± 8.42

DISCUSSION

Triallate and barban were generally the most effective herbicides against blackgrass in the trials. With triallate at the one site where two times of application were compared, application after sowing was less effective than that of pre-sowing although both sprays were incorporated into the soil surface soon after spraying. GS 14260 also gave consistent control of blackgrass at all sites with little effect on the crop. The other chemicals tested gave less consistent results and neburon proved to be relatively ineffective against blackgrass on the heavy soils of the trial sites. Diuron at 16 oz a.i. pre-emergence gave better control than the 8 oz a.i. rate but this was accompanied by crop damage. Diuron was generally more effective on blackgrass when applied post-emergence but crop selectivity was low with up to 50% loss of plant in the Chesham trial although blackgrass control resulted in a significantly higher grain yield than in the untreated crop. The simazine/methoprotryne mixture also reduced the crop plant by 40% in the Chesham trial but blackgrass control and yield results were good.

Generally responses in crop yield to the effective treatments against blackgrass were more than sufficient to cover cost of application. But counts of inflorescences in June showed that even on the most effective treatments there were of the order of 4-5 inflorescences per ft^2 surviving. This return of seed to the soil is likely to be sufficient to maintain populations of blackgrass at levels requiring further herbicide treatment in subsequent cereal crops.

Acknowledgements

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THE CONTROL OF WILD OATS (AVENA FATUA) IN CONTINUOUS SPRING BARLEY BY TRI-ALLATE OR LATE DRILLING

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Summary Both tri-allate and late sowing were effective in controlling wild oats (*Avena fatua*) in continous spring barley 1965-68, but neither were able to prevent a small return of seed each year. There was no advantage from stubble cultivations carried out in the preceding year on wild oats or barley yields at harvest 1965-67.

When sown under reasonable seedbed conditions early sown barley treated with tri-allate yielded considerably more grain than late sown barley. Differences in the initial populations of wild oats continued to show up each year.

INTRODUCTION

With the reduction in manpower and difficulties encountered in growing many of the high return break crops on the heavy lands of East Anglia, the proportion of cereals grown has increased.

Much of the cereal acreage is infested with wild oats. It has been shown at Boxworth and elsewhere that large numbers of wild oats in a crop can reduce yield. Since seed dormancy enables wild oat infestation to bridge a single clean break crop, control measures must be applied in cereal crops as well.

Since the inception of a trial at Boxworth E.H.F. in 1957 which compared dates of sowing, straw burning and baling, and stubble cultivations for wild oat control, chemical methods of control have been introduced.

It was decided to compare the efficacy of late sowing, the only really successful measure against wild oats in the previous trial (Whybrew 1964), with one of the chemical methods, the use of tri-allate soil-incorporated herbicide.

In 1964 plots early sown for each of the past 8 years had 146 wild oat plants per sq.yd. and had an enormous reservoir of seeds in the soil. This was a "larger than life" example of a common situation.

METHOD

Since in the 1957-64 trial, straw burning had usually encouraged wild oats to grow, in the autumn all straw was burnt. Stubble cultivations had also encouraged germination in both autumn and spring so were continued in the hope that a more rapid decline in wild oat populations would occur when measures were applied each spring to kill germinating wild oats.

Previously early-sown plots were split for two spring treatments.

Control measure 1. Drilling in early March and spraying with tri-allate, formulated as Avadex BW and applied at 2½ pints in 60 gallons of water per acre. The amount of water used was greater than in commercial practice but low-pressure large droplets were required to avoid drift. All the land was harrowed at the time of early drilling.

Spraying, with subsequent harrowing in both directions, was carried out as soon as possible after drilling. The longest delay between drilling and spraying was 5 days in 1967 due to high winds.

Control measure 2. Late sowing was carried out at the end of April or in early May. The land was left untouched from early March until just prior to late drilling when one or two passes with a spring tine cultivator and one pass with a thistle-bar uprooted all the seedlings. The thistle-bar was used because the shape of the plots required all working to be in one direction at late drilling.

Table 1

	Drilling and Spraying Dates				
	Early Sown		Sprayed	Late Sown	
1965	15 March	(Proctor)	17 March	7 May	(Rika)
1966	9 March	(Impala)	10 March	2 May	(Impala)
1967	15 March	(")	20 March	28 April	(")
1968	4 March	(")	5 March	3 May	(")

Seedrates were constant at 140 lb./ac. The seed was combine drilled each year with 60 units nitrogen; and in 1965, 42 units P_2O_5. Subsequently P_2O_5 was reduced to 30 units. A further 20 units of nitrogen were applied by hand as top-dressing in each year except 1965.

