TABLE II. THE EFFECT OF BARBAN AND BARBAN/MCPA MIXTURES ON *A. FATUA* AT HARWELL, BERKS.

Number of spikelets expressed as a percentage reduction of controls (mean of 3 replicates)

Date of spraying:		14.5.60. (T_1)		25.5.60. (T_2)		1.6.60. (T_3)	
Stage of growth) Barley No. of leaves:) *A. fatua*		3-3½ 1-3(86 per cent)		5-5½ 3-5(65 per cent)		5-6 3-5(84 per cent)	
Treatment:		'above' (1)	'total' (2)	'above' (1)	'total' (2)	'above' (1)	'total' (2)
4 oz barban/ac)	without MCPA	87	66	61	39	-27*	-23*
8 oz barban/ac)		94	85	70	42	4	8
12 oz barban/ac)		95	90	83	64	1	- 9*
0 oz barban/ac)	with MCPA at 1½ lb/ac applied on 25.5.60.	13	5	3	5		
4 oz barban/ac)		82	64	56	44		
8 oz barban/ac)		91	83	56	29		
12 oz barban/ac)		95	88	63	28		

Control plots: 407 spikelets/sq yd 'above' the crop.
(average of 3 dates) 550 spikelets/sq yd 'total' count.

TABLE III. THE EFFECT OF BARBAN AND BARBAN/MCPA MIXTURES ON *A. FATUA* AT BROADCHALKE, WILTS.

Number of spikelets expressed as a percentage reduction of controls (mean of 3 replicates)

Date of spraying:		3.5.60. (T_1)		12.5.60. (T_2)	
Stage of growth) Wheat No. of leaves:) *A. fatua*		3-3½ 1-3(81 per cent)		5 3-5(71 per cent)	
Treatment:		'above' (1)	'total' (2)	'above' (1)	'total' (2)
4 oz barban/ac)	without MCPA	76	40	25	-24*
8 oz barban/ac)		93	73	78	13
12 oz barban/ac)		93	78	91	67
0 oz barban/ac)	with MCPA at 1½ lb/ac applied on 12.5.60.	37	17	37	37
4 oz barban/ac)		82	53	39	25
8 oz barban/ac)		90	78	61	22
12 oz barban/ac)		90	83	75	24

Control plots: 112 spikelets/sq yd 'above' the crop.
(average of two dates) 225 spikelets/sq yd 'total' count.

* The negative sign indicates that there was an increase over control.

(1) These figures show the number of spikelets 'above' the crop expressed as a percentage reduction from the number above the crop on the controls.

(2) These figures refer to the total number of spikelets.

TABLE IV. THE EFFECT OF BARBAN AND BARBAN/MCPA MIXTURES ON A. FATUA AT SHILLINGFORD, OXON.

Number of spikelets expressed as a percentage reduction of controls (mean of 3 replicates).

Date of spraying:		25.4.60.	
Stage of growth) Wheat No. of leaves) A. fatua		4-5 1-3 (54 per cent)	
Treatment		'above'(1)	'total'(2)
4 oz barban/ac)	without MCPA	100	60
8 oz barban/ac)		66	25
12 oz barban/ac)		53	36
4 oz barban/ac)	with MCPA	8	-19*
8 oz barban/ac)	at	49	19
12 oz barban/ac)	1½ lb/ac	75	24
Control plots. 39 spikelets/sq yd 'above' the crop. 114 spikelets/sq yd 'total' count.			

TABLE V. THE EFFECT OF BARBAN ON A. FATUA AT BRETFORD, NR. EVESHAM

Numbers of spikelets expressed as a percentage reduction of controls (mean of 3 replicates).

Date of spraying:	6.5.60. (T_1)	16.5.60. (T_2)	24.5.60. (T_3)
Stage of growth) Barley No. of leaves) A. fatua	3-4 1-3(90%)	5-5½ 3-5 (66%)	5½-6 3-5 (79%)
Treatment:	Total(2)	Total(2)	Total(2)
4 oz barban/ac	43	-2*	37
8 oz barban/ac	73	29	52
12 oz barban/ac	80	52	37
Control plots: 115 spikelets/sq yd total count.			

* The negative sign indicates that there was an increase over control.

(1) These figures show the number of spikelets 'above' the crop, expressed as a percentage reduction from the number above the crop on the controls.

(2) These figures refer to the total number of spikelets.

Regrowth, however, occurred fairly rapidly from secondary tillers. These generally produced numbers of small panicles, many of which never rose above the crop. Thus although the 'apparent' control was often good, the actual reduction as measured by the 'estimated' number of spikelets was also often poor, e.g. at Shillingford where 4 oz barban gave a 100 per cent reduction of the panicles above the crop there were in fact 45 spikelets/sq yd still present.

Conversely, if total panicle counts had been used as the criterion, rather than numbers of spikelets, the degree of control could have appeared to be much less than was in fact the case, e.g. for the same treatment at Shillingford counts based on the total number of panicles would have shown a reduction of only 45 per cent whereas in fact the reduction in spikelet numbers was 60 per cent.

The main objects of weed control are of course two fold, firstly to reduce the competitive powers of the weed, and secondly to reduce the amount of viable weed seed produced. Barban satisfies the first of these, for it can reduce the competitive ability of the oats, at least temporarily. If the crop can take advantage of this reduced competition, i.e. soil conditions are right, etc., and the degree of infestation is relatively high, quite large increases in yield can result, as is shown in some of this season's N.A.A.S. trials (Evans, 1960). Unfortunately, the reduction in the amount of viable seed produced is very variable as is shown in these experiments. Thus, although barban treatments may give yield increases which more than compensate for the cost of application and materials, it seems unlikely that the wild oat population in ensuing years will be greatly reduced.

Acknowledgements

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SOME PRELIMINARY EXPERIMENTS WITH 2,3-DICHLOROALLYL DIISOPROPYLTHIOLCARBAMATE

J. Holroyd

A.R.C. Weed Research Organisation, Oxford

Summary: During 1960, three experiments on spring wheat and five on spring barley were laid down with 2,3-dichloroallyl diisopropylthiol-carbamate. At two of the sites the wild oat populations were relatively large and at three of the others light to moderate. The dose range generally used was 0, 0.5, 1 and 2 lb/ac. Discs or harrows were used to incorporate the herbicide into the seed-bed immediately after application. The time interval between application and drilling varied from 1-20 days. The optimum dose for wild oat control was between 1 and 2 lb/ac. The numbers of A. fatua spikelets where reduced by 85 percent - 99 per cent on four sites by 2 lb/ac and on two sites by 1 lb/ac. The 2 lb/ac treatment slightly reduced the density of barley drilled within 4 days of treatment, wheat was reduced more severely both in stand and vigour. It was however only slightly affected by the 1 lb/ac treatment. The increase in barley yield due to the removal of wild oat competition at the two sites when the wild oat population was high (100 and 50 panicles per sq yd) was 10 cwt/ac (74 per cent) and 3.3 cwt/ac (21 per cent) respectively.

INTRODUCTION

2,3-dichloroallyl diisopropylthiolcarbamate is a soil-acting herbicide which has been tested on a fairly wide scale in Canada and the U.S.A. fornthe control of wild oats. It has proved very successful when applied at a rate of 1.5 lb/ac and incorporated into the soil prior to drilling. As it is relatively volatile the incorporation must be carried out very soon after application, preferably the same day. In Canada and the United States, crops of barley and flax have proved relatively resistant to 1.5 lb/ac, although wheat has shown less resistance (Hannah) 1959). During 1960 the Weed Research Organisation laid down eight experiments with this herbicide on fields which were reported to have been heavily infested with wild oat during the previous year. On three of the fields however very few wild oat appeared.

METHODS AND MATERIALS

2,3-dichloroallyl diisopropylthiolcarbamate has a very low solubility in water and a commercially formulated emulsifiable concentrate* was used. It was applied by means of an Oxford Precision Sprayer at a volume rate of 20 gal/ac to plots which were 6 x 4 yd. Treated plots alternated with control plots. The dose range was 0.5, 1 and 2 lb/ac except at Brackley where it was 0.4, 0.8 and 1.6 lb/ac. There were five replicates and paths of 2 yd width between each replicate. The treated plots were randomised in each replicate. Applications were generally made to a roughly prepared seed bed and incorporated immediately afterwards with either discs or spring timed harrows.

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*"Avadex" containing 40 per cent w/v active ingredient, Monsanto Chemical Co.

Details of sites

Experiment at Harwell, Berks. This experiment was treated on the 11th April when the air temperature was 51 °F. The soil which was a light loam with some chalk over green-sand had been worked down to a good seed bed. The top 2 in was moist and friable but the soil below was wet and sticky. After treatment the area was harrowed twice with spring tined harrows to a depth of 2-3 ins. After cultivation the soil was 'closed' and the maximum diameter of the soil clods 1½-2 ins. Three days later Proctor barley was drilled and the area rolled and harrowed. Due to the dry spring, the crop emerged in two fairly distinct phases, but evened up before harvest. The infestation of A.fatua was heavy, producing over 100 panicles/sq yd.

Experiment at Bretford, Nr. Evesham. Here a heavy silty loam had been worked down to a very rough seed bed when sprayed on 11th March, it was then very wet below 3-4 in. After treatment the area was cultivated twice with heavy discs to a depth of 4-5 in. The texture of the soil after cultivation was rather open with clods of up to 4-5 in. diameter. The air temperature was 50°F. Heavy rain followed immediately after the cultivation. Carlsberg barley was drilled on the 31.3.60 and harrowed afterwards. The population of A. fatua was moderate, giving 21 panicles/sq yd, and uneven in distribution.

