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TRIALS WITH 2-AZIDO-4-ISOPROPYLAMINO-6-METHYLTHIO-S-TRIAZINE, C7019, AS A HERBICIDE FOR PEAS

T. G. Marks and J. M. Smith

CIBA Agrochemicals Ltd., Duxford, Cambridge

Summary C7019 was tested in 1967 and 1968 as a selective herbicide in peas. At 2.0 lb/ac a wide range of important weeds were controlled when applied either pre- or post-emergence before the weeds reached the 3 leaf stage. Both pre- and post-emergence applications of 2.0 lb/ac C7019 were well tolerated by peas and yields were the same as those obtained with standard herbicides. Maturity of the crop was unaffected by C7019. Trials were carried out under a wide range of climatic conditions and on a range of soil types, none of which were proved unsuitable for its use.

INTRODUCTION

2-azido-4-isopropylamino-6-methylthio-s-triazine was first reported by Green, Ebner and Schuler (1967) and introduced into the U.K. in 1966 as a candidate herbicide for cruciferous and leguminous crops. The results of trials in Brassica crops have been reported by Smith and Marks (1968).

Screening results indicated that pre-emergence applications of 1.5-3.0 lb/ac C7019 were tolerated by peas and in 1967 preliminary field trials were carried out on peas to confirm this. During 1967 it was reported by Ensor (1967) that post-emergence applications were also tolerated by peas and a further trial was carried out to investigate the effect of post-emergence applications of C7019 at various growth stages of the crop. These trials showed that C7019 was well tolerated by peas and in 1968 a series of yield trials was carried out to evaluate the effect of pre- and post-emergence applications of C7019 on peas and obtain further weed control data.

METHOD AND MATERIALS

A 50% wettable powder formulation of C7019 was used in all trials. Doses are given as pounds active ingredient per acre. Dinoseb amine was used according to recommendations as a comparator in all the replicated plot trials. Apart from the logarithmic trial all trials were of randomised block design with three replicates, except in the preliminary investigation in 1967 when only two replicates were used. In the logarithmic trials a dose range of 6.0-0.5 lb/ac C7019 was used to establish crop tolerance at different growth stages and doses of 1.5 and 2.0 lb/ac were used in the 1967 replicated plot trials. In 1968 a range of doses - 1.5, 2.0 and 4.0 lb/ac - of C7019 were used. All treatments were applied with a precision plot sprayer in 25-50 gal water per acre.

Crop counts were made on 2 x 6 ft row length in the 1967 and 1968 trials and crop health was scored according to the scale 1-9 recommended by the European Weed Research Council. In the 1968 trials weed assessments were also made in all trials using six or more quadrat counts from each plot about four weeks after the treatments were applied. Estimates of yield were obtained by cutting an area of 12 yd^2 per plot. The cut haulm was weighed and threshed using a Plot viner to obtain the yield of green peas. Samples of peas from each plot were subjected to tenderometer testing for quality assessment. In addition samples from pre- and post-emergence treatments were submitted for taint testing by the food processing industry.

RESULTS

The results of the 1967 replicated plot trials to test crop tolerance are shown in Table 1.

Table 1

Effect of pre-emergence applications of C7019 on crop population - 1967

	Site location, soil type and crop variety	Dose of C7019	No. of crop plants as % of control
A	Knapton, Norfolk Loamy fine sand Dark Skinned Perfection	1.5 2.0	100 99
B	Walcott, Norfolk Sandy loam Jade	1.5 2.0	70 74
C	Aylsham, Norfolk Loam Perfected Freezer	1.5 2.0	100 100

In logarithmic trials with applications of C7019 made pre-emergence, at 99% emergence, and at the 4 and 6 leaf stages the crop tolerated more than 4 lb/ac of C7019.

These results, together with results reported by Ensor (1967) and King (1967), indicated that peas were extremely tolerant of pre- and post-emergence applications of C7019. Similar crop tolerance was also shown in the 1968 trials, the results of which are given in Table 2.

The results in Table 2 also show that good weed control can be obtained using 2.0 lb/ac C7019 applied either pre- or post-emergence up to the 3-4 leaf stage of the crop. After the crop has reached the 3-4 leaf stage the weeds tend to be at more than the 3 leaf stage and poor weed control results as shown at site E. Pre-emergence applications of C7019 had no effect on the crop but post-emergence applications of 4.0 lb/ac C7019 tended to reduce the height of the crop. No other damage symptoms were observed.

Table 2

Effect of C7019 on crop and weeds - 1968

Site location, soil type and crop variety	Dose of C7019	Crop stage at application	% weed control	No. of crop plants as % of control	EWRC crop score
A	1.5	Pre-em.	93	99	1
Blyth, Notts.		2-3 leaf	71	100	1
Loamy coarse sand	2.0	Pre-em.	96	92	1
Freezer 69		2-3 leaf	83	100	1
	4.0	Pre-em.	94	90	1
		2-3 leaf	97	83	1
B	1.5	Pre-em.	94	100	1
Kellington, Yorks.		2-3 leaf	80	100	1
Coarse sandy loam	2.0	Pre-em.	94	100	1
Freezer 69		2-3 leaf	86	100	3
	4.0	Pre-em.	96	100	1
		2-3 leaf	95	100	5
C	1.5	Pre-em.	76	96	1
Marston, Lincs.		3-4 leaf	96	99	2
Coarse sandy loam	2.0	Pre-em.	96	100	1
Sprite		3-4 leaf	100	94	3
	4.0	Pre-em.	96	100	1
		3-4 leaf	98	100	3
D	1.75	8 leaf	5	91	1
Paxford, Worcs. Clay loam	2.0	8 leaf	45	91	1
Onward	4.0	8 leaf	36	100	1
E Duxford, Cambs.	2.0	2-3 leaf	68	100	1
Coarse sandy loam Onward	4.0	2-3 leaf	91	100	2

During 1967-1968 over 50 trials were carried out with C7019 on various crops and its effect on individual weed species at doses of 1.75-2.0 lb/ac are given in Table 3.

Table 3

Weed Control 1967 and 1968

	Pre-weed emergence				Post-weed emergence <3 leaf			
	No. of sites occurring	% weed control			No. of sites occurring	% weed control		
		100-80	79-25	<25		100-80	79-25	<25
Poa annua	14	10	4		3	3		
Anagallis arvensis	3	3						
Capsella bursa-pastoris	18	12	5	1	8	7	1	
Chenopodium album	21	13	6	2	10	9	1	
Fumaria officinalis	2	1	1		1	1		
Lamium amplexicaule	5	3	2		2	2		
Tripleurospermum and *Matricaria* spp.	24	22	1	1	16	14	1	1
Polygonum aviculare	18	9	6	3	11	9	2	
P. convolvulus	10	5	2	3	2	2		
P. persicaria	7	4	2	1	2	2		
Senecio vulgaris	17	17			8	8		
Sinapis arvensis	11	4	5	2	7	6	1	
Solanum nigrum	3	3			2	2		
Sonchus spp.	3	1	1	1				
Spergula arvensis	1	1						
Stellaria media	29	26	3		13	13		
Urtica urens	10	8	2		7	7		
Veronica persica	8	4	2	2	6	5	1	
V. hederifolia	8	5	2	1	3	1	1	1
Viola arvensis	2	2			5	4	1	
Thlaspi arvense					1	1		

The results given in Table 3 indicate that C7019 is effective when applied pre-emergence and when weeds are at the 3 leaf stage. Of the common annual weeds listed only *Veronica hederifolia* was not well controlled by C7019 applied at the <3 leaf stage. C7019 applied pre-weed emergence also gave satisfactory weed control, although the following spp. were not always completely controlled:- *Polygonum* spp., *Fumaria officinalis*, *Lamium* spp., *Sinapis arvensis*, *Sonchus* spp. and *Veronica* spp. Susceptible species to pre-emergence treatment were:- *Poa annua*, *Capsella bursa-pastoris*, *Chenopodium album*, *Tripleurospermum* and *Matricaria* spp., *Senecio vulgaris*, *Solanum nigrum*, *Spergula arvensis*, *Stellaria media*, *Urtica urens*, *Viola* spp. and *Anagallis arvensis*. It was found from results not reported here that perennial weeds and annual grasses other than *Poa annua* were not controlled by C7019.

The 1968 yield results are given in Table 4. These results show that 2.0 lb/ac C7019 applied pre- or post-emergence did not reduce the yield of whole haulm or vined peas in comparison with the standard herbicide except at site E. Similar results have been obtained by King (1968) and Doherty and Cassidy (1968). Maturity as measured by tenderometer readings were variable but treatment with C7019 either pre- or post-emergence did not affect the grading for processing at any site.