In 1965 late sown plots were harvested 25 days after the early sown plots and in 1966, 19 days later. In 1967 and 1968 all plots were harvested at the same time.

Counts of wild oats were made
(a) in the late autumn 1964-66 (Table 2)
(b) prior to late drilling in the spring each year (Table 3)
(c) in late July before harvest each year (Table 4)

RESULTS

The treatments have been coded as follows:-

ES - = Early sown and sprayed, stubble untouched
ES R = " " " " " rotovated
ES P = " " " " " ploughed

L - = Late sown, stubble untouched
LR = " " " rotovated
LP = " " " ploughed

Table 2

	Wild oat seedlings / yd^2 late autumn		
	1964	1965	1966
ES -	25.7	6.0	3.8
ES R	83.9	4.7	16.3
ES P	38.1 *	2.6	8.9
L -	25.7	2.8	4.1
LR	83.9	4.1	27.4
LP	38.1 *	2.6	10.9

* not ploughed in 1964 (stubble too hard)

The figures show considerable variation from year to year and marked residual effects from previous treatment populations.

Table 3

Wild oat seedlings/yd^2 mid-April, prior to late drilling	1965	1966	1967	1968 * (no autumn cults)
-	141	35	11	14
R	606	143	46	64
P	403	54	22	36

Table 4

Wild oat plants/yd^2 at harvest	1965	1966	1967	1968 *
ES -	4.5	2.0	1.8	0.4
ES R	7.4	5.4	5.3	1.9
ES P	5.1	3.5	4.6	1.5
L -	0.8	3.0	3.3	0.4
LR	1.7	12.5	12.7	1.7
LP	1.2	6.0	9.2	1.3

Population trends for each stubble treatment for the years 1965-67 show very little difference between treatments. This indicates that there was no consistent advantage from either stubble cultivation. (Table 5)

Table 5

Comparison of numbers of wild oat plants per yd^2 (mean of numbers in 1965-67 as percentage of mean of numbers in 1962-64)

ES -	7.9	L -	6.7
ES R	5.7	LR	8.6
ES P	5.8	LP	7.2

Table 6

Wild oat populations at harvest (numbers each year expressed as a percentage of the previous year).

	1964/5	1965/6	1966/7	1967/8 *
ES -	5.4	53.8	108.7	22.2
ES R	3.8	96.4	104.8	34.2
ES P	3.8	73.7	132.9	43.6
L -	1.2	384.8	132.4	7.5
LR	0.9	764.3	112.9	12.8
LP	0.8	511.0	163.5	16.5

* no cultivations autumn 1967; differences are residual from previous years

Late sowing gave better results in 1965 and 1968 but in 1966 and 1967 early sowing and spraying was the better treatment. There was no consistent advantage from either stubble cultivation.

Table 7

	Yield of grain cwt/ac @ 85% D.M.			
	1965	1966	1967	1968 *
	(±0.49)	(±0.96)	(±0.85)	(±0.77)
ES -	38.8	43.7	31.1	40.0
ES R	39.5	40.5	28.1	36.8
ES P	39.3	41.1	30.0	39.3
Mean	39.2	41.8	29.7	38.7
	(±0.49)	(±0.96)	(±0.85)	(±0.77)
L -	31.7	35.4	35.3	16.4
LR	31.9	35.0	32.8	16.6
LP	31.1	34.5	31.9	17.1
Mean	31.6	35.0	33.3	16.7
Late - Early Mean differences	- 7.6	- 6.8	+ 3.6	- 22.0

* no cultivations autumn 1967 differences are residual from previous years

Yield differences between early and late sowing were large (table 6). Within sowing dates, differences were only occasionally apparent, e.g. at early sowing the nil stubble treatment outyielded rotovation by a significant amount in 1966 and 1967 and was top yielder in the latter year after late sowing.

No yield advantages were obtained from stubble cultivations. In 1967 early sown barley was drilled into an extremely poor forced tilth. In 1968 late sown barley suffered from a severe attack by mildew.

DISCUSSION

Whybrew (1964) reported increased wild oat germination in autumn and spring following rotovation of the stubble after harvest, and that straw burning encouraged autumn germination. It seemed reasonable to continue these treatments and to destroy the seedlings by late autumn ploughing and by either chemical means or late sowing in the spring.