Two experiments at Lewknor, Oxon. These experiments were in adjacent fields and both were treated on the 17th March. The soil, a silty loam, wet underneath but only damp on the surface, was essentially the same on both sites. Immediately after application of the treatment it was cultivated once each way with spring tined harrows. This left the soil surface 'closed' with a good tilth and a few clods of up to 2-3 in. diameter. The depth of cultivation was 2-3 in. The air temperature was 40°F. The day after treatment one site was harrowed again before being drilled with Koga II spring wheat. Afterwards it was harrowed twice and rolled. The other site was harrowed twice more before being drilled four days later (21st March) with Proctor barley. Subsequently it also was harrowed twice and rolled. Very few wild oats came up on either site.

Experiment at Brackley, Northants. This site was treated on the 8th March with 0.4, 0.8 and 1.6 lb/ac of the herbicide. The soil was heavy and lumpy having been disced once after ploughing. There was a fairly general infestation of Agropyron repens, the rhizomes of which tended to hold the clods together. As a result post-treatment cultivations with discs (twice), to a depth of 3-4 in left the soil surface open with clods of up to 4-5 in. The air temperature was 34°F. Nine days later (17th March) the area was disced again, dragged once and then drilled with Rika barley. After drilling it was harrowed twice. A. fatua was moderately dense, giving rise to 55 panicles/sq yd.

Experiment at Didcot, Berks. The spray applications were made at this site on the 10th March to a lightish, slightly chalky soil over 'green sand'. It was a little lumpy on the surface and wet underneath after being in kale the previous season. The air temperature was 54°F. Immediately after treatment the area was harrowed twice. This left the soil surface moderately open with clods of up to 2-3 in. Rain followed immediately afterwards. Four days later the area was harrowed twice again, drilled with Atle wheat and then given two further harrowings and a final rolling. This was another site with very few wild oats which produced only 1½ panicles/sq yd. They were nearly all A. fatua with a very occasional plant of A. ludoviciana. The distribution was patchy.

Experiment at Stagsden, Beds. The treatments were applied at this site on the 7th April to a heavy lumpy soil which had been harrowed once with spring tines after ploughing. After spraying the area was harrowed once again. This left the soil surface very open with large clods up to 8-9 in. diameter. The air temperature was 63°F. The area was drilled ten days later (17th April) with Proctor barley, harrowed twice and rolled. A dry spell of weather followed the drilling and the crop was very slow to emerge, and uneven. The population of A. fatua was light, giving 6 panicles/sq yd.

Experiment at Wytham, Berks. The soil on this site had already been worked down to a fairly fine tilth before the treatments were applied on the 21st March. The air temperature was 50°F. Immediately after treatment the area was disced twice. This resulted in a soil surface which was 'closed' with lumps of up to 1½ in. diameter. The soil was over gravel but moderately heavy with a fairly high proportion of clay. The experiment was drilled with Jufy spring wheat the following day, harrowed and rolled. No wild oats appeared on this site but observations were made of the growth of the crop, and its density was assessed.

Assessments

The assessments were made on a 2 yd strip down the centre of each plot. Shortly after emergence, when the crop had 2-4 leaves, counts were made of the number of crop plants in ten one-square foot quadrats/strip. In some of the trials the vigour of the crop was also scored at the same time.

During the latter part of July all the A. fatua panicles in the assessed area of each plot were counted and classified in the following manner:-

(i) position above or below the crop
(ii) size a) small 1-10 spikelets
b) medium 10-30 "
c) large 30 or more spikelets.

(iii) stage of growth a) fully expanded.
b) just emerging from the sheath.
c) still within the sheath.

For the purpose of calculating the numbers of spikelets the small panicles were assumed to have a mean of 5 spikelets, the medium 20 and the large 40. A rough comparison of the mean yields of grain from the treated and untreated plots was obtained at Harwell and Brackley. In each replicate the treated and untreated plots were opposite one another and only separated by a 2 yd path. Thus by ignoring the untreated path it was possible to harvest a strip 38 yd long, with a combine harvester, from the centre of each row of treated or untreated plots.

RESULTS

Table I shows the effect of the treatments on the density and the vigour of the crop. The 0.5 lb/ac treatment had little or no effect at any of the sites but 1 lb/ac reduced the vigour of the two spring wheats (at Lewknor and Wytham) which were sown on the day after application. The 2 lb/ac treatment had little or no effect on barley provided there was an interval of nine days or more before drilling. If the interval was only three or four days as at Harwell and Lewknor there was some reduction in crop density. Wheat, on the other hand, was severely reduced both in density and vigour by the 2 lb/ac treatment, the maximum interval between spraying and drilling being four days. When damage occurred the symptons shown by the two crops were rather different. The effect on the barley was much more 'all or nothing'. There were one or two trapped leaves in the very early stages of growth but in general the plants seemed either to emerge and grow fairly normally or not emerge at all. In the later stages of development no damage was visible. The symptons on wheat were much more apparent. There was a reduction in plant density and, shortly after emergence, many of the plants were stunted and their leaves trapped or tubular. Damaged plants were slow to recover and matured later than the rest of the crop. The 2 lb/ac treatment visibly reduced the yield in all three of the wheat trials.

Table II shows the counts of the wild oat spikelets on the treated plots as a percentage reduction from the counts on the controls. Unfortunately only the sites at Harwell and Brackley had wild oats present in any quantity but at both of these the 1 lb/ac treatment was sufficient to reduce the number of spikelets by 85 per cent or more. At Harwell 2 lb/ac gave almost complete eradication. The incorporation of the chemical at Stagsden was very poor due to the lumpy nature of the soil and this probably accounts for the poor control given by the 0.5 and 1 lb/ac treatments. At Didcot where the control was also not very good, the wild oat population was small and variable in density.

TABLE I. THE EFFECT OF 2,3-DICHLOROALLYL DIISOPROPYLTHIOLCARBAMATE ON CROP DENSITY

(Density as percentage of control)

Site	Crop	Variety	No. of days spraying to drilling	Method of incorporation	Control density plants/ sq ft	0.5 lb/ac	1.0 lb/ac	2 lb/ac
Harwell	Barley	Proctor	3	harrows	19	97	114	72
Brackley	"	Rika	9	discs	8	121*	111*	103*
Bretford	"	Carlsberg	20	discs	26	96	103	111
Stagsden	"	Proctor	10	harrows	15	96	94	99
Lewknor	"	Proctor	4	harrows	17	98	102	88
Lewknor	Wheat	Koga II	1	harrows	18	101	101	57
Didcot	"	Atle	4	harrows	19	97	95	63
Wytham	"	Jufy	1	discs	21	99	89	70

* Dose was 0.4, 0.8 and 1.6 lb/ac

The yields of grain which were taken from the untreated and treated plots at Harwell and Brackley emphasised the competitive effect of the wild oat which has always been suspected but never satisfactorily proved. Thus at Harwell where the wild oat population was reduced by at least 97 per cent from a control density of 3,174 spikelets or 102/panicles sq yd, the yield increase was 10 cwt/ac or a little over 70 per cent. At Brackley where the wild oat population was about half that at Harwell, and the control was not quite so good, the increase was over 3 cwt/ac or 21 per cent.

TABLE II. THE EFFECT OF 2,3-DICHLOROALLYL DIISOPROPYLTHIOLCARBAMATE ON THE PRODUCTION OF SPIKELETS BY A. FATUA AND ON CROP YIELD

(Assessment of total spikelets and of spikelets above the crop expressed as percentage reduction from their respective controls.)

Site	Assessment	Control density		per cent reduction in spikelets			Yield of crop in cwt/ac	
		Spikelets/ sq yd	Panicles/ sq yd	0.5 lb/ac	1 lb/ac	2 lb/ac	Control	Treated +
Harwell	Spikelets above crop	2,670	67	97	99	99.8	13.6	23.9
	Total spikelets	3,174	102	97	99	99.8		
Brackley	Spikelets above crop	1,445	36	81*	86*	96*	15.2	18.5
	Total spikelets	1,707	55	78	85	96		
Bretford	Spikelets above crop	129	3	47	85	92	-	-
	Total spikelets	359	21	41	75	85		
Stagsden	Spikelets above crop	126	3	45	42	84	-	-
	Total spikelets	260	6	51	46	86		
Didcot	Spikelets above crop	20	0.5	36	53	66	-	-
	Total spikelets	36	1.5	27	60	74		

* Dose was 0.4, 0.8 and 1.6 lb/ac.

+ This is the mean of all 3 doses

DISCUSSION

Many factors may influence the toxicity of a herbicide incorporated into the soil, particularly when it is volatile. These include the soil type, the method of incorporation as it influences efficiency and depth, the time interval between spraying and drilling, the depth of sowing in relation to the depth of incorporation and the weather conditions. In these experiments the soils ranged from a light calcareous loam to a heavy clay, the cultivations from light harrowing (1-2 in. in depth) to heavy discing (4-5 in. in depth) and the interval between spraying and drilling from one to twenty days. To achieve the most satisfactory incorporation it may be necessary to match up the method of cultivation with the soil type and its condition.

At Harwell a double light harrowing was sufficient to incorporate the herbicide into a light and easily worked soil to a depth of 2-3 in. The resulting soil surface was closed and the 0.5 lb/ac treatment gave a 97 per cent control of wild oat. Harrows were used at Stagsden but as the soil was heavy and lumpy, the incorporation was poor and the soil surface left open. The result was only 51 per cent control with the same dose. At Brackley the soil was also heavy and lumpy, but the herbicide was disced in so that although the soil surface was not closed the incorporation was a little deeper (3-4 in.). Here as little as 0.4 lb/ac gave a control of 78 per cent. The weather conditions also probably influenced the effectiveness of the herbicide at these two sites for whereas the soil was relatively warm at Stagsden (air temperature 63°F) when the treatments were applied, it was cold at Brackley (air temperature 34°F). Thus the vapour loss at Brackley was probably less, before subsequent cultivations, drilling and rolling closed the soil surface eight days later. At Bretford discs were also used to incorporate the herbicide relatively deeply (4-5 in.) into a heavy soil, but the cultivations left the soil surface open. The air temperature was 50°F and there was a delay of twenty days before drilling and rolling was completed an and the soil surface closed. Thus the 0.5 lb/ac treatment gave poor control (45 per cent) and the 1 lb/ac only moderate (75 per cent). If the soil is cultivated too deeply it seems likely that excessive dilution will also reduce the effectiveness of the herbicide.

