Group C (high tolerance) - Elsa, Swallow, Union, Topper, Pioneer.

The dose response curves for Proctor, Rika and wild oats assessed in a greenhouse experiment proved almost identical for Proctor and wild oats, while Rika showed much higher tolerance than either wild oats or Proctor. This result was confirmed by field observations, and it appears unlikely that selective control of wild oats will be practicable in Proctor barley or in varieties of a similar low tolerance. In a few isolated cases, however, even Proctor showed a high degree of tolerance to barban and good selective wild oat control was obtained. Research into the reasons for the variation in barban tolerance of barley under different environment conditions is in progress.

Evidence on the inherent nature of the tolerance factor was obtained from an experiment with Proctor, Rika and Proctor x Rika cross* (F.4 unselected). The cross gave an intermediate response between the clearly different responses of the parents.

Two types of barban toxicity have been observed on barley. The typical effect is a stunting of the main shoot but this may be preceded by a yellow mottling leading to "scorch". The occurrence of scorch depends on variety and environment as well as on dose. It is interesting to note that the relative susceptibility of Proctor (or Provost) and Rika (or Herta) to the scorch effect is the reverse of their sensitivity to the typical physiological barban stunting. The former follows the pattern as described by Hayes (1959) for the DDT susceptibility of these varieties. Details and implications of the authors' work on this aspect will be published elsewhere.

A field experiment in which barban was sprayed on 6 varieties of winter wheat did not give conclusive evidence of differences in tolerance between these varieties.

Interaction between barban and plant growth regulators

Several workers observed in 1959 an antagonistic interaction between barban and 2,4-D when applied in one spray. Such an admixture of 2,4-D considerably reduces the activity of barban. The authors tried to explain the mechanism of this antagonism by the assumption that a growth regulating substance, by temporarily inhibiting meristematic activity, does not enable barban to exert its specific phytotoxic effect in the growing point. Some of the barban was assumed to be detoxicated by the time normal meristematic activity started again. On the basis of this theory the authors expected to find marked antagonism even when the growth regulator was applied a few days before barban but not if it was applied several days later. A possible relationship was also expected between the degree of polar translocation of the hormone antagonist to the meristematic growing point and the subsequent reduction in barban activity. Thus, 2,3,6-trichlorobenzoic acid was expected to be the strongest, mecoprop and MCPB to be the weakest antagonists. The problem is of considerable practical interest in view of the possibility of a combined barban-hormone treatment.

The experimental results obtained can be summarised as follows:-

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* The authors gratefully acknowledge the help given by Dr. Bell, Director, Plant Breeding Institute, Cambridge.

Time of application of "hormone" antagonist

A greenhouse experiment (Oats and Barley) was carried out, using a standard barban treatment and treating the plants in addition with 2,4-D or 2,3,6-TBA at certain intervals before and after the barban treatment as well as applying the chemicals together at the same time. Figure 4 represents the overall result of this experiment. It shows reductions in barban activity even when the growth regulators were applied up to 4 days before barban but no antagonism (in actual fact some activation) is indicated when the growth regulator was applied after barban.

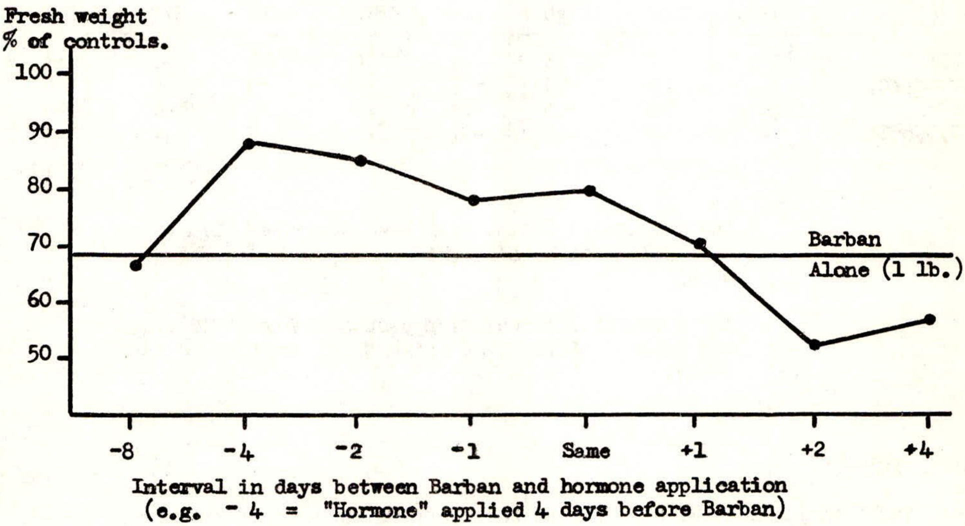

FIG. 4. EFFECT OF VARIATION IN TIME OF "HORMONE" SPRAY AS COMPARED WITH TIME OF BARBAN APPLICATION

Relative antagonistic activity of some commercial hormone herbicides

In this series of field experiments (wheat and barley infested with Avena fatua) several hormone weedkillers were applied mixed with barban and also as separate sprays applied one or two weeks after barban. The mean result of the 6 experiments is presented in table III. It shows a) 2,3,6-TBA/MCPA.to be the strongest antagonist followed by mecoprop and MCPA. A commercial formulation of MCPB (containing a small amount of MCPA) did not antagonise barban, and b) that none of the growth regulating herbicides antagonised barban if applied one week or later after barban.

TABLE III. RELATIVE ANTAGONISTIC ACTIVITY OF DIFFERENT GROWTH REGULATING HERBICIDES ON WILD OAT CONTROL

(Mean of 6 experiments)

\+ indicates per cent increase in barban activity
\- indicates per cent decrease in barban activity

Hormone dose oz/ac			Time and dose level of hormone application					
			With barban		1 week after		2 weeks after	
	High	Low	High	Low	High	Low	High	Low
MCPB*	18	9	+3	+1	0	0	-1	-4
mecoprop	38	19	-13	-17	-1	-3	-2	0
MCPA	20	10	-13	-12	+1	-4	-1	-2
2,3,6-TBA^{x}	4	2	-55	-51	+1	+2	+1	-3

* the commercial formulation used contained MCPA which was applied at 3 oz/ac (high dose) and 1½ oz/ac (low dose)

the commercial formulation used contained MCPA which was applied at 12 oz/ac (high dose) and 6 oz/ac (low dose).

Spray Volume

Three standard field experiments were carried out in 1960 to confirm previous indications that the rate of barban needed to give a certain degree of wild oat control would have to be raised with increasing spray volume. In each of these experiments 4 doses of barban were sprayed in 3.3, 10, 30 and 90 gal/ac. Each experiment had 3 replications. Blind scoring for crop depression 2 months after treatment and for wild oat control (reduction in panicle number and size) at harvest time gave the results shown in Table IV.

TABLE IV: EFFECT OF SPRAY VOLUME ON THE TOXICITY OF BARBAN

(Average result of 3 field experiments)

Barban dose	Per cent reduction of cereal growth Gal/ac				Per Cent reduction of Wild oats Gal/ac			
	3.3	10	30	90	3.3	10	30	90
16 oz	56	63	63	42	66	57	68	73
8 oz	32	37	29	16	67	62	71	73
4 oz	16	20	20	10	64	77	71	65
2 oz					49	53	44	25
Average	35	40	37	23	61	62	64	59

This table shows that on wheat and barley at all doses, and on wild oats at 2 oz (the only critical dose) application at 90 gal/ac gave substantially lower activity than application at lower volumes, and that differences between 3.3, 10 and 30 gal/ac were small.

At the lower spray volumes, where a temporary check to crop growth was more marked, the degree of wild oat control appears to have been influenced by reduced crop competition. The data obtained from the lowest volume (3.3 gal/ac) are rather erratic owing to difficulties in applying the herbicide evenly at such low volumes. Similar variation occurred in results obtained in several aircraft experiments with barban.

Work on other factors

Directional Spraying Following a suggestion that spraying at an angle (nozzles turned to spray at 45°) would give better coverage and therefore better results than vertical spraying, field experiments were carried out but failed to show any measurable difference.

Split application It was thought that splitting the standard dose of barban into two separate applications, at one or two week intervals, might increase the kill of wild oats obtained, by ensuring that all plants would be sprayed at a susceptible stage of growth. Four experiments were sprayed on sites infested with wild oats and percentage reduction in panicle size and number was estimated at harvest. The results obtained on average for all sites are shown in Table V

TABLE V. EFFECT OF SPLIT APPLICATION OF BARBAN

(Each figure is the mean of 8 plots)

Dose (oz/acre)*		Times of application	% Control of Wild oats	
Full Rate	Half Rate		Full Rate	Half Rate
6	3	Early	68	59
6	3	Medium	76	58
6	3	Late	75	63
4 + 2	2 + 1	Early + Medium	79	54
4 + 2	2 + 1	Early + Late	76	57
4	2	Early	54	41

* These doses were used in the two experiments on barley. Two-thirds of these doses were used in the experiments on spring wheat.

The figures show that no consistent advantage has been obtained to justify the additional cost of split application.