Table 4

Effect of C7019 on yield and quality of peas - 1968

Site	Compound	Dose lb/ac	Crop stage at application	Mean Yield Whole haulm tons/ac	Mean Yield Vined peas cwt/ac	Mean Tenderometer reading
A	C7019	2.0	Pre-em.	12.9	14.4	92.7
			2-3 leaf	13.6	18.3	93.3
	C7019	4.0	Pre-em.	12.7	18.3	96.8
			2-3 leaf	10.6	12.0	90.2
	dinoseb	1.85	4-5 leaf	11.6	18.5	95.9
		S.E. of diff. between means (12 d.f.)		±1.34	±1.99	--
B	C7019	2.0	Pre-em.	12.6	19.2	107.0
			2-3 leaf	12.2	20.3	102.8
	C7019	4.0	Pre-em.	11.9	17.3	102.5
			2-3 leaf	11.1	19.0	101.5
	dinoseb	1.85	4-5 leaf	11.9	18.5	104.8
		S.E. of diff. between means (12 d.f.)		±0.68	±1.59	--
C	C7019	2.0	Pre-em	18.7	39.1	105.2
			3-4 leaf	17.2	33.1	95.6
	C7019	4.0	Pre-em.	19.6	41.6	97.5
			3-4 leaf	15.9	30.6	93.2
	dinoseb	1.85	3-4 leaf	16.6	35.5	104.0
		S. E. of diff. between means (12 d.f.)		±1.12	±3.49	--
D	C7019	2.0	8 leaf	9.4	38.8	98.7
	C7019	4.0	8 leaf	8.4	26.1	93.7
	dinoseb	1.85	8 leaf	10.5	30.6	92.0
		S.E. of diff. between means (14 d.f.)		±0.58	±1.5	--
E	C7019	2.0	3-4 leaf	6.4	25.2	158.7
	C7019	4.0	3-4 leaf	6.7	26.4	158.7
	dinoseb	1.85	2-3 leaf	8.0	32.4	161.7
		S.E. of diff. between means (12 d.f.)		±0.14	±2.22	--

DISCUSSION

The results reported indicate that pre- or post-emergence applications of 2.0 lb/ac C7019 to peas give satisfactory control of a wide range of important weed species without adverse effect on the crop. It is important that post-emergence applications should be made before the weeds are larger than the 3 leaf stage for optimum results to be obtained.

The yield results do not show a consistent correlation between whole haulm weight and weight of vined peas and this is thought to be a reflection on the vining technique rather than any treatment effect. However, the results reported show that yields were largely unaffected by pre-emergence applications of 2.0 and 4.0 lb C7019 compared with the standard treatment and that post-emergence applications of 2.0 lb/ac were also well tolerated by peas. It is particularly noteworthy that at sites A and B the post-emergence applications of C7019 were made much earlier than the standard herbicide, dinoseb amine, when temperatures were frequently at less than $0^{o}C$. Sites A, B and C were also on soil types where the use of the residual herbicide prometryne is not recommended.

No varietal susceptibility to C7019 has been noted in the trials reported and from the taint testing reported by Arthey (1968) no taint has been found in canned or quick frozen peas treated with 6.8 lb/ac C7019.

It may be concluded therefore that C7019 at 2.0 lb/ac is a promising herbicide for pre- or post-emergence use in peas on all soil types.

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HARVEST MANAGEMENT WITH DIMEXAN

W.D. Kerkham

Bos Chemicals, Ltd., Gedney, Spalding, Lincs.

Summary During 1967 samples were taken from harvest pea crops which had been treated, prior to harvest, with dimexan and other chemicals. Tests showed that the treatments did not affect the germination of the peas and that dimexan treated peas were free from taint.

Harvest peas were treated with diquat at 0.5 lb/ac and with dimexan at a range of dose rates applied in different volumes of water. The effect of adding a wetter to dimexan applications was also studied. The initial rate of loss of moisture in the peas was highest with diquat and the best dimexan treatments were with 12.0 lb/ac in 30 gal/ac of water plus wetter and in 60 gal/ac water plus wetter. Samples were taken, during the wet summer of 1968, from sites treated with diquat at 0.5 lb/ac and with dimexan at the rate of 6.0 lb/ac. Loss of moisture from the peas was similar from both treatments.

An investigation undertaken to establish whether dimexan could be used to control carrot root size showed that where carrot foliage was sprayed with dimexan, crop growth was considerably reduced and the carrots remained immature in size and appearance.

INTRODUCTION

Continued production of harvest peas in the U.K. requires a reduction in labour demand at harvest time. One approach is to apply, when peas are mature, chemicals which hasten loss of moisture while the crop is in situ, thus allowing the crop to be harvested by normal cereal combines. To be suitable for this purpose a material must destroy leaf and pod tissue without marking the peas, affecting their germination or leaving a taint or toxic residue. Weeds present in the crop must also be destroyed.

For canning and other methods of prepacking, processors require carrots which are uniform in size and shape, preferably with no "whorls", cracks or other signs of maturity. Farmers have difficulty in maintaining a constant flow to the processor without the production of additional large, unmarketable produce. The mechanical removal of foliage leads to excessive loss of soil moisture and hence cracked carrots. Desiccation with translocated chemicals produces unacceptable residues and damaged carrots.

Dimexan has been used since 1959 as a contact herbicide prior to the emergence of any drilled crop (F.H. Feekes, 1962). The material breaks down cuticular tissue which then loses moisture under conditions of low air humidity. Investigations were therefore started to assess the suitability of dimexan for the harvest management of peas and for the growth control of carrots.

The mammalion toxicity is relatively low; acute oral toxicity, LD_{50} is 340 ppm; interperitoneal LD_{50} is 210 ppm. Data from Holland has indicated residue levels in pea pods to be 0.1 to 0.3 ppm, in spinach of the order of 0.16 ppm, and in carrots to be not detectable (Vondelingenplaat, unpublished data, 1967). Work in the U.K. has shown residue in pea seed to be 0.033 ppm, two hours after treatment and to be not detectable seven days after treatment. The material is highly volatile and there is no evidence that it is translocated in plants.

METHOD AND MATERIALS

All application rates are expressed in lb a.i./ac. Except where stated otherwise, dimexan was applied to peas in 1967 at 12.0 lb/ac, in 1968 at 6.0 lb/ac and on carrots at 16.0 lb/ac. Diquat was applied at 0.5 lb/ac. All sites were in commercially grown crops. In the case of the moisture tests in 1967 and of the carrots, materials were applied by pressurised knapsack sprayer to plots of the order of 60 sq yd. Treatments were replicated twice. For the taint and germination tests and the moisture tests in 1968, application was by a tractor mounted sprayer to plots at least 200 yd long and 10 yd wide. Except with the carrots, samples were taken at random. Other than with the moisture tests of 1967, applications were made in 30 or 60 gal/ac of water and volume at any site was constant. In 1967 the effect of adding a wetting agent to dimexan was studied.

Taint tests were undertaken by the Fruit and Vegetable Preservation Research Association, on samples taken by hand from .. crop of Big Ben peas. Untreated material was obtained from the area adjacent to the treated strips.

The germination tests on peas - treated with dimexan, sulphuric acid, diquat and untreated control - were carried out on samples from farm crops taken at harvest. The tests were done by the Official Seed Testing Station at Cambridge.

Moisture tests in 1967 were with New Line Perfection peas at one site and in 1968 with Maro peas from three different sites. With the moisture tester used, 10 gm of material is weighed into a pan and the measurement is of loss of moisture when the sample is heated by an infra red lamp.

Carrot samples were lifted by hand, the foliage was cut off and the samples placed in polythene bags immediately. The weights and sizes were measured within forty eight hours. Four riddles were used with round holes 6 cm, 8 cm, 10 cm and 11 cm in circumferance.

RESULTS

Taint tests with peas: 1967. Samples, from a site treated twelve days prior to harvest, were found to be untainted by the chemical.

Germination of peas: 1967. At one of the sites, where the peas were treated with dimexan and sulphuric acid, the germination of all samples including the untreated control was 94%. Similar results were obtained from the other two sites, showing that the application of dimexan did not reduce the germination of peas.

The effect on moisture loss in peas 1967 and 1968. The results of moisture content determinations carried out on peas (seed) are shown in Table 1 and 2.

Table 1

The moisture content of peas six and nine days after treatment with dimexan and diquat 1967.

Material	Dose lb/ac	Volume gal/ac	% moisture - 6th day with wetter	% moisture - 6th day no wetter	% moisture - 9th day with wetter	% moisture - 9th day no wetter
dimexan	12.0	30	36	41	17	18
"	12.0	60	34	38	18	18
"	12.0	90	44	39	17.5	17.5
"	24.0	30	nr	42	nr	16
"	36.0	30	nr	41	nr	16
diquat	0.5	30	31	nr	17	nr

nr - not recorded

The figures on Table 1 show that there was no advantage in raising the dimexan application rate above 12.0 lb/ac. At a volume of 30 gal/ac of water, the addition of a wetter increased the initial loss of moisture in the peas. Volumes of 60 and 90 gal/ac of water were no better than 30 gal/ac. The initial loss of moisture was greatest with 0.5 lb/ac of diquat, but by the 9th day all treatments had reached a moisture content of approx. 18%.