The time interval between spraying and drilling directly effects the amount of crop damage although any factor which influences the persistence of the herbicide in the soil must be important. Thus Proctor barley at Harwell and Lewknor drilled after time intervals of three and four days respectively was slightly reduced in density by the 2 lb/ac treatment, whereas it was unaffected at Stagsden (time interval ten days). Similarly at Brackley and Bretford, the barley varieties Rika and Carlsberg (Time intervals nine and twenty days respectively) were also unaffected although this may have been due to a difference in varietal susceptibility.

The depth of sowing of a crop in relation to the depth of incorporation of the herbicide may also influence its susceptibility. It was noticeable in the experiment at Wytham that the wheat plants which had accidentally been sown deeper were damaged less than those sown more shallowly, Perhaps wheat but not wild oat can grow through a contaminated layer of soil. Wheat seemed to be generally more susceptible than barley. At Didcot the 2 lb/ac treatment reduced the crop density to 63 per cent of control whereas at Harwell and Lewknor the reductions were only to 72 per cent and 88 per cent respectively. A true comparison can only be made under the same conditions i.e. on the same site, but the effect certainly persisted much longer on the wheat than the barley as has already been mentioned. However considering the wide range of conditions over which the herbicide was used, its effectiveness on wild oat was surprisingly consistent.

It was very noticeable that the effect of the herbicide on wild oat as on barley was very much 'all nor nothing'. If a plant was not killed early in development it seemed to grow almost normally. This fact is illustrated by the similarity between the figures for control based on the numbers of spikelets 'above' the crop and those based on the total number of spikelets (Table II). Treatments did not appreciably alter the proportion of small panicles to large panicles. Thus vigorous crop competition was not essential for successful control. This means that the herbicide should prove useful for the control of A. fatua not only in competitive crops such as spring barley and possibly spring wheat but also in other less competitive crops such as beet, field beans and peas. Preliminary experiments have already indicated that these crops are relatively resistant.

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THE CONTROL OF WILD OATS (AVENA FATUA) WITH BARBAN AND 2,3- DICHLOROALLYL DI-ISOPROPYLTHIOLCARBAMATE

(A Summary of N.A.A.S. Experiments 1960)

S. A. Evans

N.A.A.S. Liaison Officer, Weed Research Organisation Oxford

Summary: Fourteen experiments with barban and six with 2,3-dichloroallyl di-isopropylthiolcarbamate for the control of Avena fatua, carried out by the N.A.A.S. in 1960, are reported. Barban was applied post-emergence at two doses and at two dates, with and without MCPA applied at the second date to spring barley, spring wheat and winter wheat, at two doses and at two dates on peas and at three doses on a single occasion on spring beans. 2,3-dichloroallyl di-isopropylthiolcarbamate was applied at four doses pre-sowing, on spring barley. The effect of treatments on the crop was assessed by scoring for vigour and/or height measurements; yields were assessed in seven barban experiments and three experiments with 2,3-dichloroallyl di-isopropylthiolcarbamate. The control of wild oats was assessed by panicle counts, or occasionally by scoring for density of panicles at harvest time.

INTRODUCTION

Barban (4-chloro-2-butynyl-N-(3-chlorophenylcarbamate) and 2,3-dichloroallyl di-isopropylthiolcarbamate (hereafter referred to as X) were investigated by the Weed Research Organisation in 1960 for the selective control of wild oats in cereals (Holroyd 1960). The experiments reported in this paper, carried out by the N.A.A.S., were designed to corroborate the work of the Weed Research Organisation.

METHODS AND MATERIALS

Barban * and X * were each investigated in a separate series of experiments.

Barban

The experiments were carried out on barley (Proctor, Rika and Freja), spring wheat (Jufy I), winter wheat (Cappelle and Hybrid 46), drying peas and beans all infested with the common wild oat (Avena fatua). The standard design embodied barban at 4 and 8 oz/ac applied at approximately the 1½ to 2 - and the 4 - leaf stages of the wild oats, with and without MCPA at 24 oz/ac applied on the second occasion. Three exceptions to these treatments were at Watlington where mecocrop at 40 oz/ac replaced MCPA, at Blandford where the MCPA was applied along with the barban on each occasion and not only at the time of the second spraying and at Warmington where there was one date of application only. The treatments on peas were barban at 4 and 8 oz/ac applied when the wild oats were at approximately the 1½ to 2-leaf and 4-leaf stages, and the treatments on the beans were barban at 8, 12 and 16 oz/ac when the wild oats were at approximately the 2-leaf stage.

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*Barban as "Carbyne" and X as "Avadex".

The layouts were randomised block experiments with threefold replication in the cereal and bean experiments and fourfold replication in the pea experiments. The plot sizes in the cereal experiments were 1/100 to 1/400 ac with the exception of Watlington where plots were 1/22 ac. Barban was applied at 10-20 gal/ac by a Vehicle-mounted sprayer at Watlington and by an Oxford Precision Sprayer at the other sites. Details of each site are given in Table I.

2,3-dichloroallyl di-isopropylthiolcarbamate

The experiments were carried out on barley (Rika and Proctor) and treatments were applied to the soil, at either $\frac{3}{4}$, 1, $1\frac{1}{2}$ and 3 lb/ac or $1\frac{1}{2}$, 2, 3 and 6 lb/ac, before sowing the crop. The layout was in each case a randomised block with two control plots per block and three replicates. The plot size was approximately 1/140 ac with the exception of Watlington where plots were 1/22 ac. The volume rate used was 15 or 20 gal/ac. The chemical was applied to the soil surface and in every case was incorporated into the soil on the day of spraying by at least one stroke of the harrow or cultivator. Details of the experiments are given in Table II.

RESULTS

Barban

Crop

The effect of the treatments on the crop during the growing season are summarised in Table III and yields recorded in seven experiments are shown in Table IV. In four of the seven experiments on barley, no visible effect of the treatments was seen on the crop. In the remainder of the barley experiments and in the spring wheat experiment some of the treatments checked the crop, later applications and lower doses being generally less harmful than earlier applications and higher doses. The use of MCPA or mecoprop had little influence on the visible effect of barban on spring wheat or barley. Yields from all treatments in one trial on Rika were similar to the yield from the control plots but in the second harvested barley trial (Proctor) treatments depressed yield, particularly those applied early. On Jufy I spring wheat, treatments led to improved yields.

On winter wheat all treatments visibly checked the crop to some extent, the later treatments being more harmful than early treatments. The use of MCPA had little influence on the effect of early treatments with barban and 4 oz of barban at the later spraying, but with 8 oz barban at the later date it increased the damage. Table IV shows that the only depressed yields with barban were from late applications combined with MCPA.

Neither pea experiment was harvested but there was no visible sign of damage to the crop. Yields from the bean experiment showed the yield to be nearly trebled by all treatments.

Wild Oats

The control of wild oats (Avena fatua) achieved is summarised in Table V which is based on counts of all panicles, or scoring for panicle density at harvest time. Earlier applications when the wild oats were at about the 2-leaf stage have in nearly every case given a better control than later applications at the 4 to 5-leaf stage. The higher dose has usually given better control of wild oats than the lower dose at the early date of application but results are variable in this respect from the later applications. The addition of MCPA or mecoprop has had little influence on the earlier applications of barban but when included with the later spraying has, particularly with the higher dose, had adverse effects. Some of the variability in results can be explained by the markedly uneven infestation of wild oats at sites 3, 4, and 10 and inadequate method of assessment as at sites 2, 6 and 13. The control of wild oats from 8, 12 and 16 oz of barban on spring beans was 58, 67 and 79 per cent respectively.

2,3-dichloroallyl di-isopropylthiolcarbamate

Crop

The effect of the treatments on the crop during the growing season are summarised in Table VI and yields, recorded in three experiments are shown in Table VII. In no instance did ¾ or 1 lb/ac appear to cause appreciable harm to the crop. At doses higher than 1 lb/ac the crop response was variable. During the growing season 1½ lb/ac affected the crop in half the experiments, and higher doses tended to increase the incidence and intensity of the damage. Slight reduction in crop density was not reflected in reduction in yield (reduction in wild oat competition was probably compensatory) but reduction in plant density in the order of 25 per cent or more was accompanied by reduced yields in the experiments where yields were taken. The evidence available does not suggest that the interval between spraying and sowing, the soil condition at the time of spraying, or crop variety have had any marked influence on results on the crop.

Wild Oats

The control of wild oats achieved is summarised in Table VIII which is based on counts of all panicles at harvest time. The control of wild oats was variable, 1½ lb/ac in every experiment but one gave a 80 - 100 per cent control by harvest time. Increasing the dose above 1½ lb generally did not improve results. The condition of the soil at the time of spraying does not appear to have had any marked effect.

DISCUSSION

Barban

Part of the variability in the results on the control of wild oats may be due to uneven infestation of wild oats over the experimental area or to inadequate method of assessment. It is obvious however, that the stage of growth of wild oat when sprayed is very important and the wide range of stages of growth of wild oat that occurred at any one time and place in the spring of 1960 may also have contributed to the variable results.