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THE EFFECT OF BARBAN ON THE YIELD OF WINTER WHEAT, SPRING WHEAT AND BARLEY

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Summary: The paper presents the results of 21 replicated field experiments. Barban was applied in all experiments at several doses and in most experiments at three to four different dates. The yield of winter wheat was significantly increased in wild oats or black grass infested sites when barban was applied between November and March. This crop, however, appears to pass through a rather sensitive development stage in March and in absence of wild oats slight yield depressions were observed when barban was applied at this stage. Best control of Avena fatua, Avena ludoviciana and Alopecurus myosuroides (blackgrass) was obtained in winter wheat by spraying barban between November and February.

Spring wheat and spring barley infested with Avena fatua frequently responded with a substantial yield increase to barban applied at 4 oz and 6 oz/ac respectively. Highest yields were obtained from spraying wild oats at the 1 to 1½ leaf stage, although the degree of control of wild oats was found to be somewhat better when spraying was carried out a few days later at the 1½-2½ leaf stage. In one barley experiment a yield increase of 20-30 per cent was found to occur at seven out of ten of the application dates, although wild oat control in this experiment reached 80 per cent at only one date of application.

INTRODUCTION

In 1960 a series of yield experiments were carried out to obtain evidence on a) the effect of barban on the yield of wild oat-free winter wheat and winter barley when applied at different development stages, b) the yield response of winter wheat (infested with Avena fatua, Avena ludoviciana, or Alopecurus myosuroides) to barban treatments, and c) the yield response of spring wheat and spring barley (different degrees of infestation with Avena fatua) to barban applied at different times.

The work included the first experiment with barban on Avena ludoviciana and Alopecurus myosuroides. Very good control of these important weeds in winter wheat was obtained from late autumn and winter treatments with 4-8 oz/ac. This interesting aspect is, however, not the objective of this paper and will be discussed elsewhere.

Details of results, including statistical data, for each individual yield experiment are presented as an appendix to this paper. The actual paper only contains simplified tables indicating the more important results.

METHODS AND MATERIALS

The evidence presented is based on 21 yield experiments (over 2000 individual yield plots) carried out on farms in east and central parts of England. The preparation used was an 11.8 per cent w/v commercial formulation of barban.* Each treatment in each experiment was replicated at least 4 times, and in most experiments 6-12 times. The experiments were laid out as simple randomised blocks or as split plots, the main plots being doses and sub plots time of application. The plot size varied between 12 and 20 sq yd. Barban was applied with an "Oxford sprayer" boom fitted to a knapsack sprayer. The spray volume was 19 gal/ac.

RESULTS

Effect of time of barban application on the yield of wild-oat-free winter wheat and winter barley

Three experiments were carried out on wild-oat-free winter wheat and one on winter barley (Details in appendix Expts: 1-4). Barban was applied at 2,4, 6 and 8 oz/ac at four dates of spraying from December 1959 until April 1960.

Winter barley (Expt: 4) showed no visual effects at any date or dose. The significance of the yield data from this uneven crop is low. Winter wheat proved sensitive, even to the proposed practical rate of 4 oz/ac, when treated in the middle of March. A significant yield reduction at this rate, however, only occurred in one of the three experiments (See Table I). No explanation has yet been found for the rather sensitive growth stage of winter wheat in March; further work on this aspect is planned.

TABLE I. MEAN YIELDS OF WINTER WHEAT AS PER CENT OF CONTROLS - WILD-OAT-FREE SITES

(Mean of 3 experiments)

Application Date	2 oz	4 oz	6 oz	8 oz
December (Second week)	97.2	103.2	100.9	98.3
January (Last week)	97.7	103.2	95.5	89.5
March (Third Week)	99.0	90.6	79.9	67.4
April (First week)	97.4	99.9	92.9	86.6

* As "Carbyne"

Effect of barban on wild oat or blackgrass infested winter wheat

Winter wheat infested with Avena fatua

The germination of Avena fatua in winter wheat spreads from autumn until April and its survival through the winter in eastern counties is largely dependant on the severity of the winter. The authors find it therefore very difficult to generalise from the evidence as to the best time for application, especially since the mild winter 1959/60 led to almost complete survival of autumn germinating Avena fatua and subsequent heavy infestations of winter wheat crops. A repetition of the experimental work therefore is necessary before firm recommendations can be made. The evidence available so far indicates that the best results (both for wild oat control and cereal yields) are obtained when barban is applied between November and March, and not later. The yield results obtained from application within this period are shown in table II (for details on other spraying dates see appendix Expts: 5-9).

TABLE II. RESULTS (AT 4 OZ ONLY) FROM 5 WINTER WHEAT EXPERIMENTS INFESTED WITH AVENA FATUA

Site	Application date	Yield as per cent of controls	Untreated yield cwt/ac	Yield increase cwt/ac	Degree of wild oat infestation
Eaton	Nov 17th	104.9	36.7	1.7	Medium
Eaton	Dec 17th	112.2	36.7	4.4	Medium
Didcot	Dec 17th	114.8	28.0	4.1	Heavy
Kingston	Dec 16th	123.3	35.4	8.3	Medium
Chesterford	March 22nd	108.8	41.8	3.7	Medium
Castle Camps	March 10th	110.1	19.6	2.0	Heavy

Winter wheat infested with Avena ludoviciana

One experiment near Oxford and one at Chesterford Park were carried out on almost pure stands of Avena ludoviciana. The results obtained with the 4 oz are summarised in table III. (For yield data from other doses see appendix Expts: 10 and 11).

TABLE III. RESULTS (AT 4 OZ ONLY) FROM 2 WINTER WHEAT EXPERIMENTS INFESTED WITH AVENA LUDOVICIANA

Site	Application date	Yield as per cent of controls	Untreated yield cwt/ac	Yield increase cwt/ac	Degree of wild oat infestation
East Hanney	Jan 12th	191.9	18.3	16.8	Heavy
Chesterford	Feb 5th	151.8	23.2	12.0	Heavy
Chesterford	March 15th	148.7	23.2	11.3	Heavy

All applications (winter on both sites, and March applications at Chesterford Park) gave a remarkable increase in yield which has not been reached in any *Avena fatua* infested crops. It must however be pointed out that the infestations were heavy. The yield depressions observed by March applications on wild-oat-free winter wheat were more than outweighed by the increase resulting from wild oat control, although a temporary depressing effect could be observed on the crop for several weeks following the spraying in March.

Winter wheat infested with blackgrass (Alopecurus myosuroides)

One yield experiment on winter wheat heavily infested with blackgrass was sprayed at 3 dates, November, December, and March. The stage of growth of the blackgrass in November and December was 1-1½ and 2½-3 leaves respectively. The late application gave only very limited control and was not harvested, while good control was obtained from the earlier applications. The yield results of the two earlier treatments with 4 oz are presented in Table IV (further details in the appendix Expt: 12). Experimental work on blackgrass control with barban will continue in the following season.

TABLE IV. RESULTS (AT 4 OZ ONLY) FROM ONE WINTER WHEAT EXPERIMENT INFESTED WITH BLACKGRASS (ALOPECURUS MYOSUROIDES)

Site	Application date	Yield as per cent of controls	Untreated yield cwt/ac	Yield increase cwt/ac	Degree of blackgrass infestation
Chalgrove	Nov. 20th	141.8	17.7	7.4	Heavy
Chalgrove	Dec. 17th	132.1	17.7	5.7	Heavy

Effect of time of application and barban dose on the yield of spring wheat and spring barley (different degrees of wild oat infestation)

Spring wheat

Five experiments were carried out on spring wheat with barban applied at three dates. Table V shows the results obtained at our tentatively recommended dose of 4 oz/ac. (For results with other doses see appendix Expts: 13-17).

TABLE V. SUMMARISED YIELD DATA FROM SPRING WHEAT EXPERIMENTS 1960 SPRAYED WITH 4 OZ BARBAN

Site	Yields as per cent of controls — Stage of wild oat (leaves)			Control Yield cwt/ac	Yield increase in cwt/ac			Wild oat infestation
	1-1½	1½-2½	More Than 2½		Time I	Time II	Time III	
Whittlesford	112.8	103.2	117.2	16.0	2.0	0.5	2.8	Very heavy (V. poor crop)
Hadstock	113.9	112.9	110.1	32.2	4.5	4.2	3.3	Medium
Haverhill	108.8	100.0	89.0	18.6	1.6	-	-2.1	Medium
Castle Camps I	103.4	102.1	98.1	18.5	0.6	0.4	-0.4	Very light
Castle Camps II	97.8	96.3	97.4	36.4	-0.8	-1.4	-1.0	No wild oats

The earlier treatment has in all except one experiment given the highest yield, probably due to a substantial reduction in competition from wild oats in early development stages of the crop. A slight reduction in yield is indicated in the wild-oat-free experiment at Castle Camps.

Spring barley

The results obtained from the tentatively recommended rate of 6 oz/ac at three dates of application are shown in the table VI (for details of all three rates see appendix Expts: 18-21).