Table 2

The moisture content of peas, from treatment to harvest, after applications of 6.0 lb/ac. dimexan and 0.5 lb/ac diquat: 1968

Date August	Site 1 dimexan	Site 1 diquat	Site 2 dimexan	Site 2 diquat	Site 3 dimexan	Site 3 diquat
5	55	55	-	-	-	-
12	35	37	-	-	-	-
13	32	30	-	-	55	55
14	-	-	-	-	54	52
15	31	26	46	54	-	-
19	27	29	40	45	47	50
21	30	27	41	41	-	-
22	-	-	-	-	38	38
23	19	20	24	27	-	-
26	17.5	18	19	21	24	23

Weather conditions were dry only on Aug. 5th, 12th to 13th and 22nd to 26th.

The figures in Table 2 show that the loss of moisture after treatment with dimexan and diquat was similar and that regardless of the date of treatment, peas only lost moisture rapidly under favourable climatic conditions. It was observed that, where there were serious weed problems, the diquat treatments had the greater effect on the weeds. In untreated areas the stage of maturity of peas at harvest was very variable and weeds were more likely to be a problem to the combine harvester than where the chemical had been applied.

The effect on the size of carrots 1968. Table 3 shows the root size distribution of carrots after grading over round aperture riddles.

Table 3

Results of size-grading carrots lifted two weeks and five weeks after treatment with dimexan: 1968

% by number

Size grade cm circ.	Two weeks Treated	Two weeks Untreated	Five weeks Treated	Five weeks Untreated
Under 6	60.0	50.0	43.0	26.0
6 - 8	20.0	25.0	34.0	29.0
8 - 10	17.0	18.0	17.0	27.0
10 - 11	3.1	3.5	4.5	7.5
Over 11	0.4	2.8	1.5	10.0
Total weight (lb)	-	-	5.0	10.0

In Table 3 it can be seen that the dimexan treatment greatly reduced the rate of development of the carrots. It was observed that the treated crop had remained immature in appearance, the colour was lighter and the "whorls" were less deep than on untreated produce and there was no cracking. The treatment had destroyed the top foliage, but had left the lower, paler foliage intact. There were indications that the total yield of produce was reduced, but that the percentage of small grade carrots was increased by the treatment.

DISCUSSION

Peas. The desiccation work carried out during the dry year 1967 and the wet year 1968 indicated that dimexan is a suitable material for use as a harvest aid in harvest peas. Results suggest that application rates could vary from 6.0 lb/ac in a wet season when crop growth is soft or luxuriant, to 12.0 lb/ac in a dry season, when growth is harder and surface tissue is less susceptible to break-down by dimexan. The addition of a wetter to the tank mix, at the time of application, will improve the effect of the product, and though 60 gal/ac of water is ideal, for practical purposes 30 gal/ac of water has been shown to be sufficient. The rate of loss of moisture in peas treated with dimexan appears similar to what would be expected with other chemicals, such as diquat, which render a tissue liable to loss of moisture under dry atmospheric conditions, but do not dehydrate.

Dimexan is not translocated in plant tissue and therefore the absence of effect on germination was only to be expected. On this basis the material would appear suitable for application to crops intended to be used as seed in the following season. Taking into account the mode of action of dimexan it is unlikely that taints would be produced in peas and tests carried out in 1967 confirmed this. Confirmatory tests are at present being undertaken on 1968 produce.

Carrots. The partial kill of foliage obtained in the trial described resulted in a slowing down of maturation of the roots, and this would suggest that dimexan could be a tool for growers to use for carrot size management. The reduction in growth rate is similar to that expected from growth regulating chemicals. The absence of root cracking in this work indicates that the partial defoliation afforded by dimexan application is probably better than complete mechanical defoliation, which often leads to the soil drying out and roots cracking. Freedom from residues and taint has yet to be confirmed in the U.K. and further trials, under a range of growing conditions, are planned to define application rates and to obtain more information about the growth control that may be expected.

Dimexan is already successfully used as an harvest aid in onions and narcissi crops (S.N.UiF 1964) (W.v. Soest and M.J.Zwijns 1968). The results presented in this paper also suggest that dimexan is a safe material for aiding the mechanised harvesting of peas and the production of carrots for modern processing requirements.

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EVALUATION OF PRE- AND POST-EMERGENCE TREATMENTS FOR WEED CONTROL IN FRENCH BEANS

P. J. Doherty and J. C. Cassidy
Agricultural Institute, Kinsealy, Dublin, Ireland.

Summary In 1967 - '68, ten herbicides were examined for pre-emergence application on French beans in trials at different sites. Monolinuron + dinoseb-acetate was the most satisfactory treatment tested because of high crop tolerance and effective control of a wide weed spectrum. Good selectivity was also shown by 3, 4 - dichlorobenzyl-methyl-carbamate (UC 22463), but some important weed species in French bean crops were inadequately controlled. None of the treatments tested for overall post-emergence application had sufficient selectivity although plants treated with phenmedipham made a good recovery. No crop damage resulted under dry conditions from directed inter-row applications of different herbicides.

INTRODUCTION

At the last British Weed Control Conference results of trials with a number of pre-emergence treatments in French beans were reported (Cassidy, 1966). It was suggested that monolinuron + dinoseb-acetate was a suitable alternative to dinoseb-amine (the standard treatment) because of more effective longer lasting weed control. Promising results with this material were also described by Roberts and Wilson (1966) and King (1966).

In Ireland, a limited commercial acreage was treated with monolinuron + dinoseb-acetate in 1967 and its use was considerably extended in 1968. Results have been satisfactory and only a few isolated instances of slight crop injury have been reported on light soils of low fertility. However, some growers have found that the residual effect of this material is not sufficient to give complete weed control up to harvesting and steerage hoeing is required to control late germinating weeds or resistant weeds such as _Veronica_ spp. or _Euphorbia helioscopia_.

It was considered therefore that weed control investigations should continue in this crop to determine if any of the more recently developed herbicides would be comparable in selectivity and range of weed control to monolinuron + dinoseb-acetate, but with a longer and more reliable residual effect. Concurrent with these investigations preliminary trials were also conducted with a number of herbicides for overall post-emergence or directed inter-row application to determine if they could be used as an alternative to steerage hoeing.

METHOD AND MATERIALS

Trials were sited at Kinsealy and on growers' crops in the Carlow area. In small plot trials a randomised block design was used with four replicates. Plot size was usually 10 x 3 yd but was in some cases 5 x 2 yd. In unreplicated trials, individual treatments were applied to an area of 0.125 ac. In all trials treatments were applied with a pressure retaining knapsack at a volume of 40 gal/ac except in the directed inter-row trial where a hand-operated vibro-jet sprayer was used. Granular formulations were applied by hand. Trifluralin was incorporated to a depth of 2 - 3 in. immediately after spraying, with a rotovator at site C, a disc harrow at site D and a power harrow at site E.

At least two visual assessments of treatment effect on crop and weeds were made. Yield, plant and weed counts were also recorded. Weed counts were made within the area of a square foot quadrat thrown at random twelve times in each plot.

The monolinuron + dinoseb-acetate formulation used in these trials was a mixture containing 12.5% monolinuron + 37.5% dinoseb-acetate. In this paper doses of the mixture are referred to in terms of total active ingredient based on 25% monolinuron + 75% dinoseb-acetate. Doses of the other herbicides used are also given as lb/ac a.i.

RESULTS

Pre-emergence trials - 1967

Eight herbicides at normal and twice normal doses were examined in replicated trials at four sites in 1967. Three were located on coarse sandy loam soils (clay 9 - 12%, O.M. 4.3 - 5.1%) in the Carlow area and one at Kinsealy on a medium loam (clay 25.6%, O.M. 6.7%). Soils at Carlow were typical of those on which French beans are generally grown. Sites did not influence crop selectivity in the Carlow area and therefore the yields from only one Carlow site are given in Table 1.