The mean percentage reduction in wild oat panicles from a dose of 4 oz barban applied early was 66 (Table V). In only two experiments was the control greater than 90 per cent from this dose, which is rather surprising to the author in view of the apparently good control seen at several cereal sites. This suggests that treatment had reduced the straw length of the surviving wild oat so that the panicles did not appear above the level of the crop and were not readily seen. This was the case at site 8 on spring wheat where the wild oat panicles above the crop in the control plots were 70 per cent of the total, but only approximately 30 per cent of the total where 4 oz of barban had been applied early with or without mecoprop, 22 per cent where 8 oz of barban had been applied later and 6 per cent where 8 oz applied later had been followed with 40 oz of mecoprop, Assessments of this nature were not made at any other site. The results shown in table V are biased against barban treatment because of the absence of any indication of treatment effect on the size of panicle, a small panicle with one or two seeds counting as much as a large panicle, heavy with seed.

The effect of crop competition is important (Pfeiffer 1960) and the increases in wild oat panicles from all late application of barban at site 11 and the remarkable increase in wild oats at site 9 following later spraying with 8 oz barban plus MCPA were probably a reflection of the severe early check caused to the crop by the treatment.

The marked stunting of winter wheat by barban was quite unexpected and tended to be more severe from March applications than February applications. Yields, however, were depressed only on the most severely affected plots, and following some treatments there was an increase in wild oats but no decrease in crop yield. Checking of spring cereal crops also occurred in some instances. Proctor is known to be particularly sensitive to barban and in the one experiment on Proctor which was harvested, yields were depressed.

The yields obtained suggest that the spraying of cereals (with the exception of known sensitive varieties such as Proctor) infested with wild oats is beneficial in so far as crop yield is concerned, even though slight checking to the crop may occur and the control of wild oats is not complete. This indicates marked competition by wild oats, which may be alleviated with barban, through check to the weed, or reduction in population, or both.

2,3-dichloroallyl di-isopropylthiolcarbamate (X)

There were fewer experiments on this chemical but the control of wild oats tended to be more consistent than in the barban experiments. The poorest result was at site 19 where the maximum control was 60 per cent with a dose of 1½ lb/ac. In the other experiments this dose produced an 80 per cent or more reduction in wild oat panicles.

In only about half the experiments did barban at any dose produce a reduction of 80 per cent or more (see Table V). Direct comparison between counts from experiments with barban and X may be misleading, however, in view of the effect barban has on panicle size and plant vigour. Wild oats not succumbing to treatment with X appeared to grow away fairly normally.

Timing of the spray with X does not appear to be critical so long as the chemical is mixed into the soil before sowing the crop, although it is necessary to discover if a very early application will persist sufficiently, under differing conditions, to control wild oats germinating some time later. The results of the present series of experiments would have been more interesting if the main germination of the wild oats had been recorded. Soil-acting chemicals are generally very much influenced by soil type and soil conditions and further testing under a wider range of conditions is necessary.

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TABLE I.

Site	1 Baldock		2 Warmington	3 Blandford	
N.A.A.S. Region	East		East Midland	South West	
Crop Variety	Barley Rika		Barley Rika	Barley Rika	
Treatments	4 & 8 oz early & later ± 24 oz MCPA		4 & 8 oz ± 24 oz MCPA	4 & 8 oz early & later ± 24 oz MCPA *	
Vol(gal per ac)	10		10	10	
Dates of spraying	25/4	23/5	20/5	27/4	25/5
Stage growth of crop No. leaves on main stem Height (in.)	2.9 6½	well tillered -	4½ 8½	2½ 4	4 to 5 10
Stage growth W. Oats No. leaves on main stem Height (in.) Density (per sq ft)	2.1 3 to 4 2.6	well tillered 13 6.2	3.8 - 3.3	1½ to 2 3 -	3 to 4 7 -
Density of other weeds per sq ft	7	26	-	-	-

Note: Where figures for stages of growth are given to one decimal place they are the result of random replicated samples; otherwise the assessment is the result of casual observation

* MCPA was applied along with the barban at both times of application

\- A blank indicates that information is not available.

DETAILS OF EXPERIMENTS WITH BARBAN

4 Aldborne		5 Ovingham		6 Taunton		7 Redcar	
South West		North		South West		North	
Barley Proctor		Barley Proctor		Barley Proctor		Barley Freja	
4 & 8 oz early & later + 24 oz MCPA		4 & 8 oz early & later + 24 oz MCPA		4 & 8 oz early & later + 24 oz MCPA		4 & 8 oz early & later + 24 oz MCPA	
10		10		10		10	
21/4	25/5	27/4	24/5	9/5	23/5	4/5	30/5
1.8	4.5	2.4	4.3	5.1	-	1.2	3.8
-	-	3	9 to 12	4½	10	2	7
1½ to 2	-	2.1	3.4	1 to 6	-	1.3	3.7
2	-	1½	8	-	-	1 to 1½	6
1.2	-	15.1	-	-	-	16.3	14.4
-	-	5	10	-	7	5	5

TABLE I.

Site	8 Watlington		9 March		10 Takeley	
N.A.A.S. Region	South East		East		East	
Crop	Spring wheat		Winter wheat		Winter wheat	
Variety	Jufy I		Cappelle		Cappelle	
Treatments	4 & 8 oz early and later ± 40 oz mecoprop		4 & 8 oz early and later ± 24 oz MCPA		4 & 8 oz early and later ± 24 oz MCPA	
Vol (gal per ac)	20		10		10	
Dates of spraying	25/4	9/5	23/2	23/3	8/3	28/3
Stage of growth of crop						
No. leaves on main stem	2½	3½	3 to 3½	4½	3	5 to 6
Height (in.)	5½	9	-	4 to 6	-	6.3
Stage growth wild oats						
No. leaves on main stem	2.1	2.8	1½ to 3	4	1 to 3	4
Height (in.)	3 to 4	2 to 5	-	3 to 6	2 to 3½	1 to 3½
Density (per sq ft)	9.8	14.2	-	7.8	-	3.5
Density of other weeds per sq ft	-	4.8	-	22	-	8½

(Contd.)

11 Papworth	12 Debenham	13 Takeley	14 Britwell
East	East	East	South East
Winter wheat Hybrid 46	Peas -	Peas -	Spring beans -
4 & 8 oz early and later ± 24 oz MCPA	4 & 8 oz early and later	4 & 8 oz early and later	8, 12 & 16 oz
10	10	10	20
19/2 22/3	29/4 25/5	11/4 4/5	22/4
3¼ 4 to 5 - 5 to 7	2 to 3 6.6 2 to 3 8	¾ 3.6 1¼ 2 to 3	1 to 2 2 to 3
2½ 3¼ - 3½ - 8.3	1.5 4.7 2½ to 4 9 15.3 10.9	1.1 2.7 1 to 3½ 3½ 3.1 1.9	1½ to 3 3 to 4 -
- 4.8	- -	- -	-

TABLE II.

Site	15 Baldock	16 Haverhill	17 Warmington
N.A.A.S. Region	East	East	East Midland
Crop Variety	Barley Rika	Barley Rika	Barley Rika
Date of spraying	15/3	14/3	7/4
Date of sowing	21/3	1/4	11/4
Treatments (as lb/ac)	1½, 2, 3 & 6	1½, 2, 3 & 6	¾, 1, 1½ & 3
Cultivations	-/2 cultivated 15/3 pitchpole once after spraying 21/3 harrow & roll after drilling	14/3 harrowed once (duckfoot) 1/4 harrowed once after drilling	Harrowed twice before 7/4 Harrowed after spraying & once more on 8/4
Condition of soil when sprayed	Fairly fine tilth, moist	Very rough, moist	Fine and dry
Soil type	-	heavy	-

DETAILS OF EXPERIMENTS WITH X

18 Blandford	19 Swindon	20 Watlington
South West	South West	South East
Barley Rika	Barley Proctor	Barley Proctor
21/3	22/3	18/3
22/3	22/3	21/3
$\frac{3}{4}$, 1, $1\frac{1}{2}$ & 3	$\frac{3}{4}$, 1, $1\frac{1}{2}$ & 3	$\frac{3}{4}$, 1, $1\frac{1}{2}$ & 3
15/3 plough 21/3 cultivated once 22/3 cultivated once, harrowed	21/3 harrowed 22/3 & cultivated 23/3 harrowed after drilling	18/3 cultivated once before and after spraying
Freshly ploughed furrow, moist	Loose, fine tilth	Rough, drying on surface but wet and cold below
medium loam over chalk	light loam over chalk	heavy

TABLE III. EFFECT OF TREATMENTS WITH BARBAN ON VIGOUR AND/OR HEIGHT OF CROP DURING GROWING SEASON (TREATMENT MEANS)

(Vigour by score 0 to 10 where 0 = crop dead and 10 = maximum growth; height in inches)

Site	1		5	6	8	9		10		11	
Variety of Crop	Rika		Proctor	Proctor	Jufy I	Cappello		Cappelle		Hybrid 46	
Date of assessment	15/6		at harvest	15/7	20/6	18/5		26/5		23/5	
Type of assessment	ht	vigour	ht	-	vigour	ht	vigour	ht	vigour	ht	vigour
Barban @ 4 oz (applied early)	33.0	9.7	28	Crop apparently not affected except that 8 oz barban, early, checked crop	9.0	27.3	9.7	27.7	9.8	27.7	9.2
" " 8 oz (applied early)	31.7	8.7	25		9.0	27.3	9.5	25.3	8.7	23.7	7.8
" " 4 oz + MCPA (applied early)	33.0	10.0	28		9.2	27.3	9.7	28.0	9.7	27.3	9.2
" " 8 oz " " (applied early)	29.7	7.0	26		8.7	28.3	9.5	25.0	9.0	23.7	7.7
Barban @ 4 oz (applied late)	33.3	10.0	28		9.7	26.3	9.2	27.7	9.3	22.0	7.0
" " 8 oz (applied late)	33.0	9.3	28		9.0	24.0	7.2	24.0	8.0	20.7	5.0
" " 4 oz + MCPA (applied late)	32.7	9.0	28		9.7	24.3	7.2	27.7	9.8	25.3	8.3
" " 8 oz " " (applied late)	30.0	8.8	23		9.2	20.0	5.2	22.0	7.3	9.7	3.3
MCPA	32.7	9.7	28		9.3	29.0	9.8	26.7	9.3	30.3	10.0
Control	33.2	9.5	28		9.8	28.0	10.0	27.9	9.9	29.7	10.0

In the remaining experiments - 2 & 3 (Rika), 4 (Proctor), 7 (Freja), 12 & 13 (Peas and 14 (Spring Beans) - little or no effect on crops was seen.