TABLE VI. SUMMARISED YIELD DATA FROM SPRING BARLEY EXPERIMENTS 1960
SPRAYED WITH 6 OZ/AC BARBAN

Site	Yield as per cent of controls			Control yield cwt/ac	Yield increase in cwt/ac			Wild oat infestation
	Stage of wild oat (leaves)							
	1-1½	1½-2½	More than 2½		Time I	Time II	Time III	
Boxworth	111.9	99.7	103.5	20.1	2.4		0.7	Heavy (poor crop)
Chesterford Park	124.6	105.9	110.6	18.7	4.6	1.1	1.9	Heavy (poor crop)
Castle Camps	111.5	110.1	104.0	34.5	4.0	3.5	1.4	Heavy
Chesterford	119.8	115.6	111.1	25.5	5.0	4.0	2.8	Heavy
Sewards End	130.0	120.7	125.2	26.2	7.8	5.4	6.6	Very heavy

The yield results with barley agree with those in spring wheat indicating the best yield response from early applications, in spite of the fact that wild oat control may be somewhat better when spraying is carried out a few days later. Figures 1 and 2 illustrate the relationship between wild oat control, barley yields, and application date. The first diagram shows the percentage of wild oats remaining, after an application of 6 oz of barban at ten dates of application at three day intervals, from the 1-4½ leaf stage, while the second diagram presents the barley yields obtained from each date of application in the same experiment.

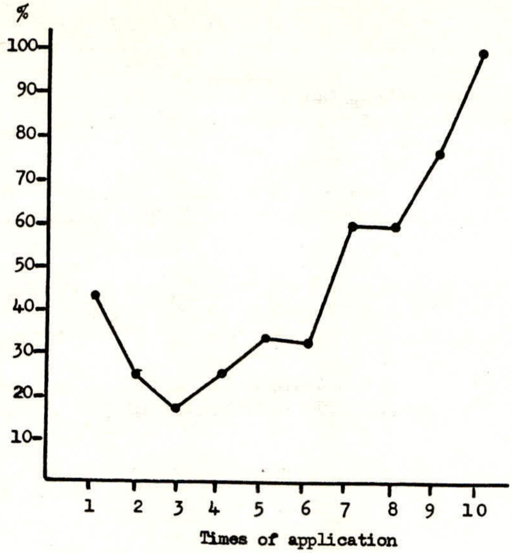

FIG. 1. PERCENTAGE OF WILD OATS SURVIVING IN BARLEY AFTER AN APPLICATION OF BARBAN

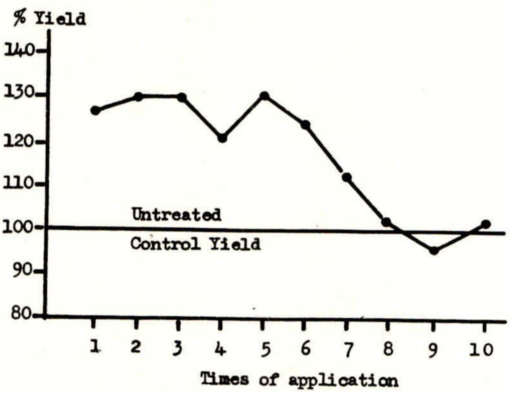

FIG. 2. BARLEY YIELD AS PER CENT OF CONTROLS

It is interesting to note that the barley yield was increased by approximately 20-30 per cent at seven of the ten application dates, in spite of the fact that 80 per cent wild oat control was only obtained at one of these dates.

DISCUSSION

Perhaps the most striking feature of the yield data obtained is the frequently considerable yield increase resulting from wild oat control with barban. The yield of cereal crops appears to be substantially increased even if only a part of the wild oat infestation was reduced. The authors realise that competition for water may have been particularly pronounced in the dry season of spring 1960.

The development stage of the cereal crop, with the exception of winter wheat in March, does not appear to be very critical as far as tolerance to barban is concerned.

Although on the basis of two years evidence 4 oz and 6 oz/ac of barban for wheat and barley respectively can be regarded as the optimum doses, no real objection can be seen for a standard dose of 5 oz/ac for both crops.

In general highest yields were obtained when spraying was carried out right at the beginning of the period when wild oats are sensitive (1-2½ leaf stage period).

APPENDIX

Experiment No. 1: Winter wheat var. Cappelle No wild oats

(Site:- Stumps cross) Control yield = 25.6 cwt/ac (8 reps/treatment)

Time of Application	Yield as per cent of control Treatments (oz of barban)			
	2	4	6	8
December 9th	99.7	106.1	102.7	97.7
January 25th	102.4	105.9	101.5	101.9
March 21st	100.9	95.7	85.9	77.3
April 4th	99.5	102.7	96.7	97.0
Statistical data (Split plot design) for P0.05	Sig. diff. for treatments at one time = 14.6 Sig. diff. for one treatment at different times = 9.2			

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 2: Winter wheat var. Cappelle. No wild oats

(Site:- Pamplsford) Control yield = 38.4 cwt/ac (8 reps/treatment)

Time of Application	Yield as per cent of control Treatments (oz of barban)			
	2	4	6	8
December 21st	93.8	105.7	100.2	99.9
January 25th	95.7	103.7	95.4	88.0
March 21st	99.9	97.1	87.0	68.7
April 4th	96.1	98.6	93.3	89.9
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 11.9 Sig. diff. for one treatment at different times = 7.4			

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 3: Winter wheat var. Cappelle. No wild oats

(Site:- Swaffham) Control yield = 27.9 cwt/ac (8 reps/treatment)

Time of Application	Yield as per cent of control Treatments (oz of barban)			
	2	4	6	8
December 21st	98.0	97.8	99.8	97.4
February 2nd	95.2	100.0	89.7	78.6
March 22nd	96.2	79.1	66.8	56.4
April 4th	96.7	98.6	91.7	82.9
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 11.8 Sig. diff. for one treatment at different times + 9.4			

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used,

Experiment No. 4: Winter barley var. Pioneer. No wild oats

(Site:- Wilbraham) Control yield = 17.4 cwt/ac (8 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)			
	2	4	6	8
December 2nd	107.1	97.6	88.7	92.6
December 21st	98.0	90.8	95.0	97.6
March 22nd	101.3	91.5	99.2	80.3
April 4th	110.1	95.4	101.4	106.4
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 21.5 Sig. diff. for one treatment at different times = 16.6			

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 5: Winter wheat var. Cappelle. Medium infestation of *Avena fatua*

(Site:- Eaton) Control yield = 36.7 cwt/ac (4 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2	4	8
November 17th December 17th	100.9 111.3	104.9 112.2	106.5 110.7
Statistical data	Sig. diff. (P0.05) = 18.4		

Experiment No. 6: Winter wheat var. Cappelle. Heavy infestation of *Avena fatua*

(Site:- Didcot) Control yield = 28.0 cwt/ac (4 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2	4	8
December 17th	122.7	114.8	131.2
Statistical data	Sig. diff. (P0.05) = 19.4		

Experiment No. 7: Winter wheat var. Cappelle. Medium Infestation of *Avena fatua*

(Site:- Kingston) Control yield = 35.4 cwt/ac (4 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2	4	8
December 16th	115.5	123.3	109.6
Statistical data	Sig. diff. (P0.05) = 23.9		

Experiment No. 8: Winter wheat var. Cappelle. Medium infestation of wild oats

(Site:- Chesterford) Control yield = 41.8 cwt/ac (6 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz barban)		
	2	4	8
March 22nd April 6th May 9th	108.3 109.4 100.9	108.8 98.3 100.5	97.1 105.9 99.9
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 12.3 Sig. diff. for one treatment at different times = 13.0		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 9: Winter wheat var. Cappelle. Heavy infestation of wild oats

(Site:- Castle Camps) Control yield = 19.6 cwt/ac (6 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	$2\frac{1}{2}$	4	8
March 10th March 31st May 9th	112.5 122.2 90.7	110.1 127.7 93.4	78.8 105.7 106.4
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 31.2 Sig. diff. for one treatment at different times = 17.1		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 10: Winter wheat var. Cappelle. Very heavy infestation of Avena ludoviciana

(Site:- East Hanney) Control yield = 18.3 cwt/ac (4 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2	4	8
January 12th	174.3	191.9	191.6
Statistical data	Sig. diff. (P0.05) = 59.9		

Experiment No. 11: Winter wheat var. Cappelle. Heavy infestation of Avena ludoviciana

(Site:- Chesterford Park) Control yield = 23.2 cwt/ac (3 reps/treatment)

Time of Application	Yields as per cent of controls Treatments (oz of barban)		
	2	4	8
February 5th	130.5	151.8	137.7
March 15th	143.8	148.7	105.2

This experiment was incomplete so no analysis was carried out.