There is no evidence to suggest that stubble cultivations in this trial since 1964 have had much influence upon the numbers of wild oats present at harvest. Reports from Weed Research Organisation (Holroyd 1964) suggest that wild oats from the lower levels of topsoil are more likely to penetrate the tri-allate barrier. Similarly cultivations before late drilling may miss wild oats germinating from greater depths if these tend to germinate or emerge later. This trial suggests that autumn cultivations can have more influence when allied to late drilling than when followed by a spraying, early drilling system of wild oat control.

Apart from differences in wild oat populations due to drilling methods and dates of sowing, the major influence at work has been the residual effect of wild oat numbers in the previous trial on the same site. It is quite evident that following a bad infestation of wild oats, control measures for several years are necessary to reduce the population.

Because of reduced grain yields it is doubtful if late drilling is warranted as a specific control measure for wild oats in spring barley if chemical treatments can be properly used as an alternative.

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CONTROL OF ALOPECURUS MYOSUROIDES HUDS. (BLACKGRASS) IN WINTER CEREALS ON SANDY-LOAM SOILS IN A MARITIME CLIMATE

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Summary. In a maritime climate, autumn-germinating blackgrass is well-developed by the end of the winter. The action of graminicides which can be applied after frosts have finished, is very uncertain.

In badly-drained, sandy-loam soils the use of some graminicides is hazardous, especially after a wet winter.

Under these conditions a pre-emergence herbicide also active against dicotyledons, and persistent in soil, is preferable. In winter wheat a second application is sometimes given in early spring, against late-germinated blackgrass. In winter barley only one application can be given, pre-emergence, e.g. methabenzthiazuron or neburon.

INTRODUCTION

In Flanders, Alopecurus myosuroides Huds. (blackgrass) occurs mainly on sandy loams, especially with a high water-table, where winter cereals must be sown early to avoid the heavy rainfall (175-290 mm) of September and October.

Under these conditions blackgrass germinates early in autumn. The winter is never severe. The mean temperature for December-February is between 2·8 and 4·4°C, with a daily minimum down to -15·6°C and maximum up to 12·9°C.

Autumn-germinated blackgrass plants (and also Poa annua) have 2 to 5 shoots by the end of the winter. A spring flush of germination occurs not later than the beginning of March. Autumn- and winter-germinating annual dicotyledonous weeds, e.g. Matricaria recutita, Ranunculus sardous, Aphanes arvensis, Stellaria media and Spergula arvensis occurring with the blackgrass are also large by the end of winter. Herbicides applied to winter wheat after frosts have finished are often ineffective because the weeds are large enough to be resistant to the herbicides and are only slightly weakened by frost. Polygonum aviculare germinating in spring infests winter wheat and more Poa annua and Ranunculus sardous germinate.

For these reasons, we studied combined or separate applications of herbicides, especially against autumn-germinating species.

METHODS AND MATERIALS

Many trials were made from 1964 to 1968 at Kwatrecht (Wetteren) and Melle in the sandy-loam region of Flanders. The soil has a clay (0-2 μ) content of 6·2 - 9·0 (-11·5)%, humus (Walkley and Black) 1·76 - 2·40 (-2·79)% and pH (water) 5·90 - 6·70. A few experiments were on heavy sandy loam (13·0% clay, 3·10% humus, pH 6·20).

Winter barley (Manon) was sown in late September and winter wheat from 1 to 11 October (Leda on very wet soils; Prof. Marchal, or occasionally Stella, on relatively wet soils; occasionally Prof. Marchal or Leda on moist or very moist soils).

Cereals reach the D-E stage (Feekes-Keller-Baggiolini scale) before the winter, i.e., 1-2 tillers, 3-4-5 leaves, 7-8 cm height, and by early March are at the E-F stage (2-3 tillers, 7-9 cm height). By the end of April the wheat has 30-45 (-75) tillers per m of row.

At the D-stage of the cereal (before the winter) blackgrass has 1-3 leaves and is 2-5 cm high. At the (E-) F stage at the end of the winter, the older blackgrass has 2-4 tillers with 3-5 (-10) leaves and is 3-7 cm high; young blackgrass plants have 2-4 leaves. In June, the blackgrass has 40-445 inflorescences per m^2.

Weeds were counted in 16 (25 x 25 cm squares) per plot, and cereal tillers and stubbles along 5 x 1 m rows, per plot.

All experiments were incomplete Latin squares. Treatments were high-volume (750 l/ha), 3 kg/cm^2 pressure and wide nozzle-opening. Control plots were sprayed after weed-counts at the H stage with ioxynil-Na (750 g/ha) or with ioxynil-Na and mecoprop-K (0·4 - 0·5 kg/ha + 1·5 kg/ha).