(78178)

TABLE IV. MEAN YIELD OF CROPS TREATED WITH BARBAN AS PER CENT OF CONTROL

Site		1	6	8	9	10	11	14
Variety		Rika	Proctor	Jufy I	Cappelle	Cappelle	Hybrid 46	Spring Beans
Barban 4 oz	applied early	94	67	126	126	119	104	Barban 8 oz 263
" 8 oz	applied early	106	64	115	126	105	113	" 12 oz 275
" 4 oz + MCPA	applied early	96	84	130 †	149	103	114	" 16 oz 293
" 8 oz + MCPA	applied early	104	64	121 †	149	98	102	Control 100
" 4 oz	applied later	99	93	103	121	100	98	
" 8 oz	applied later	102	92	117	116	98	102	
" 4 oz + MCPA	applied later	96	88	104 †	106	93	102	
" 8 oz + MCPA	applied later	91	85	108 †	84	94	59	
MCPA		95	99	108	82	116	123	
Control		100	100	100	100	100	100	
Control Yield (cwt/ac)		26.7	20.5	19.0	38.1	33.5	28.6	6.5
Assessed		as harvested	at 15 per cent moisture	at 15 per cent moisture	as harvested	as harvested	as harvested	at 15 per cent moisture

† Mecoprop used instead of MCPA

TABLE V. PER CENT REDUCTION IN TOTAL NUMBER OF WILD OAT

Site	1	2	3	4	5	6
Crop	Barley	Barley	Barley	Barley	Barley	Barley
		*				*
Barban at 4oz)	47	-	38	47	60	+20
" " 8oz)	83	-	+179	52	85	0
" " 4oz + MCPA) early	24	-	42 †	60	68	+10
" " 8oz + MCPA)	96	-	+ 71 †	43	89	0
" " 4oz)	+37	72	+171	38	25	0
" " 8oz)	32	94	+58	38	45	+50
" " 4 oz + MCPA) later	+59	40	+108	46	29	+20
" " 8oz + MCPA)	8	37	+316	65	13	10
MCPA alone	+86	13	+208	68	18	+30
Mean density of wild oats in control plots (per sq yd)	19.25	approx	24.0	13.8	approx 100	-

\+ A plus sign indicated an increase in panicles of wild oats

* Figures based on assessments by scoring to an original scale of 0 to 10, where 0 = no wild oats and 10 = maximum density

† MCPA applied at same time at barban

‡ Mecoprop used instead of MCPA

PANICLES AT HARVEST TIME AFTER TREATMENT WITH BARBAN

7	8	9	10	11	12	13	14	Mean excl. expts 2, 6, 12, 13 & 14
Barley	Spring wheat	Wntr wheat	Wntr wheat	Wntr wheat	Peas	Peas *	Spring beans	
65	64	91	77	96	73	19	-	66
74	92	96	81	58	80	34	58	49
65	69 ‡	93	53	87	-	-	-	62
75	91 ‡	98	81	+2	-	-	-	55
9	12	69	45	+36	17	13	-	+5
12	30	50	75	+54	0	34	-	19
+1	+8 ‡	29	23	+82	-	-	-	+15
30	9 ‡	+174	23	+963	0	-	-	+144
9	15	+92	53	4	-	-	-	+24
16.8	81.9	41.4	27.0	19.4	112	-	123.6	

TABLE VI. THE EFFECTS ON THE CROP DURING THE GROWING SEASON OF THE TREATMENT WITH X

Site	15	16	17	18	19	20
Method of assessment	Score 0-10 for crop vigour	Crop density: plants per ft drill length	Crop density: tillers per ft drill length	-	-	Plants per sq yd
Date of assessment	24/5	9/5	18/5	11/4	-	25/4
¾ lb/ac	-	-	9.3	Thinning of crop noted at 1½ to 3 lb per acre	No effect noticed	260
1 "	-	-	10.0			237
1½ "	9.7	12.0	7.7			184
2 "	9.0	12.1	-			-
3 "	7.7	12.7	11.7			138
6 "	3.7	4.1	-			-
Control	10.0	16.6	11.0			274

TABLE VII. MEAN YIELD OF CROPS TREATED WITH X AS PERCENTAGE OF CONTROL

Site	15	16	20
Assessment	as harvested	as harvested	85 per cent dry matter
Variety	Rika	Rika	Proctor
$\frac{3}{4}$ lb/ac	-	-	102
1 "	-	-	101
$1\frac{1}{2}$ "	98	112	80
2 "	102	98	-
3 "	87	125	81
6 "	66	63	-
Control as cwt/ac	30	20	28

TABLE VIII. PERCENTAGE REDUCTION IN THE NUMBER OF WILD OAT PANICLES AT HARVEST TIME AFTER TREATMENT WITH X.

Site	15	16	17*	18	19	20
$\frac{3}{4}$ lb/ac	-	-	(85)	35	45	72
1 "	-	-	(69)	46	45	85
$1\frac{1}{2}$ "	100	93	(81)	81	60	92
2 "	96	97	-	-	-	-
3 "	100	96	(91)	72	55	95
6 "	100	92	-	-	-	-
No. panicles in control plots (mean/sq yd)	8.6	12.8	approx 30	43.0	1.1	5.1

* Figures based on assessments by scoring to an original of scale 0 - 10 where 0 = no wild oats and 10 = maximum density (= approx 30 panicles per sq yd).

EXPERIMENTS ON THE CONTROL OF WILD OATS IN PEAS : A PROGRESS REPORT, 1959-60

W. A. Armsby and J. D. Reynolds

Pea Growing Research Organisation, Yaxley, Peterborough

Summary: In 1959 trials were undertaken to establish the minimum interval that should elapse before drilling peas following pre-sowing application of propham at 3 lb per acre, to minimise risk to pea germination. Results of four trials indicated that a six-day interval is desirable. Four screening trials were done in 1959 and 1960 to test post-emergence applications of a number of "new" chemicals for the control of wild oats in peas. Only barban gave promising results.

INTRODUCTION

Between 1954 and 1958 the P.G.R.O. was associated with a large number of trials with TCA and propham for wild oat control in the pea crop; the results of 57 completed trials with TCA and 38 with propham were presented at the last three Conferences (Gregory et al, 1955; Holmes et al, 1957; Proctor and Armsby, 1957; Proctor and Armsby, 1960). These investigations led to recommendations for the use of both herbicides for this purpose, although it was recognised that each possessed certain drawbacks. TCA, although giving very good wild oat kills, can inflict severe crop injury with consequent loss of yield, while propham is less damaging to the crop (although on occasions pea emergence is adversely affected) but is less consistent than TCA in degree of wild oat eradication. Propham also has the advantage over TCA in that it can give useful control of certain broad-leaved weeds.

Except for some simple trials to elucidate the effect of propham on pea germination (described in Part I of this paper), it was considered that sufficient work had been carried out with both TCA and propham, and that further trials in 1959 and 1960 should be concerned with the screening of the many "new" chemical treatments which showed promise for wild oat and/or broad-leaved weed control in peas. Twenty-eight herbicide treatments were tested in these screening trials and the results of pre-sowing and pre-emergence applications have been reported separately (Reynolds and Armsby). Only the results of post-emergence applications are dealt with in the present contribution (Part II).

PART I: STUDIES ON EFFECT OF PRE-SOWING APPLICATIONS OF PROPHAM ON PEA PLANT POPULATIONS

METHODS AND MATERIALS

Four trials were carried out in 1959 to study the effect of pre-sowing applications of propham on pea emergence, with the object of finding the minimum period that should elapse between application and drilling of peas so as to reduce the risk to pea germination. Single plots were treated with propham wettable powder at 3 and 6 lb in 50 gal/ac of water (4 lb only in 50 gal/ac of water at one site) and an untreated plot left between them. Spraying was done with an Oxford Precision Sprayer using Allman "O" jets. Three rows of 100 pea seeds, variety Big Ben, were sown on each of the plots at intervals of approximately 0,2,6, 10 and 14 days after spraying. Due to delayed germination caused by propham, two series of pea counts were made on each trial at 2-4 week intervals.

RESULTS

Results are presented in Table I.

TABLE I. EMERGENCE COUNTS EXPRESSED AS PERCENTAGES OF UNTREATED CONTROLS

Trial 1 - Peaty loam soil, worked down with heavy harrows the day before chemical application which was made on 21 March. No cultivations before drilling.

Interval between spraying and drilling	Dose of propham			
	3 lb		6 lb	
Days	1st Count	2nd Count	1st Count	2nd Count
0	89	100	64	95
2	95	96	44	80
6	103	100	89	102
10	103	102	96	99
14	96	97	95	96

Trial 2 - Peaty loam soil, worked down with heavy harrows on 20 March. Chemical application made on 4 April. Light-harrowed and cross-harrowed immediately afterwards.