Experiment No. 12: Winter wheat var. Cappelle. Heavy infestation of Blackgrass

(Site:- Chalgrove) Control yield = 17.7 cwt/ac (4 reps/treatment)

Time of Application	Yields as per cent of control Treatment (oz of barban)		
	2	4	8
November 20th	145.9	141.8	142.5
December 17th	108.1	132.1	143.3
Statistical data	Sig. diff. (P0.05) = 44.3		

Experiment No. 13: Spring wheat var. Koga 11. Very heavy infestation of wild oats

(Site:- Whittlesford) Control yield = 16.0 cwt/ac (12 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2½	4	8
April 8th April 15th April 22nd	105.4 103.2 89.6	112.8 103.2 117.2	106.2 79.4 103.2
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 14.2 Sig. diff. for one treatment at different times = 10.9		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 14: Spring wheat var. Jufy 1. Medium infestation of wild oats

(Site:- Hadstock) Control yield = 32.2 cwt/ac (12 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2½	4	8
April 11th April 20th April 27th	109.6 109.1 109.9	113.9 112.9 110.1	107.3 104.9 104.4
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 5.1 Sig. diff. for one treatment at different times = 4.7		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 15: Spring wheat var. Atle. Medium infestation of wild oats

(Site:- Haverhill) Control yield = 18.6 cwt/ac (12 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2½	4	8
April 27th May 4th May 11th	102.7 99.7 89.8	108.8 100.0 89.0	108.6 105.9 94.8
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 10.5 Sig. diff. for one treatment at different times = 9.3		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 16: Spring wheat var. Koga 11. Very light infestation of wild oats

(Site:- Castle Camps 1) Control yield = 18.5 cwt/ac (12 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2½	4	8
April 20th April 27th May 4th	101.8 98.0 97.7	103.4 102.1 98.1	92.4 87.6 103.7
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 5.7 Sig. diff. for one treatment at different times = 5.3		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 17: Spring wheat var. Jufy 1. No wild oats

(Site:- Castle Camps 11) Control yield = 36.4 cwt/ac (12 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	2½	4	8
April 16th April 25th May 2nd	98.1 98.6 95.6	97.8 96.3 97.4	90.8 85.9 87.7
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 4.9 Sig. diff. for one treatment at different times = 4.6		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 18: Spring barley var. Rika. Heavy Infestation of wild oats

(Site:- Boxworth) Control yield = 20.1 cwt/ac. (7 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	4	6	8
May 5th May 16th May 23rd	101.0 102.5 102.4	111.9 99.7 103.5	115.4 99.5 100.5
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 18.6 Sig. diff. for one treatment at different times = 14.7		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 19: Spring barley var. Rika. Heavy infestation of wild oats

(Site:- Chesterford Park) Control yield = 18.7 cwt/ac (12 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	4	6	8
April 15th April 22nd April 29th	106.3 106.0 103.5	124.6 105.9 110.6	113.6 91.7 105.3
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 13.3 Sig. diff. for one treatment at different times = 10.6		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 20: Spring barley var. Herta. Heavy infestation of wild oats

(Site:- Castle Camps) Control yield = 34.5 cwt/ac (12 reps/treatment)

Time of Application	Yields as per cent of control Treatments (oz of barban)		
	4	6	8
April 21st April 29th May 9th	114.6 110.2 98.6	111.5 110.1 104.0	111.2 113.9 107.5
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 8.0 Sig. diff. for one treatment at different times = 7.5		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

Experiment No. 21: Spring barley var. Rika. Heavy infestation of wild oats

(Site:- Chesterford) Control yield = 25.5 cwt/ac (12 reps/treatment)

Time of Application	Yields as per cent of controls Treatments (oz of barban)		
	4	6	8
April 15th April 22nd April 29th	118.7 119.1 110.4	119.8 115.6 111.1	121.8 107.7 112.5
Statistical data (split plot design) for P0.05	Sig. diff. for treatments at one time = 10.2 Sig. diff. for one treatment at different times = 8.1		

For comparison with control (100 per cent) the sig. diff. for one treatment at different times should be used.

FIELD RESULTS ON THE RELIABILITY OF BARBAN FOR THE CONTROL OF WILD OATS IN CEREALS

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Summary: Performance and reliability of barban was assessed in 84 field trials in the 1960 crop season. Field trials consisted of development trials, ground and aircraft application, and farmer trials. Both the development and farmer trials illustrate that if wild oats are sprayed with barban when 70-80 per cent are in the $1\frac{1}{2}$-$2\frac{1}{2}$ leaf stage good control is achieved. Of the farmers who reported they were not satisfied with the results of their trials 72 per cent had sprayed either at an incorrect wild oat stage or at an incorrect dose. The farmer trials revealed that wild oat control below 70 per cent is unacceptable to the farmer. The general performance of barban in the 1960 trials is in line with the results obtained in the 1959 trials, even though the weather conditions experienced in each season were quite different.

INTRODUCTION

Following encouraging results of experiments with barban in 1959 it was decided to test the reliability of barban applied under very varied field conditions in 1960. With the knowledge that the stage of growth of wild oats was very critical for good control the work aimed at comparing the reliability of barban's performance under well controlled development field trials and under normal farming conditions.

The doses used were 6oz barban/ac for spring barley and 4oz barban/ac for spring and winter wheat, which were the ones tentatively recommended as a result of trials carried out in 1959. An additional aim of the 1960 work was to test the reliability of these rates.

I DEVELOPMENT TRIALS

The development trials comprised (a) Eighteen sites ranging from South of Oxford, through Northamtpon, Essex, Suffolk, Norfolk, to North Lincolnshire. Each of these sites was sprayed by ground machine with accurate doses of barban at a known and recorded correct stage of wild oat growth, that is when 70-80 per cent of the wild oats were in the $1\frac{1}{2}$-$2\frac{1}{2}$ leaf stage.

(b) Five sites in the vicinity of Cambridge, and one in Essex sprayed by aircraft at varied stages of wild oat growth.

MATERIALS AND METHODS

Chemical: An emulsifiable concentrate containing 11.8% w/v barban.*

* As "Carbyne"

Ground Application The Chesterford Logarithmic Sprayer was used to apply at each site (a) One logarithmic strip starting at 12oz barban/ac peak. (b) Constant doses of 4, 6 and 8oz barban/ac, each applied in strips 5 yd wide by 60 yd long. All the above treatments were applied in 18 gal of water/ac.

Aircraft Application: A helicopter was used to apply 4oz barban to spring wheat and 6oz barban to spring barley in 3 gal of water/ac. Aircraft application was made to 5 ac plots and was compared with the same dose applied by ground machine to a 5 x 60 yard strip in 18 gal of water/ac. A control strip was left at each site for comparison.

RESULTS

The results of the development trials are given in Tables I and II. Two assessments were made of all these sites during the season. At both, assessments of wild oat panicles above and below the crop were made. On some sites during the last assessment, counts of wild oat panicles were made and these are underlined in Table I. Although it was intended to make wild oat counts on all the sites during the last assessment, it was mostly found impossible owing to the effect of severe storms in July. Wild oat panicles below the level of the crop were greatly reduced in size and their presence varied from site to site. The number mainly depended on the number of wild oats germinating after spraying or which were past the 2½ leaf stage at spraying time. Stunted wild oats were always less or absent in the higher-dose plots.

TABLE I. PER CENT WILD OAT CONTROL ACHIEVED IN DEVELOPMENT TRIALS

GROUND MACHINE APPLICATIONS

SPRING BARLEY

Expt No.	County	Variety	W.O. density /sq yd	4oz	per cent control 6oz	8oz	12oz (log strip)
1	Oxford	Vada		85-90	95	98	98
2	Norfolk	Herta	20	88	95	99	99
3	Suffolk	Rika		75-80	95	98	98
4	Lincs	Rika		75-80	80	85-90	95
5	Lincs	Rika	13	76	74	89	93
6	Hunts	Rika		75	85-90	95	98
7	Lincs	Rika		75	85-90	95	98
8	Lincs	Rika	11	62	80	91	98
9	Lincs	Rika		60	85-90	98	98
10	Lincs	Rika	[illegible]	60	90-95	95	98
		range (as percentage)		60-90	74-95	85-98	93-99
		mean (as percentage)		73.2	87.2	94.5	97.3

Percentages underlined are based on actual wild oat counts

SPRING WHEAT TABLE I (Contd.)

Expt No.	County	Variety	W.O. density /sq yd	4oz	per cent control 6oz	8oz	12oz (log strip)
1	Lincs	Koga II		85-90	95	98	98
2	Lincs	Koga II		85-90	90	95	98
3	Suffolk	Koga II	11	92	95	99	99
4	Norfolk	Koga II		75-80	90-95	98	98*
5	Lincs	Jufy I	17	85	99	99	99
6	Lincs	Koga II		75	95	98	98
		range (as percentage)		75-92	90-95	95-99	98-99
		mean (as percentage)		83.8	95	97.8	98.5

WINTER WHEAT

Expt No.	County	Variety	W.O. density /sq yd	4oz	per cent control 6oz	8oz	12oz (log strip)
1	Lincs	Cappelle		90	95	95-98	98
2	Lincs	Mills Wonder		70	75-80	90	95

* Wild oat infestation sparse in all treatment plots

TABLE II PER CENT WILD OAT CONTROL ACHIEVED IN DEVELOPMENT TRIALS

AIRCRAFT APPLICATIONS

SPRING BARLEY - 6oz barban/ac

Site	Variety	Aircraft - 3 gal/ac per cent W.O. control	Land Machine - 18 gal/ac per cent W.O. control
1	Rika	80-85	90-95
2	Rika	Poor	Poor
		60-70 per cent wild oats beyond 2½ leaf stage	
3	Rika	Poor	Poor
		30-35 per cent wild oats beyond 2½ leaf stage	
4	Carlsberg	Poor	Poor
		30-35 per cent wild oats beyond 2½ leaf stage	

No effect on crop except from aircraft application at site 6 where slight depression recorded at first but not visible later.