Table 1

Effect of pre-emergence treatments on crop and weeds - 1967

Herbicide	Dose lb/ac	Yield (tons/acre)		% weed control*		
				Site A		Site B
		Kinsealy	Site A	Polygonum aviculare	Polygonum persicaria	Chenopodium album
Monolinuron + dinoseb-acetate	3.0	3.0	3.7	90	93	94
Monolinuron + dinoseb-acetate	6.0	3.3	3.9	99	100	99
Monolinuron	0.75	2.9	2.8	0	25	94
"	1.5	3.3	3.6	68	93	98
Propachlor	3.9	2.9	2.0	80	0	11
"	7.8	2.7	2.3	86	0	71
UC 22463	3.0	3.1	2.3	0	59	54
"	6.0	2.4	3.2	88	93	77
C 6313	1.5	3.7	3.0	82	75	77
"	3.0	1.9	3.2	68	96	97
CP 50144	1.5	3.0	n.u.	n.u.	n.u.	n.u.
"	3.0	2.5	n.u.	n.u.	n.u.	n.u.
SD 11831	2.0	3.4	1.7	28	0	5
"	4.0	2.9	1.9	0	0	44
Dinoseb-amine	3.7	3.3	3.0	70	97	99
Control (untreated)		1.9	1.9	-	-	-
S.E.		0.34(df=45)	0.33(df=39)			
Weed/10 ft^2 in control plots				45	124	76

* Based on weed counts taken from 12 x 1 ft^2 random quadrats in each plot.

In these trials monolinuron + dinoseb-acetate was the most effective and consistent herbicide tested. Even at twice normal doses no crop injury occurred at any site. With the exception of *Veronica* spp. excellent control was obtained of *Polygonum aviculare*, *Polygonum persicaria* and *Chenopodium album* the main species at these sites. Less effective weed control resulted from applications of straight monolinuron at equivalent doses to that contained in the mixture. Propachlor and 2-chloro-2, 6 - diethyl-N-(methoxy methyl)-acetanilide (CP 50144) at the higher doses caused puckering and chlorosis of the simple leaves but the crop outgrew this effect and yields were not reduced. Both herbicides gave poor weed control. *Polygonum persicaria* and *Chenopodium album* were particularly resistant. These species were also poorly controlled with 3, 4 - dichlorobenzyl methylcarbamate (UC 22463), but this treatment gave good control of Veronica spp. Plots treated with this herbicide showed considerable yellowing and marginal chlorosis in the first month of growth, but the crop recovered and yields were not significantly reduced even at 6.0 lb. Severe crop check occurred with N-(4-bromo-3-chlorophenyl) - N-methoxy-N-methylurea (C 6313) particularly at the higher dose of 3.0 lb. This herbicide gave good weed control, but was not as effective as monolinuron + dinoseb-acetate. Although 4-methylsulphanyl-2, 6 dinitro-N, N-dipropylaniline (SD 11831) was very selective, it proved ineffective against the weed species occurring in these trials.

Nine unreplicated large plot trials (0.125 ac per treatment) were also conducted on light soils in the Carlow and Cork areas. Monolinuron + dinoseb-acetate 3.0 lb, monolinuron 0.75 lb, UC 22463 4.0 lb and dinoseb-amine 3.7 lb were compared. Results were similar to those obtained in the replicated trials. The mixture of monolinuron + dinoseb-acetate again proved the best and most reliable treatment, giving good control of a wide spectrum of annual weeds which lasted at most sites until harvesting. Veronica spp., Galium aparine and Euphorbia helioscopia were the only weeds resistant to this mixture. UC 22463 was more effective against these species, but was less satisfactory on Polygonum spp. Weed control was satisfactory with dinoseb-amine at seven sites but at the others poor control was obtained.

Post-emergence trials - 1967

In trials at two sites monolinuron 0.5, 1.0 lb, monolinuron + dinoseb-acetate 2.0, 4.0 lb, propachlor 3.9, 7.8 lb and simazine 0.5 lb were applied about seven weeks after drilling when the crop was commencing to flower. The object of this investigation was to examine the possibility of using these materials as a supplement to the pre-emergence application of monolinuron + dinoseb-acetate to ensure season-long weed control. However, all treatments severely checked the crop and yields were reduced compared with untreated plots.

Pre-emergence trials - 1968

Trifluralin, UC 22463 and 2-azido-4-isopropylamino-6-methylthio-1, 3, 5 triazine (C 7019) at normal and twice normal doses were compared with the standard treatments, monolinuron + dinoseb-acetate and dinoseb-amine, in replicated trials at three sites. Trifluralin was used as an incorporated treatment prior to sowing. Results are given in Table 2.

Table 2

Effect of pre-emergence treatments on crop and weeds - 1968

Herbicide	Dose lb/ac	Site C Yield tons/acre	Site D Yield tons/acre	Site E Yield tons/acre	Site D Beans plants /10 ft row	Site D % weed control* Chenopodium album	Site E % weed control* Capsella bursa-pastoris
Monolinuron + dinoseb-acetate	3.0	3.0	6.1	5.1	60	95	100
Monolinuron + dinoseb-acetate	6.0	2.6	7.3	5.7	58	100	100
UC 22463	4.0	2.1	3.1	4.7	53	65	96
"	8.0	2.4	3.9	6.2	51	60	100
C 7019	2.0	3.2	4.6	5.4	53	70	50
"	4.0	3.5	5.6	5.2	62	91	92
Trifluralin	1.0	2.8	3.6	5.5	66	39	0
"	2.0	1.6	3.6	6.0	43	65	46
Dinoseb-amine	3.7	2.7	7.0	4.6	62	93	100
Control		2.2	1.4	5.3	46		
S.E. of treatment mean (df=33)		0.49					
Weeds/10 ft^2 in control plots						48	22

* Based on weed counts taken from 12 x 1 ft^2 random quadrats in each plot.

Site details: C O.M. = 5.7%, clay = 25.6% D O.M. = 5.9%, clay = 8.6%
E O.M. = 4.5%, clay = 16.7%

As in previous trials the mixture of monolinuron + dinoseb-acetate again showed excellent crop selectivity and gave more effective weed control than any of the other treatments tested. At the normal dose of 3.0 lb satisfactory control of most species was maintained until harvesting, except for some Polygonum persicaria which germinated late and became established during the month prior to harvesting. Plots treated with the twice normal dose remained weed free throughout the growing season.

Typical yellowing and marginal chlorosis occurred in the early stages of growth where UC 22463 was applied. Although these effects were more pronounced at site E, particularly at the higher dose of 8.0 lb, the crop recovered well and yield was not reduced. At site D, however, low yields were obtained with this herbicide because of its failure to adequately control Chenopodium album the prevalent species at this site. Only moderate control of Polygonum persicaria and Brassica rapa ssp campestris was obtained at a dose of 4.0 lb at site E.

Severe chlorosis was evident in plots treated with C 7019 but this effect had largely disappeared before harvesting and no significant reduction in plant stand or yield occurred with this herbicide at doses up to 4.0 lb. The relatively lower yields obtained with a dose of 2.0 lb at site D was due to severe competition from Chenopodium album which was not satisfactorily controlled. Capsella bursa-pastoris and Brassica rapa ssp campestris also showed resistence at this dose.

Severe crop check occurred in the initial stages at all sites where trifluralin 2.0 lb was used and at site D plant stand was reduced. However, very little damage was evident at a dose of 1.0 lb. Brassica rapa ssp campestris and Capsella bursa-pastoris were resistant and Chenopodium album moderately resistant to trifluralin with the result that in these trials weed control was generally unsatisfactory. Dinoseb-amine 3.7 lb gave good weed control in the early stages, but many weeds had become established in plots treated with this herbicide before harvest at sites C and E.

Post-emergence trials - 1968

C 7019, phenmedipham, 3, 5-dibromo-4-hydroxy-benzaldoxime-0-(2, 4-dinitrophenyl)-ether (C 9122) and UC 22463 in granular form were examined for post-emergence application in replicated trials at three sites. Treatments were applied 5 - 6 weeks after sowing when the crop had 1 - 2 trifoliate leaves. In all trials monolinuron + dinoseb-acetate was applied pre-emergence. Results are given in Table 3.

Table 3

Effect of post-emergence treatments on crops and weeds - 1968

Herbicide*	Dose lb/ac	Yield tons/acre F	Yield tons/acre G	Site F Sept. 2 Crop	Site F Sept. 2 Weeds	Site G Sept. 5 Crop	Site G Sept. 5 Weeds	Site H July 26 Crop	Site H July 26 Weeds
				Assessments (average of 4 replications)					
C 7019	2.0	3.1	3.0	6.5	8.3	6.8	5.8	5.3	9.0
"	4.0	2.3	1.5	5.3	9.8	4.3	8.0	3.3	9.0
C 9122	1.5	1.5	3.1	4.3	9.3	8.0	7.5	5.3	9.0
"	3.0	0.9	1.7	1.8	9.8	4.5	8.5	2.3	9.3
Phenmedipham	1.0	2.9	4.6	7.3	9.5	9.3	8.3	7.5	9.0
"	2.0	2.7	4.1	5.3	9.8	9.0	9.0	5.0	9.0
UC 22463	4.0	3.4	4.9	8.8	9.5	10.0	3.5	10.0	8.5
"	8.0	3.3	3.7	9.5	9.0	10.0	0.8	10.0	8.5
Control		3.3	4.8	9.8	8.8	10.0	0.8	10.0	8.5
S.E. of treatment mean (df=27)			0.52						
" " control mean			0.37						

*Trial area treated with monolinuron + dinoseb-acetate 3.0 lb pre-emergence.
Rating scale Crop: 0(Complete kill) - 10(No crop damage)
Weed: 0(Dense cover of weeds) - 10(No weeds)

Severe scorch and reduction in crop vigour occurred with C 7019 and C 9122 at all sites and although chlorotic symptoms had disappeared by harvesting the plants remained checked throughout.