Interval between spraying and drilling	Dose of propham			
	3 lb		6 lb	
Days	1st Count	2nd Count	1st Count	2nd Count
0	96	97	88	95
2	105	100	93	98
6	104	102	91	92
10	101	101	95	96
16	107	104	102	100

Trial 3 - Organic loam soil, harrowed on 21 March. Chemical application made on 23 April. Light-harrowed immediately afterwards.

Interval between spraying and drilling	Dose of propham			
	3 lb		6 lb	
Days	1st Count	2nd Count	1st Count	2nd Count
0	102	103	98	102
2	102	104	93	97
6	101	102	100	103
9	102	102	101	105

Trial 4 - Clay-loam soil, harrowed before chemical application on 4th April, and whole area rotovated afterwards.

Interval between spraying and drilling	Dose of propham 4 lb	
Days	1st Count	2nd Count
0	81	89
2	90	95
6	91	96
10	97	98
14	101	106
18	106	106

DISCUSSION

It is evident that pre-sowing applications of propham can either delay emergence or reduce the pea plant population. Repeat counts made on trials in 1958 where germination was effected by propham did not reveal delayed germination but pea kill. Soil conditions in 1958 were inclined to be cold and wet and it is possible that under these adverse conditions the peas did not survive the initial setback. In 1959 much better growing conditions prevailed, which allowed the peas to overcome initial damage and make healthy growth subsequently.

The results of these trials confirm that the longer the interval between propham application and sowing, the smaller the risk to pea germination. Previous work has indicated that best wild oat kill results when propham is applied 1-2 weeks before drilling (Proctor and Armsby 1960; Murant 1960) and it has been recommended that peas should be sown 4-14 days after an application of 3 lb/ac (Armsby, 1958). In the light of the present trials, and in order to further reduce the danger of pea damage, it is advised that an interval of 6-14 days should elapse between spray application and sowing.

PART II: STUDIES ON POST-EMERGENCE APPLICATIONS OF "NEW" CHEMICALS

METHODS AND MATERIALS

A completely randomised block layout with two-fold replication was used at each of the four sites, and all herbicides were applied by means of an Oxford Precision Sprayer. The spray volume used throughout was equivalent to 50 gal/ac, using Allman "0" jets, except that in 1960 "000" jets set at an angle of 45°* were employed for barban, which was applied in 20 gal/ac of water. Individual plot size was approximately 0.005 ac.

The chemicals, each tested at two rates (see tables II, III and IV), were:

1959: atrazine, 50 per cent wettable powder; maleic hydrazide (25 per cent triethanolamine salt solution); fenac (18 per cent sodium salt

* In all other experiments the jets were directed vertically downwards.

solution); dalapon (85 per cent sodium salt soluble powder); dalapon 85 per cent sodium salt soluble powder) plus dinoseb (18.5 per cent alkanolamine salt solution); dalapon (85 per cent sodium salt soluble powder) plus MCPB (40 per cent sodium salt solution); amiben (24 per cent triethylamine salt solution).

1960: barban† (12 per cent emulsifiable concentrate); atrazine (50 per cent wettable powder); amiben (24 per cent triethylamine salt solution).

The following are the site details (1959: Trials A and B; 1960 Trials C and D).

	Trial A	Trial B
Site	Stonea, Cambs.	Shelton, Beds.
Soil type	Loam	Silty loam
Wild oat population/ sq yd	<1‡	25
Variety of pea	Zelka	Harrison's Glory
Date of sowing	17 March	20 March
Date of emergence	8 April	7 April
Date of herbicide applications	7 May	8 May
Weather conditions at time of applications	Sunny, no wind Air temp. 62°F.	Sunny, little wind Air temp. 65°F.
Average size of plants at time of applications		
Peas	4-5 in. high	4-5 in. high
Wild oats	3-leaf stage, tillering	3-leaf stage, tillering
Broad-leaved weeds	Seedling to 2-leaf stage	Seedling to 2-leaf stage

† Included at three times of application in Trial C only.

‡ The number of wild oats that emerged at this site was very much less than expected.

		Trial C	Trial D
Site		Kimbolton, Hunts.	Whittlesey, Peterborough
Soil type		Clay loam	Peaty loam
Wild oat population/ sq yd		68	17
Variety of pea		Big Ben	Big Ben
Date of sowing		2 March	11 March
Date of pea emergence		24 March	31 March
Date of herbicide applications	Early	8 April	8 April
	Inter	19 April	12 April
	Late	28 April	-
Weather conditions at time of applications	Early	Sunny, little wind Air temp. 55°F.	Sunny, little wind Air temp. 55°F.
	Inter	Warm but windy Air temp. 55°F.	Cold and windy Air temp. 48°F.
	Late	Some wind Air temp. 50°F.	-
Average size of plants at time of applications Peas	Early	1 in. high, starting to unfold	1 in. high, starting to unfold
	Inter	2 in. high, unfolded	1-1½ in. high, unfolding
	Late	3-4 in. high	-
Wild oats	Early	1-1¼-leaf stage, still emerging	1-leaf stage, still emerging
	Inter	1-2-leaf stage, some still emerging	1-1½-leaf stage
	Late	1-3-leaf stage, starting to tiller	-
Broad-leaved weeds	Early	Seedling stage	Seedling stage
	Inter	Seedling to 2-leaf stage	Seedling stage
	Late	2-3-leaf stage	-

RESULTS

1959 Trials

Assessments were limited to making periodic notes on the appearance of the peas and weeds. On Trial A the almost complete absence of wild oats allowed the effect of treatments on broad-leaved weeds to be recorded, whilst on Trial B the dominating wild oats made any assessment of broad-leaved weed control virtually impossible. Results are summarised in Table II.

TABLE II. VISUAL ASSESSMENT OF TREATMENTS, 1959 TRIALS

Chemical	Dose (lb/ac)	Trial A		Trial B	
		Peas	Broad-leaved weeds*	Peas	Wild oats
Atrazine	1	Marginal chlorosis of lower leaves	Good weed control excepting mayweed and wild oats	No effect	No control
	2	Some scorch of lower leaves	Good weed control, mayweed slightly checked	No drastic effect, perhaps fewer pods	No control
Maleic hydrazide	5	Peas stunted and very pale. Low yield.	Mayweed controlled, other weeds stunted.	Severe stunting and loss of colour. Yield reduced.	Very good control
	10	Severe stunting and loss of colour. No yield.	"	Very severe stunting. No pods produced.	Complete control
Fenac	2	Severe stunting and distortion	No effect	Very stunted	Wild oats greener and more vigorous
	4	Peas severely distorted	Slight check to weeds	Severely stunted and retarded	"
Dalapon	1.5	Loss of bloom. Yield appeared unaffected.	No effect	No effect	Wild oats appeared less vigorous
	3	"	"	"	"
Dalapon + amine dinoseb	1 + 1	Loss of bloom	Good control	No effect	No effect
	2 + 2	"	Very good control	"	Wild oats appeared to be more sparse

* Broad-leaved weeds present on Trial A included black bindweed (Polygonum convolvulus), redshank (Polygonum persicaria), fathen (Chenopodium album), scentless mayweed (Matricaria maritima ssp. inodora), hempnettle (Galeopsis tetrahit), chickweed (Stellaria media), wild radish (Raphanus raphanistrum), shepherd's purse (Capsella bursa-pastoris), speedwell (Veronica spp.), knotgrass (Polygonum aviculare), white campion (Melandrium album) and charlock (Sinapis arvensis).

TABLE II (CONT)

Chemical	Dose (lb/ac)	Trial A		Trial B	
		Peas	Broad-leaved weeds*	Peas	Wild oats
Dalapon + MCPB	1 + 2	Loss of bloom	No effect	No effect	Slight reduction in vigour
	2 + 4	"	Black bindweed checked	"	"
Amiben	4	No effect	No effect	No effect	No effect
	8	Slightly stunted	Black bindweed controlled	"	"

1960 Trials

Trial C

The wild oat stand was uniformly dense at this site, and five scorings at weekly intervals were made for loss of pea vigour and wild oat control, after applications had been made. Weights of wild oat plants were obtained from one square yard per plot prior to harvesting, and wild oat panicles were weighed separately for comparison against total weight of heads plus straw (Table III). The whole of each plot was harvested for yield determination (Table IV).

TABLE III. YIELDS OF WILD OAT PLANTS (STRAW + HEADS) IN CWT/AC, 1960 TRIALS

Time of Application	Untreated	Atrazine		Amiben		Barban			
		1 lb	2 lb	4 lb	8 lb	0.5 lb	0.75 lb	1.0 lb	Mean
Early		78.3	12.2	124.2	(±12.1) 108.0	25.7	35.1	31.1	(±7.0) 30.6
Inter.						14.9	14.9	18.9	16.2
Late						54.0	39.2	29.7	41.0
Mean	(±8.5) 114.1	78.3	(±12.1) 12.2	124.2	108.0	31.5	(±7.0) 29.7	26.6	29.3

S.E. per plot as per cent of general mean = 31.4 (14 d.f.)

Sig. differences in cwt/ac	P = 0.05	P = 0.01
Between treatments in body of table	36.6	50.8
" means of barban treatments	21.1	29.3
" untreated and treatments in body of table	31.7	44.0
" untreated and means of barban treatments	23.6	32.8

* Broad-leaved weeds present on Trial A included black bindweed (*Polygonum convolvulus*), redshank (*Polygonum persicaria*), fathen (*Chenopodium album*), scentless mayweed (*Matricaria maritima* ssp. *inodora*), hempnettle (*Galeopsis tetrahit*), chickweed (*Stellaria media*), wild radish (*Raphanus raphanistrum*), shepherd's purse (*Capsella bursa-pastoris*), speedwell (*Veronica* spp.), knotgrass (*Polygonum aviculare*), white campion (*Melandrium album*) and charlock (*Sinapis arvensis*)

TABLE IV. YIELDS OF THRESHED PEAS IN CWT/AC, 1960 TRIALS

Time of Application	Untreated	Atrazine		Amiben		Barban			
		1 lb	2 lb	4 lb	8 lb	0.5 lb	0.75 lb	1.0 lb	Mean
Early		11.9	12.0	8.9	(±1.6) 7.8	18.3	18.6	18.3	(±0.9) 18.4
Inter.						16.3	17.0	14.0	15.8
Late						12.5	16.7	17.3	15.5
Mean	(±1.1) 8.6	11.9	(±1.6) 12.0	8.9	7.8	15.7	(±0.9) 17.4	16.5	16.6

S.E. per plot as per cent of general mean = 16.6 (14 d.f.)