* Percentages underlined are based on actual wild oat counts.

SPRING WHEAT - 4oz barban/ac

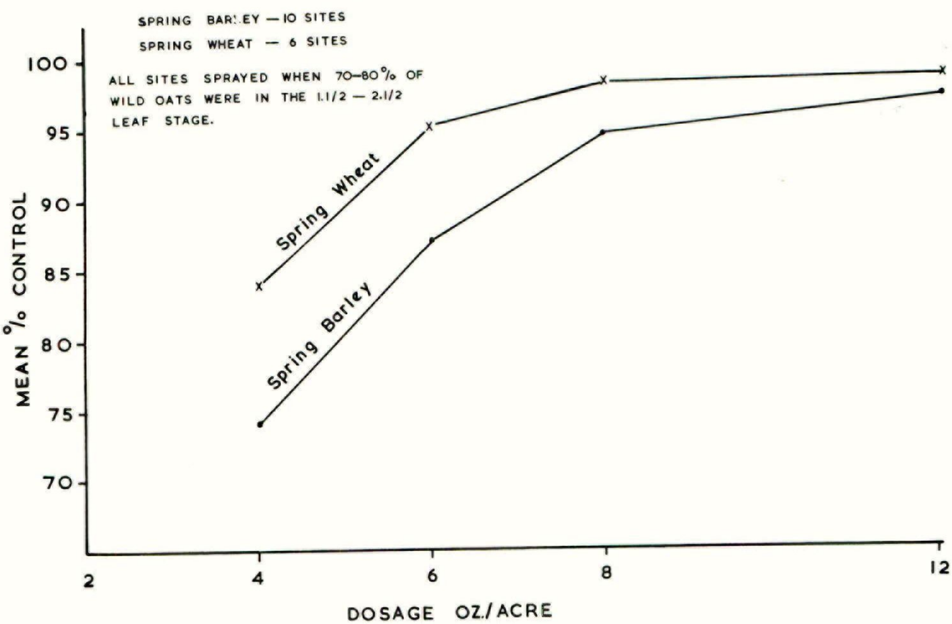
TABLE II (Contd.)

Site	Variety	Aircraft - 3 gal/ac per cent W.O. Control	Land Machine - 18 gal/ac per cent W.O. Control
5	Koga II	90	50
6	Koga II	85-90	60-70

No effect on crop except from aircraft application at site 6 where slight depression recorded at first but not visible later.

Figure I

BARBAN DEVELOPMENT TRIALS



Ground Application

The mean percentage control obtained at each dose used is shown in Figure 1. This clearly illustrates that the percentage wild oat control obtained at any dose is greater in spring wheat than in spring barley.

This is attributed to the greater competition exerted by the spring wheat crop. Winter wheat is not included on the graph since the stages of wild oat found in this crop early last spring varied from the one to four leaf stage. This was due to a large number of autumn-germinating Avena fatua surviving the winter. Winter wheat is therefore a more difficult problem than spring cereals, though it was found that autumn-germinated wild oats even in the 3 leaf stage were susceptible to barban in late March to early April.

A mean percentage control of wild oats of 86 per cent was obtained from all trial sites (see Figure 2). It can also be seen from Figure 2 that the percentage probability of obtaining 71-80 per cent control is 95 per cent.

Aircraft Application

Aircraft application of barban usually leads to patchy wild oat control, and is probably impracticable owing to the very adverse wind conditions apt to be encountered in early spring. These difficult conditions do not lend themselves to even chemical application or often to any application at all at the critical wild oat growth stage. Included in Table II are sites where the wild oats were beyond the 2½ leaf stage at the time of spraying, which illustrates that the same critical wild oat stages apply to aircraft spraying as well as to ground spraying. In two experiments in spring wheat control by aircraft was superior to control by land machine.

II FARMER TRIALS

METHODS AND MATERIALS

Samples of barban, sufficient to treat one acre, were sent to farmers together with complete instructions for use in spring barley and spring and winter wheat, the aim being to find whether barban would control wild oats reliably when applied by the farmer himself. Nearing harvest time report forms were sent to each farmer on which to record the details of his application, the effect of the chemical on the crop, and percentage wild oat control obtained.

RESULTS

Table III is a general summary of farmers opinions as to the general success of the trial as recorded on the 60 reports received.

TABLE III SUMMARY OF FARMER OPINION ON SUCCESS OF BARBAN TRIALS

	Number of sites	per cent recorded as satisfied	per cent not indicating full satisfaction
Spring barley	22	68	32
Spring wheat	21	71	29
Winter wheat	17	53	47
Total: all sites	60	65	35
Total: excluding sites on which spray timing inaccurate	44	88	12

The 60 farmer trials have been divided into 10 groups ranging from no wild oat control to 100 per cent wild oat control, and the number of trials in each group is shown in two histograms (Figures 3 and 4). In Figure 3 all 60 trials are plotted, including all the failures due to faulty application. Figure 4 excludes all the failures due to faulty application, that is, mostly late spraying when the wild oats are past the $1\frac{1}{2}$-$2\frac{1}{2}$ leaf stage.

Comparing the results expressed in Figures 2-4 it can be seen that:-

1. The mean percentage wild oat control obtained in:-

   (a) the development trials (excluding aircraft application) is 86 per cent

   (b) all farmer trials is 60 per cent

   (c) farmer trials excluding inaccurate application is 79 per cent.

2. The percentage probability of wild oat control is as follows:-

   (a) carefully controlled development trials - probability of 71-80 per cent wild oat control = 95 per cent

   (b) all farmer trials - probability of 71-80 per cent wild oat control = 55 per cent

   (c) farmer trials excluding incorrect application - probability of 71-80 per cent wild oat control = 77 per cent

This very clearly illustrates the increasing reliability of wild oat control with barban, with increasingly accurate timing of the spray application.

EFFECT OF BARBAN ON THE CROP

Only one case of crop damage was reported in the farmer trials and this was on Atle spring wheat. There was no visible effect in any barley crop at doses up to 12oz barban/ac. At doses up to 8oz in wheat two cases of crop damage were observed in spring wheat, variety Koga II, and winter wheat, variety Mills Wonder. Damage appeared as slightly retarded growth which generally looked more severe in the early stages of crop growth. Later in the season only a very slight check, if any, was visible in the crop.

DISCUSSION

The work clearly indicates that accurate timing of a barban spray is probably the most important factor contributing to successful wild oat control. As weed control becomes increasingly more specialised and application time and techniques more critical, it is obvious that farmers will at first find some difficulty in using new chemicals efficiently. This is particularly the case where barban is concerned, since not only is it difficult for a farmer to time his spray when the wild oats are in the correct stage, but it is in many cases difficult for him to identify the wild oats present amongst his crop.

Figure 2

BARBAN DEVELOPMENT TRIAL RESULTS (18 SITES)