RESULTS

The results of the experiments giving inadequate weed-control or too much crop-damage cannot be shown here but may be obtained from the References.

After spring treatment with grass-killing herbicides, it was observed that certain urea derivatives caused more crop-damage on moist sandy loams than on heavier, drier soils, although blackgrass is not better controlled. This is so for monolinuron (0·5 kg/ha), fenuron/phenylurea mixtures (0·7 - 1·05 kg/ha fenuron with 0·2 - 0·3 kg/ha phenylurea) and also for buturon (1·5 kg/ha) especially when mixed with cycluron, much more soluble in water. Even fluometuron is not without danger.

Metoxuron, at 4 kg/ha was ineffective against annual monocotyledons and dicotyledons after the winter 1966-7 but, by contrast, after the winter 1967-8 results with blackgrass (though not _Matricaria recutita_) were comparable to those obtained with the simazine/methoprotryne mixture (0·2 + 0·35 kg/ha).

Chlorobromuron (1 kg/ha), lenacil (0·750 kg/ha) and neburon (3 kg/ha) applied in spring gave insufficient control of blackgrass and dicotyledons.

The most successful treatments were pre-emergence neburon or methabenzthiazuron, eventually followed in spring by methabenzthiazuron or simazine-methoprotryne (Tables 1 and 2). They avoided the wheel-damage which was inevitable in autumn post-emergence spraying under these conditions of soil and climate, and gave good control of annual grasses and dicotyledons. Neburon (2·5 kg/ha) was safe and effective in several winter cereals. Methabenzthiazuron was completely safe at 1·5 - 3·0 kg/ha and could be used again in spring at 1·5 kg/ha.

Adding lenacil (0·3 kg/ha) to neburon (1.5 kg/ha) improved its activity against blackgrass, but increasing the dose of lenacil damaged winter wheat.

With the simazine/methoprotryne mixture in spring, the following triazines can be used pre-emergence in winter wheat: GS 13529, 2-chloro-4-ethyl-amino-6-t. butylamino-1,3,5-triazine (0·3 kg/ha), terbutryne (1·5 kg/ha), or GS 13529/terbutryne mixtures (0·15 + 0·6 kg/ha or 0·2 + 0·4 kg/ha) and simazine/terbutryne (0·2 + 0·4 kg/ha or, better still, 0·15 + 0·6 kg/ha). Above 0·3 kg/ha pre-emergence, simazine is more toxic than GS 13529 to winter wheat.

BV 201, 1-(3,4-dichlorophenyl)-3-methyl-2-pyrrolidinone at 2·5-5 kg/ha performs well when used pre-emergence in winter wheat and followed by simazine/methoprotryne in spring.

Nitrofen used pre-emergence is a good grass-killer but its safety-margin in winter wheat is small. Its inadequate control of _Matricaria recutita_ and even worse

Table 1.

Weed control by pre-emergence applications combined with spring treatments in winter wheat on wet sandy loam. (Grouped experiments from the same field)

Treatment 16/17.10.67 (pre-em.)	kg./ha.	8/12.3.68 (F).	kg./ha.	Weeds % of untreated (19.4.68) Alo. myo.	Poa ann.	Ran. sar.	Mat. rec.	Ste. med.	Aph. arv.	Alo.myo. % ears 15.5.68
neburon	2.5	-	-	49	22	3	0	0	0	61
-	-	simazine+ methoprotr.	0.2 0.35	23	8	50	2	3	2	52
tri-allate	1.2	simazine+ methoprotr.	0.2 0.35	13	2	36	4	0	1	28
simazine	0.3	simazine+ methoprotr.	0.2 0.35	9	0	45	0	0	0	11
GS.13529	0.3	simazine+ methoprotr.	0.2 0.35	6	0	14	0	0	0	19
terbutryne	1.5	simazine+ methoprotr.	0.2 0.35	2	0	2	7	0	0	10
GS.13529+ terbutryne	0.15 0.6	simazine+ methoprotr.	0.2 0.35	9	0	12	0	0	0	17
GS.13529+ terbutryne	0.2 0.4	simazine+ methoprotr.	0.2 0.35	5	0	17	0	0	0	12
simazine+ terbutryne	0.15 0.6	simazine+ methoprotr.	0.2 0.35	5	0	7	0	0	0	10
simazine+ terbutryne	0.2 0.4	simazine+ methoprotr.	0.2 0.35	10	0	19	0	0	0	14
neburon	2.5	simazine+ methoprotr.	0.2 0.35	7	1	2	0	0	0	9
neburon	2.5	methabenz.	1.5	10	0	0	0	0	0	12
methabenz.	1.5	methabenz.	1.5	6	0	0	0	0	0	10
benzthiaz.	5.0	methabenz.	1.5	2	0	0	0	0	0	1
methabenz.	3.0	-	-	9	4	1	0	2	0	3
OCS.21693	5.0	simazine+ methoprotr.	0.2 0.35	4	1	2	0	1	0	14
ACP.D-497+ linuron	2.5 0.35	-	-	4	5	6	0	1	0	4