Sig. differences in cwt/ac

	P = 0.05	P = 0.01
Between treatments in body of table	4.9	6.8
" means of barban treatments	2.8	3.9
" untreated and treatments in body of table	4.2	5.9
" untreated and means of barban treatments	3.2	4.4

Effects on Peas - The series of assessments for loss of pea vigour are not presented in this paper; in any case scorings on a particular date are not comparable since recording did not begin until all applications had been made. Results indicated, however, little or no pea damage by the three doses of barban at the first (early) time of application. Considerable pea damage in the form of schorching of the lower leaves and loss of foliage colour was caused by the second (intermediate) application and became more pronounced with increasing dose. The third (late) application of barban also resulted in pea damage, but not to the extent of the intermediate application, and was again more severe with the higher doses.

These results are reflected in the yields obtained (Table IV), which show that early application of barban led to significantly more peas than the late application. The difference between the early and intermediate applications also approached significance at P = 0.05. Differences in yield between doses of barban did not reach significance except that 1 lb applied late resulted in a higher yield than 0.5 lb, presumably because of the inferior wild oat control achieved by the latter treatment (Table III). Despite crop damage, barban at all doses and times of application significantly outyielded the untreated controls, by reducing wild oat competition.

The high dose of atrazine led to considerable loss of pea vigour and some plants succumbed. This effect was less noticeable with 1 lb. Amiben at both doses caused the peas to lose colour. Yields from both doses of these two herbicides were not significantly different from the untreated controls, although the higher yields from the atrazine treatments (Table IV) followed the significant effect of this herbicide on the wild oat population, particularly at the higher (2 lb) dose (Table III).

Effects on Wild Oats - Weights of whole wild oat plants and heads were recorded to determine if certain treatments, whether or not reducing the population, had the effect of inhibiting flowering and seed production. In general, however, all weights of heads and whole plants were approximately proportional to those from the untreated controls. By comparison with no treatment, all applications of atrazine and barban significantly reduced wild oat competition in terms of weight of straw. The difference between the amiben applications and untreated controls was not significant. Lower wild oat straw weights were given by the intermediate application of barban, compared with the early and late (significant) applications. Differences between doses were not significant.

Effects on Broad-leaved Weeds - Barban, at all doses and times of application, had little effect on broad-leaved weeds. Both doses of atrazine gave a complete kill and amiben also gave very good results in this respect.

Trial D

Visual scorings indicated that neither atrazine nor amiben had any lasting effects on peas, wild oats or broad-leaved weeds on this soil type. Barban-treated plots showed some pea chlorosis at 1 lb, but lower doses caused no visual damage. Broad-leaved weeds were only slightly affected by barban, but wild oats appeared stunted with blackened tips a few days after applications. By June wild oats were virtually non-existent on the barban plots, with little difference between doses. The extreme unevenness of wild oats at this site did not make pea and wild oat yield assessments worth while.

Discussion

No chemical treatments used post-emergence in 1959 showed promise for the control of wild oats in peas at any time or dose tested. Only maleic hydrazide gave satisfactory wild oat control, but with a drastic effect on the peas.

As amiben and atrazine function mainly through the plant's root system and as a result of observations made on pre-emergence applications of these herbicides it was decided to apply them in the 1960 trials soon after pea emergence when the wild oats were small and vulnerable. It was also considered that this time of application might result in less pea damage by these chemicals. In the event amiben caused less pea damage when used post-emergence at Trial C in 1960, compared with the pre-emergence application, but gave no control of wild oats. On the other hand the high dose of atrazine led to an excellent wild oat kill but produced more pea damage than the pre-emergence application (Reynolds and Armsby, 1960). On the basis of the 1960 trials neither amiben nor atrazine would appear to warrant further tests as post-emergence treatments for use in peas.

At Trial C all three rates of barban at the first (early) time of application resulted in an almost complete kill of wild oats that had emerged at that time; the peas were just beginning to unfold and suffered little visual damage. All rates of the second application also gave an equivalent control of all wild oats that had emerged; however, the peas had unfolded by this time and sustained more damage, in proportion to dose. It appeared that the yield depression caused by pea injury far outweighed the degree of wild oat control achieved. By the time of the third application, wild oats had become fairly well established and were tillering. Kills were not so good although they improved with increasing dose. Pea damage was less marked, possibly due to the fact that the plants were stronger and more established. The higher doses were only justified on the last application, when wild oats had commenced to tiller, and required larger doses to secure adequate control. It is possible that two applications of, say, 0.25-0.375 lb/ac, made at the time of the first and third applications at Trial C would have given virtually complete wild oat control with minimum pea damage. Further trials with lower doses and two times of application would seem to be warranted.

It is not known if better wild oat kills were secured with barban by setting the sprayer jets at an angle of 45°, but is seems reasonable to assume that better coverage is obtained by this means. More trials are needed to study the effect of temperature and other conditions at the time of application of barban in relation to pea damage, but from these limited trials it appears that peas are less vulnerable immediately after emergence when the leaves have not unfolded, and again later on when they are larger and well-established.

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Presentation by Mr. J. Holroyd of preceding four papers

The methods used for the assessment of wild oat in the various trials reported differ considerably. In the N.A.A.S. trials, only total oat panicles were counted; in the WRO experiments the panicles were counted and classified according to size and maturity; and in the P.G.R.O. experiments, panicles and straw were weighed. One of the effects of barban is to reduce panicle size and the amount of seed produced, thus the method of assessment used in the N.A.A.S. trials underestimated the effectiveness of barban. The W.R.O. methods probably gave the best measure of the amount of seed produced and those of the P.G.R.O. a more accurate estimate of the effect of the treatments on the competitive powers of the oat.

Many of the differences between the two herbicides are due to the different methods and time of application used for each. To summarise these differences. (a) Barban is a post-emergence herbicide which must be applied when the main flush of wild oat has between 1 and 2½ leaves. (b) Crop competition with the wild oat must be vigorous to achieve a good control with barban. (c) Considerable yield increases can result from the use of barban in crops with moderately heavy infestations of wild oat, provided that there is little or no check to the crop itself; although the reduction in actual wild oat seed produced may not be very great. (d) The farmer has to be educated not only to recognise wild oat in the seedling stage but also to be able to judge when the main flush has between 1 and 2½ leaves. (e) The thiolcarbamate (X) is a soil acting herbicide which needs to be incorporated into the soil, the shallower and more efficiently the better; although as is shown in these papers good control of wild oat can be achieved in spite of relatively poor incorporation, as long as the soil clods are not too large. (f) X can cause crop damage, particularly of wheat, although it may be possible to overcome this by delaying drilling, increasing the seeding rate or modifying the method of incorporation. (g) However it has the advantage that the timing of the application need not be precias as long as the soil conditions are reasonably good and the incorporation is immediately after spraying. (h) Finally there is the psychological problem of persuading the farmer to spray before he sees his weed - this is particularly difficult as he can always persuade himself that "this is not going to be a wild oat year".

POT EXPERIMENTS WITH NEW HERBICIDES FOR THE CONTROL OF WILD OATS

K. Holly

*Agricultural Research Council, Unit of Experimental Agronomy, Department of Agriculture, Oxford

Summary: A series of experiments investigated the influence of a variety of factors on the efficiency of barban and 2,3-dichloroallyl diisopropylthiolcarbamate for the control of wild oats in cereals. With barban these factors included spray volume, site of spray deposition, stage of growth, depth of sowing and light intensity. The first three were particularly important. With 2,3-dichloroallyl diisopropylthiolcarbamate some variation in toxicity with soil type and environmental conditions was found, and an appreciable degree of persistance noted. Experiments on the feasibility of undersowing grass-clover mixtures in crops treated with these herbicides suggested that it might be possible with barban but not with the thiolcarbamate. A preliminary experiment indicated the possibility of some risk from spraying a post-emergence herbicide onto a crop treated with the thiolcarbamate.

INTRODUCTION

During the past two years two herbicides have been discovered in the United States and put forward as having potentialities for the selective control of wild oat in cereal crops. One was 4-chloro-2-butynyl-N-(3-chlorophenyl) carbamate (barban), used as a post-emergence spray (see Hoffman et al, 1960, which includes bibliography of earlier references). The other was 2,3-dichloroallyl diisopropylthiolcarbamate, used as a pre-sowing soil-incorporated treatment (Deming et al., 1959, Hannah, 1959). These two compounds were included in the Unit's programme of pot experiments to evaluate potential killers of wild oats (Holly, 1956). The present paper summarises the results of many experiments designed to investigate the influence of several factors on the activity of these two herbicides.

METHODS AND MATERIALS

A medium loam was used for the experiments with pre-sowing treatments. Incorporation was simulated by placing the appropriate amount of soil for the depth of incorporation required into a rectangular tin, spraying the herbicide on the surface, allowing a short time for drying, and then mixing the bulk of soil by pouring at least three times through a funnel. A definite number of seeds was then sown at the appropriate depth in this soil, in a suitable sized pot. After treatment the pots were kept in randomised blocks on the greenhouse bench and watered only by sub-surface irrigation to avoid leaching.