Less scorch and growth check occurred with phenmedipham and the crop recovered quickly. This is reflected in the satisfactory yields obtained from plots treated with this herbicide.

Except for chlorotic spotting on some leaves where granules lodged, no crop injury was observed with UC 22463. There was also no visible effect on weed growth. Dry weather which preceded and followed application of the granules at all sites was considered responsible for this lack of activity.

Very few weeds were present at sites F and H when treatments were applied. At site G, however, there was high population of Veronica spp. and all treatments except UC 22463 gave good control of this species. Phenmedipham was particularly effective.

In a further trial a number of herbicides were tested for directed inter-row application. These were monolinuron + dinoseb-acetate 3.0 lb, monolinuron 0.75 lb, linuron 0.75 lb, prometryne 1.25 lb, simazine 0.5 lb, paraquat 0.5 lb, UC 22463 4.0 lb and chlorthiamid 4.0 lb. The latter two were applied in granular form. No visible injury occurred and yields were not affected by any treatment. However these materials were applied during a period of dry weather and crop tolerance may not be as high under moist conditions. The effectiveness of the different treatments for weed control could not be assessed since a pre-emergence application of monolinuron + dinoseb-acetate 3.0 lb had given very satisfactory control.

DISCUSSION

The results of this series of trials show that monolinuron + dinoseb-acetate was the most satisfactory treatment tested for pre-emergence application in French beans. Although some herbicides were equally selective, none proved as effective for weed control. Most of the trials were located on light soils of the coarse sandy loam type (clay 8 - 16%, O.M. 3 - 6%) and no crop damage occurred even with twice normal doses of this material. Compared with the recommended herbicide (dinoseb-amine) this mixture gave more effective prolonged weed control. Experience with monolinuron + dinoseb-acetate over the past four years show that most of the important weed species in arable crops are susceptible. Exceptions are Veronica spp., Galium aparine and Euphorbia helioscopia. Fumaria officinalis and Polygonum aviculare have also shown partial resistance in some trials. In some trials however, the residual activity of this treatment at a normal dose of 3.0 lb was not sufficient to maintain weed control up to harvesting. The problem of late germinating weeds is expected to be greatly reduced when French beans are grown in narrow rows through the development of improved harvesting equipment.

Results with UC 22463 confirmed those reported by Roberts and Wilson (1966) and Cassidy (1966). Although crops have always shown chlorosis in the early stages, following the application of this herbicide, crop growth and yields were not affected. However, control of Chenopodium album and Polygonum persicaria, problem weeds in French bean crops, was not satisfactory. Control of Veronica spp. was good in these trials and a mixture of this herbicide and monolinuron + dinoseb-acetate may be worth investigating.

Little difference was noted in weed susceptibility and crop selectivity between propachlor 3.9 lb and CP 50144 1.5 lb. Although less crop damage occurred with propachlor than in previous trials (Cassidy 1966) the rather narrow weed spectrum controlled by this herbicide limits its usefulness.

Results of only one year's trials were obtained with C 7019 and C 6313 but the indications were that neither herbicide has sufficient selectivity. Crop tolerance was also suspect with trifluralin as an incorporated treatment.

Although least damage was caused by phenmedipham in post-emergence trials it is doubtful if the crop injury sustained would be tolerable in commercial practice. However it may have possibilities as an emergency measure.

Good tolerance was shown by all herbicides when used as directed inter-row treatments under dry conditions. More experience is needed under moist conditions to test the value of this method for the control of late germinating weeds.

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THE POST-EMERGENCE USE OF DINOSEB-ACETATE IN DWARF BEANS

H. L. Ensor

Unilever Research Laboratory, Colworth House, Sharnbrook, Bedford

Summary The results of three years trials have shown that dinoseb-acetate 2.4 lb/ac can be used as a selective herbicide in dwarf beans if applied at the fully expanded monofoliate leaf stage. Stage of crop growth and weather conditions can be critical, therefore this treatment should only be used to "salvage" crops infested by weeds due to the failure or omission of pre-emergence herbicide treatments.

INTRODUCTION

In 1961 dinoseb-amine was approved as a pre-emergence herbicide for use on dwarf beans and was soon accepted by farmers in preference to mechanical and manual methods of weed control. However weed control from dinoseb-amine was unreliable as it varied considerably between years and sites.

Dwarf beans grown for processing on the continent had been successfully treated with dinoseb-acetate as a post-emergence contact herbicide, but opinions as to the commercial value of this treatment varied within and between the processing companies growing the crop. The need for a herbicide to replace or supplement dinoseb-amine in crops grown in the UK was such that trials with dinoseb-acetate were started in 1964.

METHODS AND MATERIALS

Dinoseb-acetate was tested in replicated yield trials in 1964 and 1965 on Tendercrop dwarf beans as a post-emergence treatment made at the fully expanded monofoliate leaf stage, and compared with the standard commercial treatment, pre-emergence dinoseb-amine. Both trials were on clay loam sites and contained two sowing dates and eight replicates.

Eight trials in 1965 assessed the effect of dinoseb-acetate at various stages of crop growth in hand weeded crops. In one, finite rates were examined at four stages of crop growth and in the others a logarithmic series; the first contained four replicates and the second was unreplicated.

In 1966 twenty, two replicate strip trials were used to test dinoseb-acetate for phytotoxicity in dwarf beans at three stages of growth in hand weeded crops. The effect of water volume on crop damage was assessed from eight sites by spraying once, twice or three times in 35 gal/ac, with appropriate concentrations of active ingredients necessary for a total of 2.4 lb/ac.

In the 1964 trials chemicals were applied in 100 gal/ac at 30 p.s.i., subsequently 35 gal. was used at 70 p.s.i. unless otherwise stated. Herbicide rates are presented throughout as lb a.e./ac.

RESULTS

Yield Trials

The results are given in Tables 1 and 2.

In 1964, good growing conditions allowed rapid crop and weed growth providing yields of up to 4.5 tons/ac and weed yields of 9 tons/ac. In the first sowing the main weeds were Sinapsis arvensis, Anagallis arvensis and Chenopodium album, in the second S.arvensis, Sonchus spp., A.arvensis and C.album.

Weed control from dinoseb-acetate was significantly better than from dinoseb-amine in the first sowing, but similar in the second.

Yield was increased nearly five times by dinoseb-acetate 2.4 lb/ac over the unweeded control in the first sowing and was significantly greater than the yield from dinoseb-amine. In the second sowing this yield increase was 50 % and not significantly different from the yield using dinoseb-amine.

Dinoseb-acetate at 4.8 lb/ac scorched the crop in both sowings. In the first sowing the monofoliate leaves were hanging down when sprayed and the spray collected at the leaf tip causing scorch, in the second the leaves were above the horizontal and scorch occurred where the leaf and petiole join.

In 1965 cold weather induced weak initial crop and weed growth. The crop grew away well to yield about 5 tons/ac, but weed yields were low at 1.5 cwts/ac. The dominant weeds were A.arvensis, Veronica spp. and S.arvensis.

Initial weed control from dinoseb-acetate was consistently better than from dinoseb-amine and significantly so in the first sowing. This significant effect was still apparent at harvest.

Dinoseb-acetate at 4.8 lb/ac caused a significant reduction in plant and pod weight in the second sowing.

Scorch occurred from dinoseb-acetate in the first sowing where the spray was retained on wrinkled monofoliate and opening trifoliate leaves. In the second sowing damage was more severe after spraying under warm, humid conditions following 1.85 in. of rain in three days. Logarithmic rates were also applied in this trial. The results are included in Table 4 listing sowings 1 and 2 as sites 6 and 7.

1965. Effect of growth stage-yield trial

The results are given in Table 3.

Early growing conditions were cold for the dwarf bean crop, this may have influenced the results of early treatments in the first sowing and caused considerable variations in yields between replicates in both sowings.

Plant stand was significantly reduced by dinoseb-acetate at 2.4 and 4.8 lb/ac applied at the wrinkled monofoliate leaf stage and by 4.8 lb/ac at the second trifoliate leaf stage. Yields were not significantly reduced by any treatment, but the highest yields were obtained from treatments made at the expanded monofoliate and first trifoliate leaf stages.