Abbreviations :-

Herbicides

Methoprotr. = Methoprotryne
Methabenz. = Methabenzthiazuron
Benzthiaz. = Benzthiazuron

Weeds

Alo. myo. = Alopecurus myosuroides
Poa ann. = Poa annua
Ran. sar. = Ranunculus sardous
Mat. rec. = Matricaria recutita
Ste. med. = Stellaria media
Aph. arv. = Aphanes arvensis

Table 2

Weed control with methabenzthiazuron in winterwheat

(Leda, sown 11.10.67, on wet sandy loam)

Treatment Stage	Date	kg/ha	Weeds : % of untreated on 19.4.68 Alo. myo.	Poa ann.	Mat. rec.	Ste. med.	Ran. sar.	Aph. arv.	Spe. arv.	Alo. myo. % ears 15.8.68.
Pre-emergence	16.10.67	1·5	35	14	1	2	9	0	0	32
Pre-emergence	16.10.67	3·0	4	2	0	1	1	0	0	5
D-stage	17.11.67	3·0	6	3	0	0	0	0	0	12
F-stage	8.03.68	3·0	4	1	0	1	2	0	0	16
F-stage	8.03.68	4·5	1	0	0	0	1	0	0	10
Pre-emergence and D-stage		1·5 and 1·5	4	0	0	0	0	0	0	11
Pre-emergence and F-stage		1·5 and 3·0	2	0	0	0	0	0	0	3
Pre-emergence and D-stage		3·0 and 1·5	2	0	0	0	0	0	0	1
Pre-emergence and F-stage		3·0 and 3·0	1	0	0	0	0	0	0	0
D and F-stage		1·5 and 1·5	5	0	0	0	0	0	0	15
D and F-stage		3·0 and 1·5	2	0	0	0	0	0	0	5
Untreated			100	100	100	100	100	100	100	100

Abbreviations:

Alo. myo. = Alopecurus myosuroides
Poa ann. = Poa annua
Mat. rec. = Matricaria recutita
Ran. sar. = Ranunculus sardous
Aph. arv. = Aphanes arvensis
Spe. arv. = Spergula arvensis
Ste. med. = Stellaria media

of Stellaria media and Ranunculus sardous (hairy buttercup) is a great disadvantage, necessitating further spring treatment against dicotyledons.

The following herbicides are promising when used pre-emergence in winter wheat: benzomarc (1·5kg/ha), chlorobromuron (1·5 kg/ha) and OCS 21693, methyl-2,3,5,6-tetrachloro-N-methoxy-N-methylterephthalamate (5 kg/ha).

Benzthiazuron (above 4 kg/ha), buturon (1 kg/ha) and ACP D-497, N [1 or 2-(3a,4,5,6,7a-hexahydro)-4,7-methanoindanyl] -N', N'-dimethylurea at 1-2 kg/ha showed themselves too toxic to winter wheat, while metoxuron (3-6 kg/ha) was not sufficiently active after pre-emergence application.

CONCLUSION

On wet sandy loams in a maritime climate, pre-emergence herbicides, e.g., neburon or methabenzthiazuron are preferred. They are effective against annual grasses and dicotyledons, and have a long enough residual effect without damaging winter cereals. After the winter a second application at stage (E)-F of winter wheat is sometimes required against late-germinating blackgrass and other weeds. The spring treatment can be methabenzthiazuron or other grass-killers, such as simazine/methoprotryne or simazine/terbutryne. Spring application is often required in early-sown crops, especially after a mild winter.

In winter barley sown very early, only the pre-emergence treatment is possible, using methabenzthiazuron (1·5 kg/ha) or neburon (2.5 kg/ha). On heavier soils this crop tends to lodge and is encouraged to do so by many grass-killing herbicides applied in spring. Moreover, in spring the blackgrass is too large to be affected by herbicides, but plants affected by the pre-emergence application are more easily dominated by the crop.

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