Plants for the post-emergence treatments were generally grown in a 2:1 soil-sand mixture. In the winter they were raised in the greenhouse; at other

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* Now on staff of Agricultural Research Council, Weed Research Organisation, Begbroke Hill, Kidlington, Oxford.

seasons they were grown in the open. After spraying they were protected from rain for about 24 hours and then given a heavy overhead watering.

A laboratory apparatus embodying a fan nozzle moving over the pots at constant speed was used for all spray applications. Volume rates of between 11 and 17 gal/ac were used generally. Both barban and 2,3-dichloroallyl diisopropylthiolcarbamate were applied as emulsions derived from proprietary emulsifiable concentretes ("Carbyne" and "Avadex" respectively.)

RESULTS

Barban

Volume rate

One of the earliest experiments in 1959 investigated the effect of variation in volume rate of application on the activity of barban. Different volume rates were obtained by changing the nozzle and speed of movement and adjusting the concentration to give the same dose per unit ground area. At the time of spraying the Avena fatua was at the two-leaf stage and Proctor barley very slightly in advance with the tip of the third leaf visible. Spray retention was measured by including tartrazine in the water phase of the emulsion, washing the foliage quantitatively and estimating the dye in the washings colorimetrically. Assuming the retention of the oil phase is proportional to that of the water phase the amount of barban retained per plant from an application at 1 lb/ac is shown in Figure 1. The proportion of oil to water of course varied according to volume rate and dose and ranged from 1.8 to 13.4 per cent v/v of oil at 1 lb/ac in these volumes. Barley consistently retained more than A.fatua and with both species retention was less efficient at the highest volume rate. The initial effect was a reduction in growth of both species. Plant heights were measured four weeks after spraying. These were reduced appreciably by 0.25 and 1.0 lb/ac. Differences between volume rates were small but with a slight trend for the 0.25 lb dose to have least effect at the highest volume rate. Ultimate mortality of plants and reduction in inflorescences produced was assessed 4½ months after spraying. The data for plant kill are shown in Figure 2. This was greatest at the low volume rates, with a reduced kill of barley at 18.7 gal/ac and above, and of A.fatua at 47.5 gal/ac. The same picture was presented by the data for the prevention of flowering.

Surface-active agents

Another way in which the characteristics of the spray application may be varied is by the addition of further surface-active agent above that already present as an emulsifier. A variety of substances were tried and some gave small increases in retention and toxicity to wheat, barley and A.fatua, but little useful change in selectivity.

Stage of growth

Early reports from the U.S.A. had indicated the importance of stage of growth in governing the response of A.fatua. This was verified in a pot experiment in which A.fatua, Proctor barley and Atle wheat, each at five stages of growth were all sprayed on the same occasion. The mortality of plants 12 weeks after spraying is shown in Figure 3. The resistance of wheat as

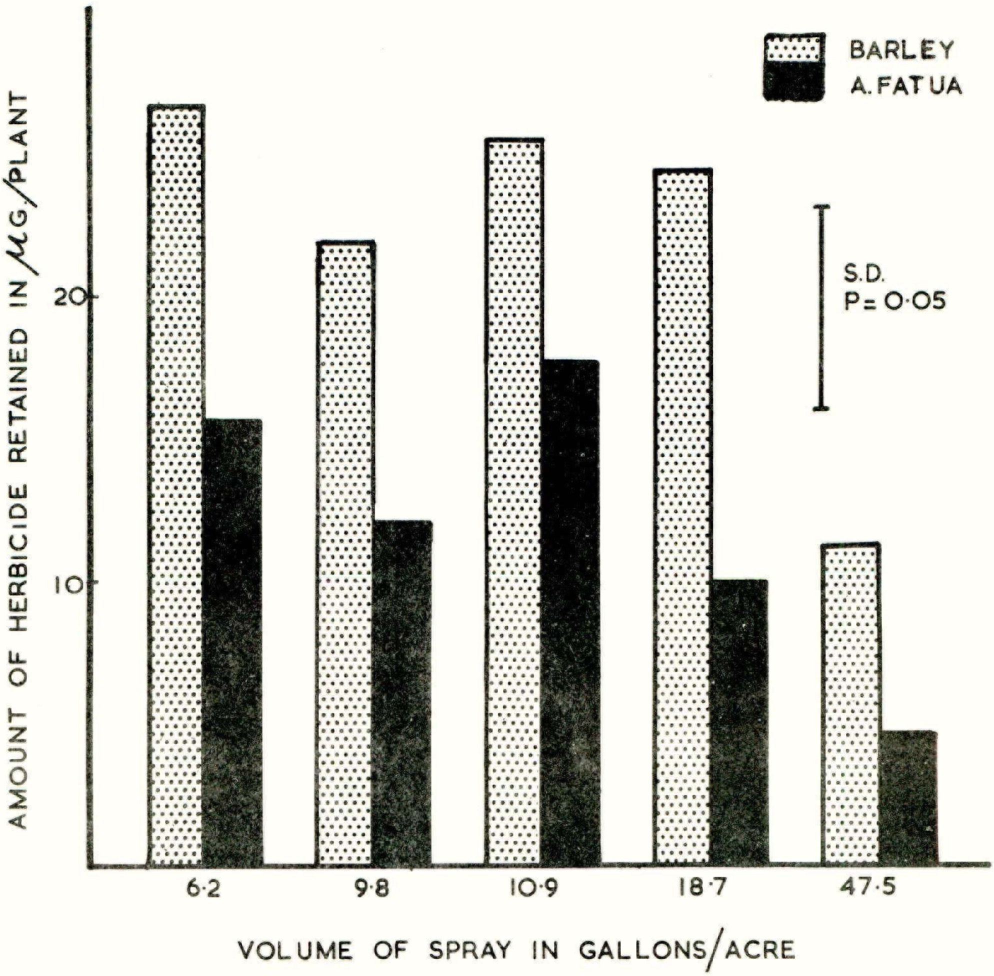

Fig. 1. Retention of barban by barley and A.fatua plants, when applied at 1 lb/ac in various volumes of spray.

compared with both Proctor barley and A.fatua is strikingly indicated. The latter was most susceptible at the 2 to 2½-leaf stage while the barley showed greatest susceptibility at a slightly later stage. Other data measuring growth inhibition 3 weeks after spraying and ultimate suppression of inflorescence production confirmed these indications, which, as far as A.fatua is concerned, are in line with American results (Hoffman et al., 1960). A separate experiment showed that pre-emergence applications of up to 3 lb/ac of barban on the soil surface or incorporated at the time of sowing were without effect on A.fatua.

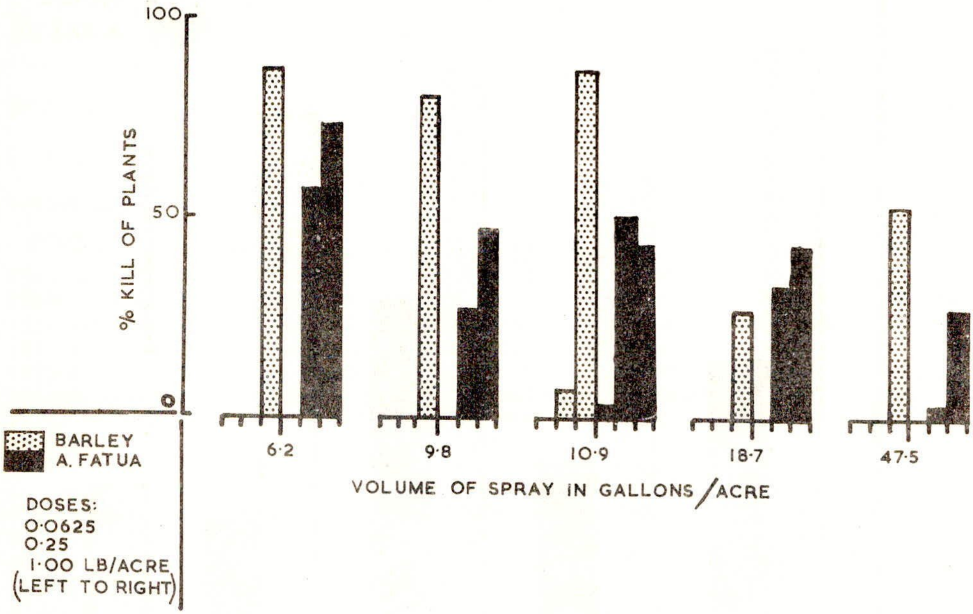

Fig. 2. Percentage kill of barley and A. fatua by barban at various volume rates.

Depth of sowing

Hoffman (unpublished information) suggested that depth of sowing influenced the recovery of wheat and barley but not of <u>A.fatua</u>, from treatment with barban. He indicated that this might be connected with the length of the translocation path from the soil surface to the growing point of the plant. A detailed investigation was made therefore of the depth of the growing point below the soil surface in relation to sowing depth of these plants. This culminated in an experiment to determine the response of plants sown at various depths and subsequently treated with barban. At the time of spraying there were only very slight differences in growth of plants from the various depths, namely ½, 1 and 2 inches. <u>A.fatua</u> was at the 1½-leaf stage while the cereals had 2-2½ leaves. There was a trend for the deepest sown Atle wheat and Rika barley to retain less spray than the shallow sown. There was no such trend with <u>A.fatua</u> or Proctor barley. The effect on the plants was assessed by measurement of fresh weight above ground level 2½ weeks after spraying. Even at the highest dose of 1 lb/ac there was no large effect on Rika barley. This dose caused a very considerable reduction in growth of the Proctor barley and <u>A.fatua</u> which was the same at all sowing depths. Atle wheat germinating from ½ and 1 inch was reduced in growth by about the same amount as the Proctor