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Table 1.

Effect of dinoseb-acetate and dinoseb-amine on weed control and yield 1964

Treatment (lb/ac)	Initial weed assessment by number after spraying: Weed count (transformed) Sow:1	Sow:2	Weed cont* (%) Sow:1	Sow:2	Final weed assessment by weight at harvest: Weed wt (transformed) Sow:1	Sow:2	Weed cont* (%) Sow:1	Sow:2	Plant wt (%) Sow:1	Sow:2	Pod wt (%) Sow:1	Sow:2
Dinoseb acetate 2.4	1.31	1.14	88	73	1.19	0.90	81	89	257	160	470	151
Dinoseb acetate 4.8	-	-	97	88	1.00	0.87	96	89	246	161	449	150
Dinoseb amine 3.24	3.22	1.25	24	66	1.68	1.11	67	79	181	190	271	177
Handweeded (twice)	1.74	0.81	79	88	-	-	94	95	257	191	472	185
Interrow cultivated (twice)	1.97	1.30	73	64	1.85	1.18	67	70	140	151	230	143
Unweeded (weeds/ft^2 or cwt/ac)	-	-	(6.9)	(2.2)	-	-	(174)	(82)	(67.7)	(97.1)	(19.1)	(48.0)
Sig.Diff. (P=0.05)	0.43	0.43			0.29	0.29			37	28	71	28

Table 2.

Effect of dinoseb-acetate and dinoseb-amine on weed control 1965

(Column headings as in Table 1)

Treatment (lb/ac)	Weed count Sow:1	Sow:2	Weed cont* (%) Sow:1	Sow:2	Weed wt Sow:1	Sow:2	Weed cont* (%) Sow:1	Sow:2	Plant wt (%) Sow:1	Sow:2	Pod wt (%) Sow:1	Sow:2
Dinoseb acetate 2.4	0.35	0.17	86	83	0.58	1.00	91	61	109	99	116	98
Dinoseb acetate 4.8	0.07	0.18	100	75	0.39	1.24	94	32	103	85	116	80
Dinoseb amine 3.24	0.73	0.22	38	67	1.28	0.98	57	63	111	109	113	107
Handweeded	-	-	-	-	0.73	0.78	87	76	121	108	123	110
Interrow cultivated	-	-	-	-	1.24	1.10	60	50	108	104	110	111
Unweeded (weeds/ft^2 or cwt/ac)	0.93	0.35	(0.86)	(0.12)	1.63	1.40	(47)	(28)	(253)	(207)	(106)	(91)
Sig.Diff. (P=0.05)	0.31	0.18			0.52	0.56 N.S.			40 N.S.	24	14 N.S.	22

* Calculated from original data. N.S. = No significance in overall test.

\- Not analysed, extreme results omitted to reduce variation.

Table 3.

Effect of dinoseb-acetate when applied at various stages of crop growth 1965

Stage of crop growth	Rate (lb/ac)	Plant stand % of control Sow:1	Plant stand % of control Sow:2	Plant wt % of control Sow:1	Plant wt % of control Sow:2	Pod wt % of control Sow:1	Pod wt % of control Sow:2
Wrinkled	2.4	74	114	84	114	79	110
monofoliate	4.8	54	102	58	96	54	92
Expanded	2.4	84	102	87	104	99	107
monofoliate	4.8	97	95	95	102	100	99
Expanded	2.4	96	94	86	118	97	113
1st trifoliate	4.8	101	100	78	100	102	96
Expanded	2.4	93	94	85	115	92	109
2nd trifoliate	4.8	85	122	79	107	89	101
Control		(46/ yd^2)	(33/ yd^2)	(156 cwt/ac)	(147 cwt/ac)	(66 cwt/ac)	(75 cwt/ac)
Sig.Diff. (P=0.05)		11	10	7	12 NS	46 NS	44 NS

1965 Logarithmic trial

The results are given in Table 4.

Table 4.

Effect of a logarithmic dose range of dinoseb-acetate on yield expressed as % of dinoseb-amine control plots. All plots handweeded 1965

Site	To nearest 0.5 lb/ac:- Stage applied	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
1	Expanded monofol.		80		68	83			51		
2	1st trifol: leaf	50		58			65				50
3	Wrinkled monofol.		60		55			42		30	
4	Expanded monofol.		107	115				123			119
5	Expanded monofol.	103	84	101	86		105	88	82	84	84
6	Expanded monofol.		106	109	110	110		107	109	107	107
7	Expanded monofol.		93	82	80	64		54	66	63	55

Yield reductions of up to 50 % occurred from rates of about 2.5 lb/ac. If treatment was made at the expanded monofoliate leaf stage, yields were between 80 % and 107 % with a mean of 94 % of the control plots. Rate did not have much effect when applied at the monofoliate leaf stage except under the humid conditions experienced at sites 1 and 7.

1966 Strip trials

The results are given in Table 5.

Results from twenty strip trials showed that rainfall or high humidity after spraying could increase crop damage, and that in general damage was minimised by

Table 5.

Effect of dinoseb-acetate 2.4 lb/ac on yield, haulm weight and maturity when applied at different stages of crop growth. Strip trials 1966

Crop stage when sprayed																					
	Yield of pods (% of control)																				
Site No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean
Control cwt/ac	123	147	143	163	53	73	123	105	152	126	201	144	46	50	41	59	169	169	158	74	
Expanded monofoliate	94*	99	97	100	89	103	71*	97	71*	99											92
First trifoliate											95	107	61+	111	78	106					93
Second trifoliate																	85	95	100	86	92
	Haulm weight (% of control)																				
Control cwt/ac	294	352	359	387	146	168	313	196	334	376	409	303	106	96	86	108	402	389	308	191	
Expanded monofoliate	107	97	100	95	95	108	71	97	74	95											94
First trifoliate											93	103	77	117	90	107					98
Second trifoliate																	81	92	92	90	89
	Maturity (difference from Control in days)																				
Expanded monofoliate	-3	-1	+3	0	0	0	-2	+3	+2	0											+0.2
First trifoliate											+1	-2	0	-	+1	-					0.0
Second trifoliate																	-1	0	+2	+1	+0.5

* Rained shortly after spraying. + 92% RH at spraying.

\+ No evidence of spray damage, low result probably due to known non-uniformity of crop.

spraying at the fully expanded monofoliate leaf stage. There was no consistent effect of treatment on maturity.

1966 Water volume

The results are given in Table 6.

Table 6.

Effect of water volume on yield (cwt/ac) 1966

Dinoseb-acetate applied at 2.4 lb/ac at three stages of crop growth

Gallons /ac	Site	Monofoliate A	1st Trifoliate B	C	D	2nd Trifoliate E	F	G	H
35		162	190	138	154	160	158	64	143
70		-	-	137	-	-	-	-	-
105		156	193	159	151	164	157	70	151
Control		163	201	-	144	169	158	64	169

Water volume had little effect on yield, but did affect scorch. Scorch on monofoliate leaves increased with water volume due to the spray collecting at the lipped leaf edge, or in hollows of unexpanded leaf tissue. Scorch on trifoliate leaves decreased as water volume increased due to run off in the absence of a retaining edge.

DISCUSSION

During three years trials dinoseb-acetate scorched dwarf beans but the crop generally recovered well. Good weed control was obtained but in the absence of residual qualities no control can be expected of post-treatment weed emergence.

Dinoseb-acetate has been accepted for use at 2.4 lb/ac in about 35 gal water/ac at the fully expanded monofoliate leaf stage providing treatment is made when relative humidity (%) and temperature (^{o}F) are below 75. Crop leaves must be dry and fine weather expected for at least four hours after spraying.

Dinoseb-acetate at 2.4 lb/ac has been successfully used commercially where a weed problem has been apparent in the early stages of crop and weed growth. Thus reducing the need for inter-row cultivations and hand hoeing to "salvage" crops which otherwise would be impossible to harvest mechanically, and not economic to harvest by hand. It is believed that dinoseb-acetate should not be used as a routine treatment but only to "salvage" a weed infested crop.

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WEED CONTROL EXPERIMENTS IN DWARF FRENCH AND BROAD BEANS

J. M. King

Pea Growing Research Organisation Ltd., Thornhaugh, Peterborough

Summary The results of experiments conducted in dwarf French beans on a range of soils, showed that a mixture of monolinuron and dinoseb-acetate applied pre-emergence could provide more efficient weed control than a standard pre-emergence treatment of dinoseb-amine and did not damage the crop. Propachlor applied pre-emergence, and trifluralin applied pre-sowing and incorporated, proved less selective. In two experiments a pre-emergence application of monolinuron/paraquat gave similar results to a monolinuron/dinoseb-acetate treatment containing the same rate of monolinuron. In experiments carried out in broad beans over a three year period dinoseb-acetate applied post-emergence at 2.5 lb/ac gave satisfactory weed control and proved less damaging than post-emergence dinoseb-amine. The treatment was, however, less efficient than pre-emergence simazine applications which provided excellent weed control without damaging the crop.