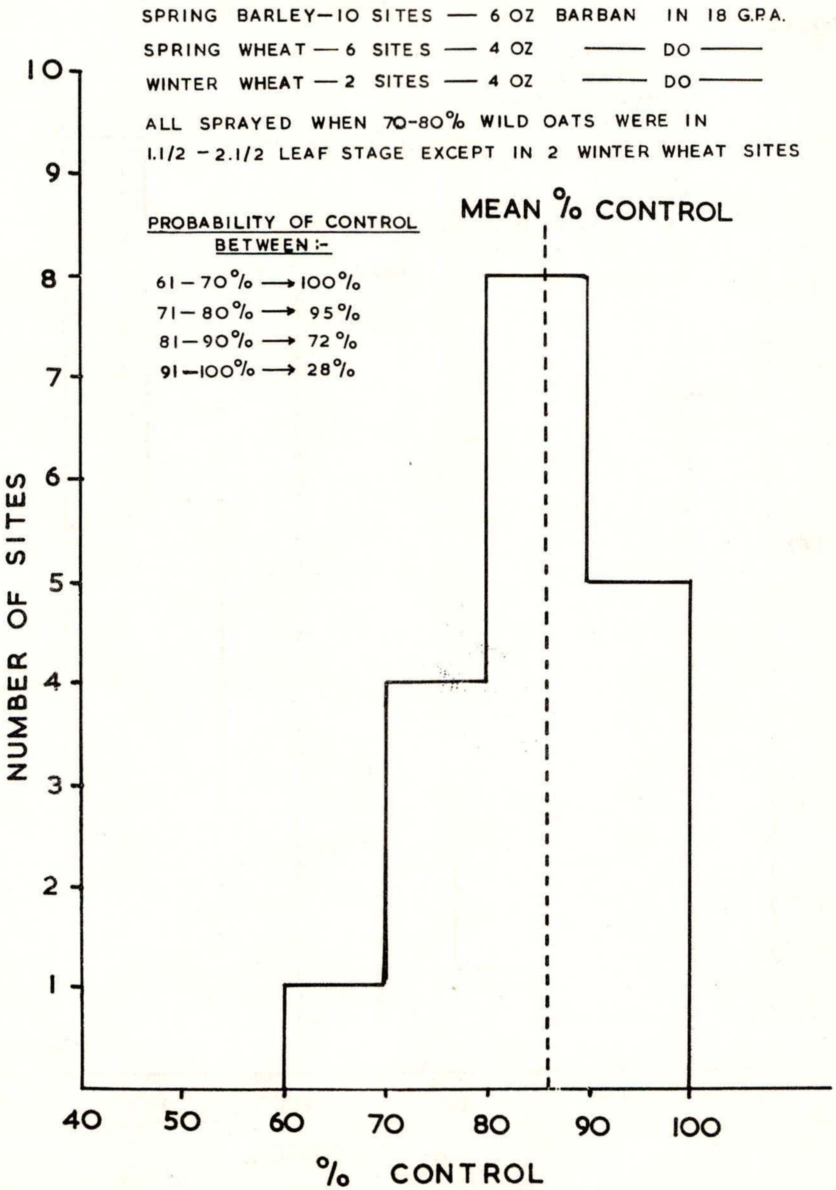
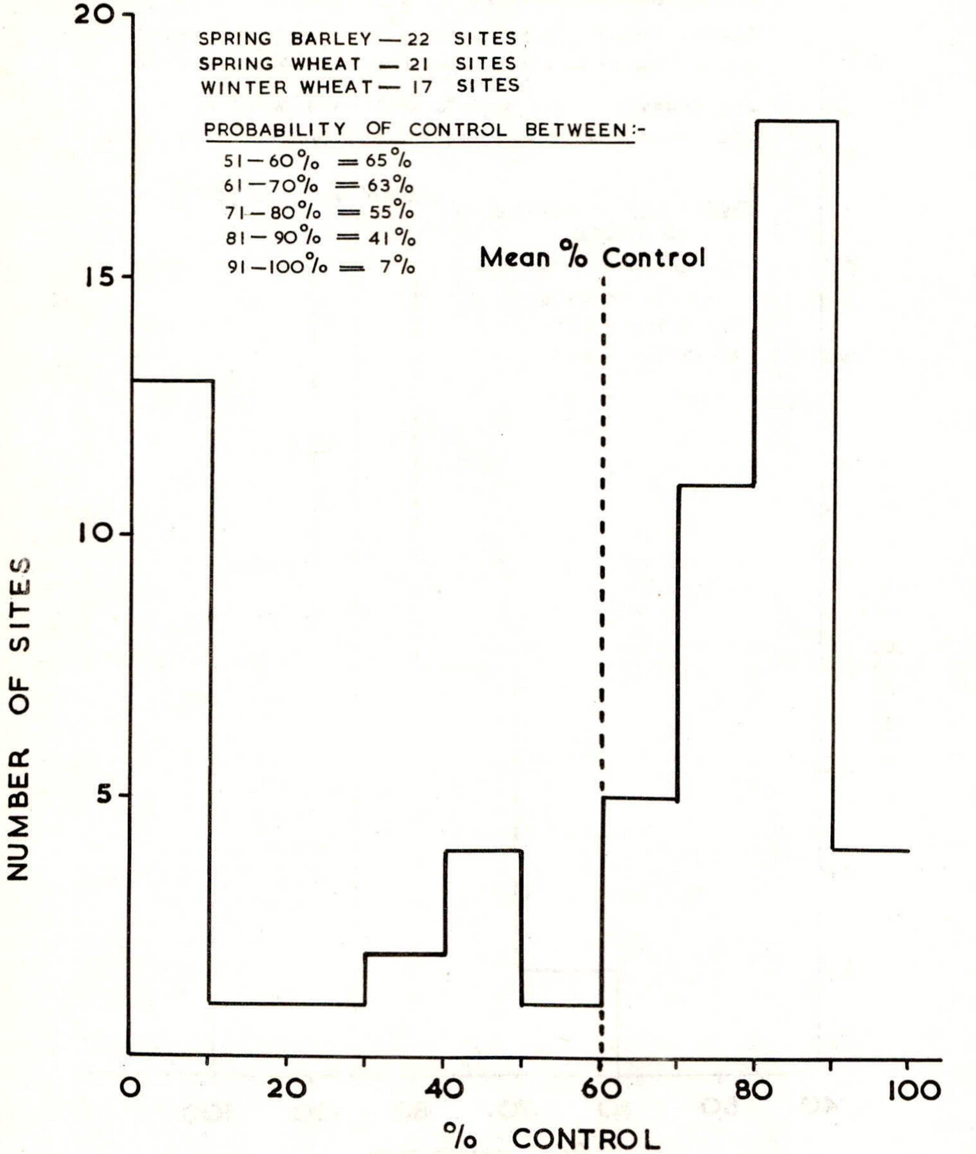


Figure 3

BARBAN FARMER TRIAL RESULTS 60 SITES

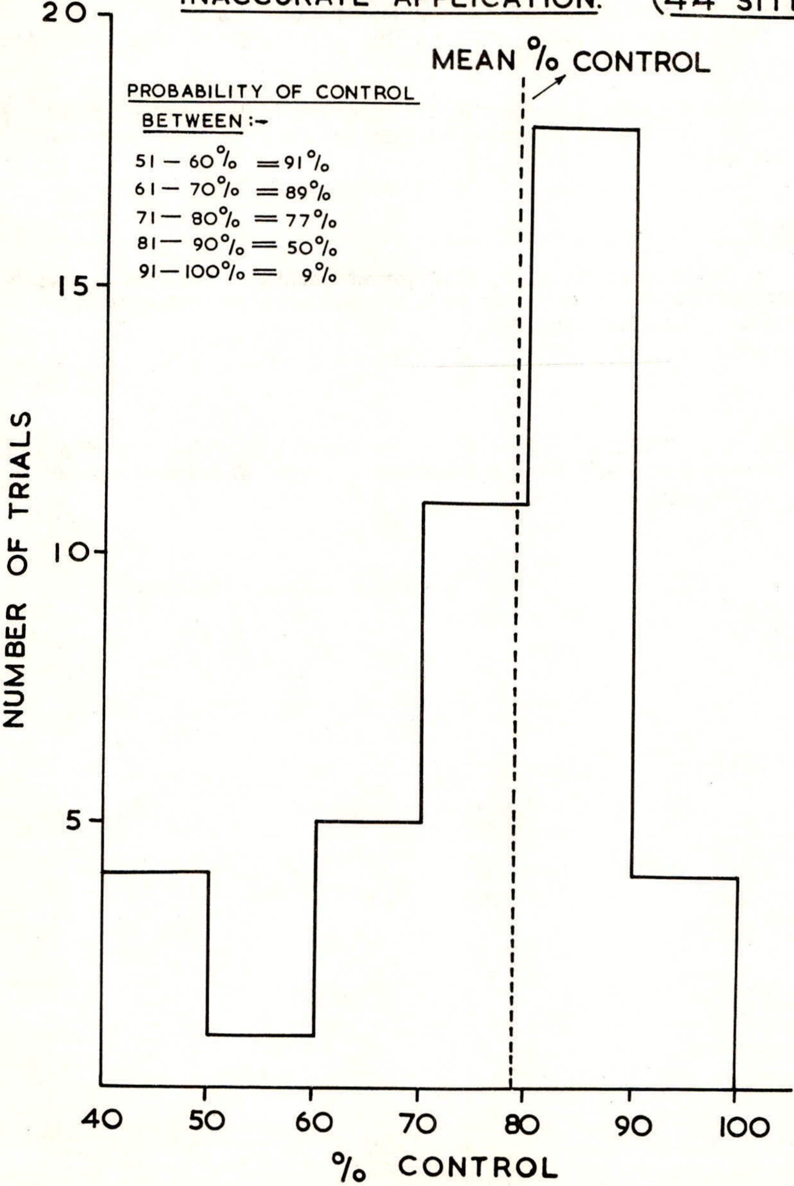
Farmers Opinion



(78178)

Figure 4

BARBAN FARMER TRIAL RESULTS, OMITTING INACCURATE APPLICATION. (44 SITES)



It should also be borne in mind at for the 1960 farmer trials only a limited amount of simple advice could be provided. In future years more comprehensive advice will be given to the farmer, which will aid him to identify wild oats amongst grasses and cereals and to time his spray correctly.

Considering these points, the results of farmer trials in the 1960 season can be considered encouraging and with increasing experience following education on wild oats it can be expected that farmers will, in the future, be able to achieve results comparable with those obtained in the development trials reported above.

It is interesting to note that the results reported in this paper are in line with the results obtained from trials carried out in 1959 under very different weather conditions.

Acknowledgements

The writer is indebted to Dr. R. K. Pfeiffer who designed the experiments and suggested the method of assessing the results which are presented in the manner used by Holmes and Pfeiffer (1956.)