INTRODUCTION

The advent of mechanical harvesting for dwarf French beans has enabled the crop to be grown on a far more extensive scale than was previously possible. Although dwarf beans are planted in wide rows inter-row cultivations are not a suitable method of controlling weeds, the loose soil and clods produced interfere with harvesting, as do any weeds left in the row. The disturbance of the roots which develop just below the soil surface is generally detrimental to growth. There is therefore a very real need for efficient herbicides for use in this crop. The P.G.R.O. commenced work in 1964 and the results of experimental work from 1965-1966 were reported at the previous Conference (King, J.M. 1966). Further work is now described covering experiments conducted during 1967 and 1968.

The use of simazine as a pre-emergence herbicide for broad beans is a well established and efficient treatment. For various reasons, however, simazine may not always be used and an efficient post-emergence herbicide would be useful in this crop. Post-emergence dinoseb-amine generally gives excessive damage and therefore the experiments described here were carried out during the period 1965-67 to assess the efficiency of dinoseb-acetate, a herbicide which generally gives less crop damage.

METHOD AND MATERIALS

Randomised block layout was used in the experiments with three or four replicates and a plot size of 0.00025 acre. Experiments were sited either on the Thornhaugh trial ground or in commercial crops of beans. Applications were made with an Oxford Precision Sprayer at a volume of 50 gal/ac and all doses are presented as lb a.i./ac. Visual assessment of weed control and crop injury were recorded periodically although not all the data is presented. Weed counts in a number of random quadrats were made on some experiments. The experiments were harvested by hand and the yields are presented in the tables as percentages of the untreated control values, differences from the control statistically significant at P = 0.05 are indicated by asterisks. Samples of produce from treated plots were processed where necessary for taint assessments.

Three dwarf bean experiments were conducted each year, but in 1968 one site suffered severe waterlogging and the limited data recorded is not presented. The soil analyses for the sites are as follows:-

1967	Site A	Loamy very fine sand, organic matter 2.2%;	silt 2%;	clay 20%
	" B	Silty loam, " " 2.5%;	" 12%;	" 24%
	" C	Sandy clay loam, " " 2.9%;	" 10%;	" 52%
1968	" D	Fine sandy loam, " " 2.6%;	" 16%;	" 24%
	" E	Very fine sandy loam, " " 2.2%;	" 7%;	" 22%

Two broad bean experiments were conducted each year, except in 1965 when only one successful experiment was completed. In 1965-1966 all sites (F, G and H) were on high organic content, peaty loam soils while in 1967 one site (I) was on the fine sandy loam soil at Thornhaugh and the other on a silty clay loam (site J).

RESULTS

Dwarf bean experiments

In 1967 pre-emergence applications of a monolinuron/dinoseb-acetate mixture and propachlor each at two dose rates were compared to a standard pre-emergence application of dinoseb-amine and an untreated control. The applications were made approximately four days after drilling, the seedbed was level and very dry at site A, level and moist at site B and slightly cloddy and dry at site C. Weed assessments were made at sites A and B approximately four weeks after treatment while counts were carried out at site C.

Table 1

Weed control and yields - 1967

Material	Dose lb/ac	Weed control(%)			Yield as per cent of untreated control		
		A	B	C	A	B	C
monolinuron/dinoseb-acetate	0.75/2.25	78	65	52	181*	114*	99
" " "	1.50/4.50	88	85	71	194*	127*	76
propachlor	4.00	48	58	43	123*	121*	100
"	8.00	58	78	50	119*	138*	106
dinoseb-amine	3.75	45	65	50	119*	127*	94
S.E. as % of gen. mean					20.9	8.7	22.6

At sites A and B weed competition was high; Chenopodium album, Atriplex patula and Urtica urens were the dominant species at site A and Polygonum aviculare the dominant species at site B. At site C weed competition was low, Alopecurus myosuroides, Sinapis arvensis, Galium aparine and Polygonum convolvulus all being present in small numbers. Slight marginal necrosis of the simple leaves was recorded on the high rate of the monolinuron/dinoseb-acetate treatment at site A, but this was soon outgrown. Also at this site the high rate of propachlor caused stunting of the crop which was not completely outgrown by harvest. No other effects on crop growth were recorded.

In 1968 pre-emergence applications of a monolinuron/dinoseb-acetate mixture at two dose rates, a monolinuron/paraquat mixture at one dose rate and two dose rates of a pre-sowing incorporated treatment trifluralin, were compared to an untreated control. The pre-sowing treatment was applied immediately prior to sowing and incorporated by means of a rotovator fitted with cultivating fingers, the rest of the trial area also being rotovated. The pre-emergence treatments were applied seven days after sowing at site D and two days after sowing at site E. At both sites the seedbed was level and dry on the surface. Weed assessments were made seven and five weeks after sowing at sites D and E respectively.

Table 2

Weed control and yields - 1968

Material	Dose lb/ac	Weed control (%) D	Weed control (%) E	Yield as per cent of untreated control D	Yield as per cent of untreated control E
monolinuron/dinoseb-acetate	0.50/1.50	70	83	126*	108
" " "	0.75/2.25	83	85	129*	98
trifluralin	1.0	60	70	107	113
"	2.0	75	65	86	29*
monolinuron/paraquat	0.75/0.50	80	80	148*	90
S.E. as % of gen. mean				15.6	14.9

At both sites there was moderately severe weed competition, Sinapis arvensis, Fumaria officinalis and Polygonum aviculare being the dominant species at site D while Tripleurospermum maritimum spp. inodorum, Chenopodium album and Atriplex patula were the principal species at site E. At site D trifluralin at 1.0 and 2.0 lb/ac did not satisfactorily control Sinapis arvensis and Aethusa cynapium while at site E Tripleurospermum maritimum spp. inodorum, Senecio vulgaris and Capsella bursa-pastoris were not fully controlled. A slight delay in emergence and stunting was recorded at both sites on the plots treated with 1.0 lb/ac trifluralin, approximately 10 per cent of plants being affected, while more severe symptoms were recorded on the 2.0 lb/ac rate where approximately 50 per cent of plants were affected. At site E the effects on crop growth were still evident at harvest.

Taint assessments

No taints were detected in samples of produce taken from plots treated with the high rates of monolinuron/dinoseb-acetate and propachlor. The results of the tests carried out on produce from trifluralin and monolinuron/paraquat treated plots are not yet available.

Broad bean experiments

One experiment in 1965 and two in 1966 were conducted to study the effects of three dose rates of dinoseb-acetate applied post-emergence to broad beans. At sites F and G the application was made when the majority of the weeds had reached the young plant stage, the crop being approximately twelve inches high. At site H the weeds were mainly at the seedling stage and the crop was seven inches high. At all sites the temperature was above 60°F with moderate humidity at the time of the application.

Table 3

Weed control and yields 1965-66

Material	Dose lb/ac	Weed control (%)			Yield as per cent of untreated control		
		F	G	H	F		H
dinoseb-acetate	1.5	60	48	73	97	95	94
" "	2.5	70	73	73	100	97	100
" "	3.5	88	74	78	90	90	102
S.E. as % of gen. mean					15.1	9.7	14.5

The maturity of the beans was determined by means of a tenderometer and no significant differences between treatments were found.

At site F distortion of the upper leaves was recorded the effect being slight at the 1.5 lb/ac and 2.5 lb/ac rates, but more severe at 3.5 lb/ac. Recovery was rapid and by harvest no differences could be detected between treatments. Slight effects were also recorded at 3.5 lb/ac in 1966 at site G, but none at site H. At site F the 2.5 and 3.5 lb/ac rates checked, rather than killed, a wide range of annual weeds the most predominant species being Polygonum convolvulus, Capsella bursa-pastoris, Senecio vulgaris and Urtica urens. The crop provided severe competition and suppressed weed development later in the season. The 1.5 lb/ac rate did not produce satisfactory control under these conditions. At site G all three dose rates controlled Chenopodium album, Sonchus oleraceus, Sinapis arvensis and Senecio vulgaris, but Polygonum convolvulus was only checked even at 3.5 lb/ac. At site H, where the weeds were less advanced when sprayed, all rates gave satisfactory control of Polygonum convolvulus and Polygonum aviculare.

In 1967 two experiments were carried out comparing two dose rates of dinoseb-acetate and one dose rate of dinoseb-amine applied post-emergence, one dose rate of simazine applied pre-emergence with an untreated control. At site I early and late applications of all the post-emergence treatments were made, the first was applied when the weeds were at the seedling stage and the second thirteen days later when they were at the young plant stage. Conditions for spraying were good on both occasions the temperatures being 63°F and 60°F respectively. At site J the application was made when the weeds were mainly at the advanced young plant stage.