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THE PERFORMANCE OF 2,3-DICHLOROALLYL DIISOPROPYLTHIOLCARBAMATE IN THE WILD OAT AREAS OF NORTH AMERICA

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INTRODUCTION

In the vast prairie provinces of Canada and the northern tier of the United States from the Great Lakes to the Pacific ocean, the wild oat (Avena fatua) ranks as the number one weed problem. This weed has invaded some 61 million acres of crop - of which half is considered as seriously infested. Recommended cultural practices (McDonald, B.K. 1949) which include repeated tillage during early spring, and delayed seeding of the crop, are partially successful in controlling this widespread pest. However, delayed seeding often resulted in substantial crop reduction, which, added to the expense of tillage, made such a programme quite costly. Furthermore, in a cold wet spring, delayed seeding was not always effective.

Early in the 1950's attention was turned to the evaluation of chemicals as a possible aid to the farmer in his battle against the wild oat. Two of the first chemicals to meet partial success were isopropyl N-phenylcarbamate (IPC) and iso-propyl N-(3-chlorophenylcarbamate (CIPC) (Anon. 1956). However, their use has been limited to such minor crops as peas and sunflower. With the inconsistent performance of the chemical and its high cost of $10 to $12 per acre, there has been limited farmer acceptance. During the last five years it has been estimated that over 75 chemicals have been field tested as a possible wild oat herbicide. Early in this period 2-chloro-NN-diallylacetamide (CDAA) was evaluated by several experiment stations and found, under certain conditions, to give good control (Friesen, G. 1956). In subsequent testing, results varied from excellent to poor and it was dropped from further consideration because good wild oat control was obtained in less than 50 per cent of the trials (Leggett, H. W. 1957). At about the same time another chemical, 1,2,4,5-tetrachlorobenzene, was widely tested but it too failed to give acceptable wild oat control. (Leggett, H. W. 1957).

The Monsanto Chemical Company's Agricultural Research Laboratory conducted exhaustive studies, screening thousands of potential wild oat chemicals. From this programme, several chemicals were submitted to selected research personnel for field testing as a pre-planting treatment. Results from these early trials indicated that one chemical (2,3-dichloroallyl diisopropylthiolcarbamate) consistently controlled wild oats in a wide variety of agronomic crops (Selleck, G. W. 1958).*

METHODS AND MATERIALS

This new chemical was so outstanding that it was decided to demonstrate it under conditions on several commercial farms in Canada and the United States. In co-operation with weed research personnel and Monsanto's distributors of Agricultural Pesticides, farmer-co-operators were selected for an on-the-farm demonstration programme. The widely scattered fields selected for these trials were known to be heavily infested with wild oats. At most of the locations, doses of 1, 1.25, 1.5, 1.75 and 2 lb/ac were applied using the farmer-co-operator's sprayer. The volume of water used in making the applications

*Monsanto has adopted the trademark "Avadex" for the product developed from this compound.

However, when the chemicals was placed deeper in the soil and the crop seeded into the treated area, severe stand reduction generally occurred. Our agricultural research laboratory has since been able to demonstrate that selectivity in wheat depends upon incorporation and seeding depths.

TABLE I - EFFECT OF SOIL DILUTION ON GERMINATION AND GROWTH INHIBITING ACTION OF 2,3-DICHLOROALLYL/DIISOPROPYLTHIOLCARBATE

Conc. of X	Per Cent Inhibition	
ppm	Wheat (Av 3 Varieties)	Wild Oats
0.7	82.0	99
0.35	59.0	99
0.23	0.6	96
0.175	0.2	69

TABLE II - EFFECT OF ZONE OF UNTREATED SOIL BETWEEN 2,3-DICHLOROALLYL/DIISOPROPYLTHIOLCARBATE AND SEED

Depth of Untreated Zone (in.)	Per Cent Inhibition	
	Wheat	Wild Oats
	0.7 ppm (0.1 lb/ac of X)	
0	88.0	100
3/8	8.1	100
3/4	8.5	100
1-1/8	10.0	100
	1.4 ppm (0.2 lb/ac of X)	
0	95.0	100
3/8	14.7	100
3/4	12.1	100
1-1/8	15.0	100

X effectively inhibits all wild oat germination and growth at soil concentrations of 0.23 ppm (97 per cent) and above. (Table I). It is fairly effective at concentrations as low as 0.175 ppm (69 per cent). Wheat (average of 3 varieties - Selkirk, Thatcher, Pembina) is critically injured at soil concentrations of 0.35 ppm (59 per cent) and above. It has been found that wild oats are effectively controlled when only the coleoptile contacts a lethal quantity of chemical. (Table II). Wheat appears to be quite resistant to excessive concentrations of X if the roots are in untreated soil.

Where wild oats have been a serious problem, significant yield increases have been obtained with the use of X. In a flax trial in Canada, yields were 6 and 15 bush/ac respectively for the control plot and the 1.5 lb/ac dose. At another location, barley yielded in excess of 30 bush/ac at 1.5 lb and only 4 bush in the control plot (Selleck, G. W. 1961). In one major pea producing area of the United States, at 1.5 lb/ac, an increase of 965 lb/ac was obtained over the untreated plot. In wheat where the stand was reduced 25 per cent by 1½ lb, the treated plot yielded 19 bush compared to 10 bush in the untreated plot.

Residue studies have been conducted to comply with the requirements of the Food and Drug Administration in the United States and Canada. Analysis shows that the chemical does not exist in the mature plants that have been harvested from plots treated with doses as high as 6 lb/ac. These crops are barley, peas, flax, sugar beets, wheat, sunflower, rapeseed and lentils. The chemical is presently registered in Canada for sales on a "no residue" basis and it is anticipated this will also be the case in the United States.

DISCUSSION

Based on the results of several years work by Experimental Stations, of field testing and one year of commercialization, the following conclusions regarding 2,3-dichloroallyl diisopropylthiolcarbamate may be made.

At a dose of 1½ lb/ac it has given consistent 90 to 99 per cent wild oat control both under controlled experimentation and farmer use. Flax, barley, sugar beets, lentils, peas, sunflower, safflower, rapeseed, potatoes, alfalfa, clovers, Kentucky bluegrass and orchard grass, demonstrated tolerance to doses required for satisfactory wild oat control.

Preliminary field and greenhouse data indicated that wheat at doses ranging from 1 to 1½ lb/ac is tolerant when seeded to treated areas where chemical is not incorporated to depths greater than 2 in. Data which are available from the majority of the farmer tests show a substantial increase in crop yields from the use of this herbicide. The heavier the infestation, the greater the increase in yield. Wild oat control is increased only slightly when doses higher than 1½ lb/ac are used provided proper incorporation procedures are followed at the lower doses. Soil should be in good working condition at the time of applying the chemical to ensure proper mixing.

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THE USE OF BARBAN FOR THE CONTROL OF AVENA FATUA

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Summary: During 1960 a series of experiments was carried out to investigate the effect of barban on the yields of clean crops of spring wheat and barley (a resistant variety), and wild oat (A. fatua) in crops of spring wheat and spring barley.

The yield trials showed that if the crop had 3 leaves at the time of application even 12 oz of barban had little effect on the yield. There was, however, a tendency, particularly with spring wheat, for susceptibility to increase with age. In contrast, wild oat was susceptible at an early stage of growth (1-2½ leaf stage) and their resistance increased with age.

MCPA-triethanolamine applied at 1½ lb ae/ac when the crop had 5 leaves, did not interfere with the effect of barban applied about a week earlier. However, if MCPA was applied at the same time as the barban the control of wild oat was reduced, although the susceptibility of the crop was increased. The need to assess the total number of spikelets produced, rather than merely the number of panicles above the crop is also emphasised.

INTRODUCTION

Barban (4-chloro-2-butynyl N-(3-chlorophenyl) carbamate) has been developed as a post-emergence chemical for the control of wild oat in cereals (Corns, 1958; Hoffman et al. 1958). During 1959 it was tested on a fairly large scale in this country by Fisons Pest Control Ltd., and preliminary trials were also carried out by the A.R.C. Unit of Experimental Agronomy. These trials confirmed the earlier reports from the United States of America (Brown, 1958; Hoffman et al., 1958), that wild oat is most susceptible when it has from 1 to 2½ leaves. Plants treated with an appropriate dose of barban cease to grow and form a characteristic rosette of short, broad, bluish-green leaves; the stem apices fail to develop primordia and it is thought that, like most carbamates, it acts as a mitotic poison.

Although, even in the absence of crop competition, barban kills wild oat at doses that are not harmful to certain cereals, vigorous crop competition has been shown to be necessary if full advantage is to be taken of the check to the survivors. Regrowth is then limited. The volume of spray applied per acre is also important for the formulation used and it is generally agreed that increasing the rate from 10 to 100 gal/ac reduces the effectiveness of this herbicide by almost half. (Holly, 1960; Holroyd, 1959).

Many spring wheats and spring barleys are fairly resistant to barban, but the barley varieties Provost and Proctor are exceptions (Pfeiffer et al. 1960; Holroyd, 1959).

Mixtures of barban with other herbicides showed a marked antagonism with 2,3,6-TBA and to a lesser degree with other auxin herbicides (Pfeiffer *et al.* 1960; Holroyd, 1959).

In 1960 therefore a number of experiments were laid down to investigate the effect of barban on the yields of clean crops of spring wheat and barley, the interaction of barban with a standard dose (1½ lb/ac) of MCPA, and the effect of barban on *Avena fatua* at different stages of growth when growing in crops of spring wheat and barley.

METHODS AND MATERIALS

Yield Trials. Four yield trials were laid down on clean cereal crops in 1960, two on spring wheat and two on spring barley. The same design and treatments were used in each trial. The spraying was carried out with a Land Rover mounted sprayer, using plots of 40 yd x 5 yd. The barban was formulated in an emulsifiable oil* and applied in water at a volume rate of 13.4 gal/ac.

The treatments were 4, 8 and 12 oz/ac of barban applied when the crop had a) approximately 3 leaves - date I, and b) approximately 5 leaves - date II. The experimental design was a randomised block replicated four times with one control plot in each block. The control plots in the odd numbered blocks were wheel marked at date I and those in the even numbered blocks at date II. At harvest yields of grain were obtained by harvesting a strip down the centre of each plot with a combine harvester.

Trials on Avena fatua in spring cereals. Four experiments were laid down in 1960. The same formulation of barban was used as in the yield experiments. The treatments were applied with an Oxford Precision Sprayer to plots which were 6 yd x 2 yd. The volume rate was 15 gal/ac.

The experimental design was a randomised block replicated three times. A discard strip of 1 yd was left between plots.

Experiment at Harwell, Berks.

This experiment was on a crop of Carlsberg spring barley grown under conditions of moderate fertility, with a moderate infestation of *A. fatua* (17 panicles/sq yd). The germination of the crop was uneven due to the dry spring; it evened up later in the season but its competitive ability was never high.

Experiment at Bretford, Nr. Evesham.

The crop was Carlsberg, spring barley growing under conditions of high fertility. The treatments were 0, 4, 8 and 12 oz of barban applied at three times. This crop was unfortunately badly laid early in July, so that although its competition with the oats was very vigorous in the early stages, many of the panicles, particularly the smaller ones, had little or no competition for light in the later stages of development.

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* 'Carbyne' containing 11.8 per cent w/v barban, Fisons Pest Control.

Experiment at Shillingford, Oxon.

The crop here was spring wheat, var. Atson, growing under conditions of high fertility. The A. fatua plants were very variable and the growth stages ranged from 1 leaf to fully tillered. Adjacent controls were used for each treated plot.

Experiment at Broadchalke, Nr. Salisbury, Wilts.

This was on spring wheat var. Atle, growing under conditions of moderate fertility.

Assessment. The stage of growth of A. fatua at the time of spraying was assessed by selecting 20 plants at random on each of the sprayed plots. Visual observations were made at intervals and during the latter part of July all the A. fatua panicles were counted on the plots and classified according to:

their position above or below the crop,
their size (a) small 1-10 spikelets
(b) medium 10-30 spikelets
(c) large 30 or more spikelets
their stage of growth
(a) fully expanded
(b) just emerging from the sheath
(c) still within the sheath.

The stage of growth of the crop was assessed by selecting six samples of ten plants at random over the experimental area.

RESULTS

Yield trials. The results are shown in Table I. These show that Rika barley and the spring wheats Koga II and Jufy are unaffected by up to 12 oz/ac of barban applied at the 3 leaf stage. In fact little or no damage was visible on the crops at any time subsequent to spraying. If, however, applications were delayed until the 5 leaf stage Koga II in particular was checked in growth and the 12 oz/ac treatment reduced the crop height and the head size. This resulted in a 30 per cent fall in the yield. The 4 oz and 8 oz treatments also produced effects but these were less marked. The crops of Jufy and Rika were little affected. There was a significant difference between the mean yields of Rika at the two times, T_1 and T_2 in the Towcester experiment which was most probably due to 'wheel-marking' a high yielding crop later in development, as there was no dose trend and no interaction between dose and time of application.

Trials on A. fatua in Spring Cereals. The results of these are shown in Tables II, III, IV and V. Two sets of figures are given, one referring to the number of spikelets visible above ('above') the crop and the other to the total ('total') number of spikelets. The figures are based on the counts, but have been weighted for size of panicles. It has been assumed for the purpose of calculation that the small panicles had a mean of 5 spikelets, the medium 20 and the large 40. Although a spikelet may contain from 1-3 viable seeds these figures do give a more accurate estimate of the number of actual seeds produced than panicle counts alone. In tables II, III, IV and V control counts at the different treatment times (T) have been averaged. The control counts for

Table IV were made on the discards between each pair of treated plots, a total of nine, and averaged.

The results of the trials in which treatments were applied at different times (T) are fairly consistent and show conclusively that A. fatua was most sensitive at the 1-3 leaf stage. At this stage 8 oz barban/ac reduced the total spikelets by over 70 per cent and 4 oz by 40-66 per cent. The apparent control, i.e. the reduction in numbers of wild oat panicles above the crop was even better, 76-85 per cent for 4 oz/ac treatment. As the numbers of wild oat at the susceptible stage decreased so the effectiveness of the barban declined, and 9-11 days later when the number of A. fatua at the 1-3 leaf stage had dropped by 51-56 per cent, 8 oz barban gave a reduction which varied from 13-42 per cent, although the apparent control was approximately 70 per cent. When treatment was delayed further until 84 per cent of the wild oat was at the 3-5 leaf stage, as at Harwell, the reduction became almost negligible.

The spring wheat at Shillingford was a very competitive crop but also sensitive, presumably as the spraying was late. Thus the 4 oz treatment gave the best control. Increasing the dose reduced the competitive powers of the crop and allowed the wild oat to recover. Also as the crop was growing strongly at the time of treatment, many of the oats, particularly those germinating late, were shielded and thus probably received little or no spray.

MCPA applied after barban (the shortest time interval was 9 days) had little effect on the degree of control, in fact at Broadchalke the MCPA itself seemed to give some reduction. However, when the barban and the MCPA were applied together at the second date (T2) there was a very marked interaction as measured by the toxicity of the chemicals to wild oats. At both Harwell and Broadchalke the effectiveness of the 12 oz treatment of barban was more than halved, although this antagonism was less marked at the lower doses. The position is complicated as the mixture was damaging to the crop and the damage increased as the proportion of barban was increased. The wheats suffered more than the barley although there was also very marked scorch on the barley at Harwell shortly after treatment. However, here the crop recovered almost completely. The damage on the wheat was characterised by a reduction in height, head length, and number of heads. Symptoms similar to those observed on Koga II in the yield experiment at Porton. This damage was accompanied by a number of head deformities such as 'opposites' and sterile ears, which did not occur in the absence of MCPA.

DISCUSSION

These results show that (a) the varieties of cereals tested were resistant at the 3 leaf stage and some of the spring wheat varieties tended to become more susceptible with age, (b) there was no interaction between barban and MCPA applied later, and (c) A. fatua was most susceptible at the 1-3 leaf stage.

Thus it follows that the maximum control of A. fatua will be obtained from barban treatments which are applied when the main flush has 1-3 leaves. At this time the crop will generally have approximately 3 leaves. MCPA can then be applied as usual when the crop has 5 leaves.

When A. fatua plants which had just begun to tiller were treated with barban, growth was checked and the existing tillers were stunted and often eventually died.

TABLE I. YIELDS OF SPRING CEREALS, TREATED WITH BARBAN, IN CWT/AC CORRECTED TO 15 PER CENT MOISTUREE

Experiment at	Crop	Date of Spraying	Stage of Growth	Treatment in oz/ac of barban					Coef. of variation	L.S.D. (P = 0.05) Treatment means	T_1 v. T_2
				0	4	8	12	Mean			
Porton, Wilts	S. Wheat	4.5.60. (T_1)	3-4 leaves	30.2	30.9	32.6	32.4	31.7			
	Koga II	12.5.60. (T_2)	5 leaves	31.0	31.2	29.9	20.7	28.5	16.2%	9.6	N/S
Porton, Wilts	S.Barley	4.5.60. (T_1)	3-4 leaves	18.45	18.9	18.1	18.4	18.5			
	Rika	12.5.60. (T_2)	5 leaves	18.4	17.1	18.0	18.2	17.4	8.9%	N/S	N/S
Bedford.	S.Wheat	29.4.60. (T_1)	3 leaves	27.0	26.4	26.8	26.6	26.7			
	Jufy	10.5.60. (T_2)	5-5½ leaves	27.1	26.1	25.9	26.4	26.3	3.7%	N/S	N/S
Towcester.	S.Barley	9.5.60. (T_1)	3-3½ leaves	43.0	41.7	41.4	42.7	42.1*			
	Rika	23.5.60. (T_2)	5-6 leaves	39.1	39.6	40.8	37.8	39.4	4.2%	3.3	1.3

(N.B. * There was no interaction between dose and time).