Table 4

Weed control and yields - 1967

Material	Dose lb/ac	Weed kill (%)		Yield as per cent of untreated control	
		I	J	I	J
dinoseb-acetate	2.5(e)	50	-	92	-
" "	2.5(l)	53	45	118	121
" "	5.0(e)	67	-	106	-
" "	5.0(l)	67	53	110	125
dinoseb-amine	1.4(e)	77	-	96	-
" "	1.4(l)	60	55	89	127
simazine	1.0	95	90	149*	195*
S.E. as % of gen. mean	Early application (e)			16.3	-
	Late application (l)			10.1	18.8

No significant differences between treatments were recorded after tenderometer assessments on the produce.

At site I the predominant species was Polygonum aviculare and none of the post-emergence treatments gave completely satisfactory control of this weed even when applied early when the weeds were small. Dinoseb-amine was the most successful of these treatments, but again the weeds generally recovered and grew vigorously later in the season. This treatment resulted in excessive scorch at both applications and dinoseb-acetate at 5.0 lb/ac also produced moderate distortion and scorch. Simazine afforded almost complete control of all species including Polygonum aviculare and had no adverse effect on the crop. At site J simazine again was the most successful treatment controlling all the weed species present and not affecting the crop. The post-emergence treatments, which were applied when the weeds were well established, controlled the principle weed present Sinapis arvensis, but did not completely eliminate Polygonum aviculare, Polygonum convolvulus, Polygonum persicaria, Tripleurospermum maritimum spp. inodorum or Stellaria media. Dinoseb-amine produced moderate scorch and dinoseb-acetate at 5.0 lb/ac also caused distortion and some scorch on the crop. These effects were soon outgrown.

DISCUSSION

Dwarf beans

In the 1967 experiments the herbicide mixture containing 0.75 lb/ac of monolinuron and 2.25 lb/ac of dinoseb-acetate gave better weed control than pre-emergence dinoseb-amine at 3.75 lb/ac and the lack of any adverse effect on the crop by the application of the twice-normal rate, showed that this mixture has a good degree of 'selectivity'. Propachlor at 4.0 lb/ac resulted in slightly less efficient control than dinoseb-amine and the serious stunting resulting from the use of the twice-normal rate at site A suggested that the degree of 'selectivity' for this material is rather low. In 1968 the mixture of monolinuron and dinoseb-acetate again performed well giving good weed control and satisfactory yields at both rates. A mixture of monolinuron and paraquat containing 0.75 lb/ac monolinuron performed in a similar manner to the rate of the monolinuron/dinoseb-acetate mixture containing 0.75 lb/ac of monolinuron. Grass weeds were not present at either site in 1968, but it is likely that the monolinuron/paraquat mixture would prove superior where grasses were present. The pre-sowing incorporated treatment trifluralin did not give such complete weed control as the monolinuron mixtures and failed to adequately control several species. The twice normal rate of 2.0 lb/ac caused delayed emergence and stunting which reduced the yield at both sites below that of the untreated control and at site E the yield was only 29% of the untreated control. It would appear that under the conditions of these experiments trifluralin lacked adequate crop tolerance.

These experiments have substantiated the promising results reported with monolinuron/dinoseb-acetate mixtures in previous work, (Cassidy J.C. 1966 and King J.M. 1966) and their use in dwarf beans is likely to provide safe and efficient weed control.

Broad beans

Dinoseb-acetate at 2.5 lb/ac did not cause crop damage in any of the five experiments and applied at 5.0 lb/ac proved safer than dinoseb-amine at 1.4 lb/ac. Several weed species were not fully controlled at 2.5 lb/ac, particularly the polygonous weeds, but the check afforded to the weeds was generally sufficient for the crop competition to prevent undue weed development later in the season. On the basis of these experiments dinoseb-acetate would appear to be a useful and safe post-emergence herbicide for broad beans. The degree of weed control may, however, be governed by the species present and the stage of growth at which they are treated. Particularly when polygonous weeds are present the application must be made when the weeds are at the seedling stage. Pre-emergence simazine at 1.0 lb/ac proved a very efficient treatment and provided that it can be applied under satisfactory conditions it is likely to be more efficient than post-emergence dinoseb-acetate.

Acknowledgments

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

EXPERIMENTS ON WEED CONTROL IN RED BEET GROWN FOR BOTTLING AS SMALL WHOLE BEET

H. M. Lawson

Scottish Horticultural Research Institute, Invergowrie, Dundee.

Summary Experiments are reported on methods of obtaining satisfactory weed control in closely drilled rows of red beet under East of Scotland conditions. Five residual herbicides were evaluated in 1966. None was able to keep the crop clean throughout its growing season without supplementary hand-weeding and none significantly affected crop yield.

In 1967 a further range of residual herbicides was evaluated in association with the use of a stale seedbed technique where weeds were burned off with paraquat/diquat before crop emergence. The seedbed treatment by itself gave adequate weed control and no supplementary weeding was required. The addition of the residual herbicide treatments gave very little extra weed control and again no effect on yield was found. In 1968 lenacil applied pre-emergence proved unsatisfactory, but phenmedipham applied at the cotyledon/first true-leaf stage gave excellent results without adverse effect on crop yield. A later application was only slightly less effective and a repeat treatment following the later application gave useful results on weeds at the flowering stage but may have checked the crop. Supplementary hand-weeding was not used in this experiment and yield data show the very marked effects of the weed competition which resulted on unweeded plots and on those treated with lenacil.

INTRODUCTION

Increasing interest is being shown by processors in Scotland in the bottling of red beet both sliced and as small whole beet. Weed control is being investigated at S.H.R.I. as part of a general programme to discover suitable methods of producing high yields of small whole beet under conditions in the East of Scotland. The dry soil conditions which often occur in this area around the time of drilling red beet are not those suited to the most efficient performance of soil-applied residual herbicides and few growers have access to irrigation. The need for supplementary cultivation to maintain weed control has therefore been one reason why growers have kept to wide rows instead of growing the crop at the closer row spacings more likely to produce higher yields of the premium priced small whole beet grades. The experiments reported in this paper cover three seasons' investigations into the problems of achieving adequate weed control in closely drilled crops.

METHODS AND MATERIALS

The experiments were carried out on a sandy clay loam soil using randomised block layouts with three or four replications of each treatment. Red beet (variety Crimson King) was drilled in late May/early June in rows 12 in. apart in 1966 and 6 in. apart in 1967 and 1968. Plot size was 15 ft x 4 ft in 1966 and 20 ft x 6 ft in 1967 and 1968. Herbicide treatments in 1967 and 1968 are shown in Tables 1 and 2. Herbicide applications were made by Oxford Precision Sprayer in a water volume of 40 gal/ac in 1966 and 100 gal/ac in subsequent years. Germination and weed counts were taken on 2 x 1 yd^2 quadrats/plot. Regular visual scores of weed control efficiency were made and for the purpose of comparison, untreated plots were scored on the same basis. Assessments of the degree of crop shading by weed foliage were made in 1968. Weedfree plots were kept clean by hand. In 1967 roots were graded into the following sizes by diameter:- $\frac{3}{4}$ - $1\frac{1}{2}$ in. 'baby beet', $1\frac{1}{2}$ - $2\frac{1}{4}$ in. 'sweet little beet', and $> 2\frac{1}{4}$ in. 'slicing beet'. The size grades and names vary somewhat between processors. In 1968 an additional grade was introduced by one processor - $\frac{1}{2}$ - $\frac{3}{4}$ in. 'beet buds'.

RESULTS

1966 The following treatments were applied two days after drilling:-

A	Pyrazon	3 lb a.i./ac.	D	Propham/chlorpropham /fenuron †	10 pts. product/ac.
B	Lenacil	1 lb a.i./ac.	E	Chlorpyrazon	3 lb a.i./ac
C	Endothal/ propham*	21 pts. product/ac.	F	Control - Handweeded	

Growth of the crop over the whole trial area was poor, and provided no real assistance to the herbicides in suppressing weed growth. The post-sowing weather was wetter than average so that the herbicides were not put at a disadvantage by dry soil conditions. The main weed species on the experiment were Chenopodium album, Fumaria officinalis, Stellaria media and Veronica spp. By 15th July the percentage weed control on plots treated with pyrazon, chlorpyrazon and endothal/propham had fallen below 70% and these plots were hand-weeded. Plots treated with lenacil and propham/chlorpropham/fenuron did not fall to 70% weed control until 23rd August when they were hand-weeded. All herbicide treatments had to be weeded again in September to control a late germination of Stellaria media. At harvest there were no significant differences between treatments in total yield or weight of marketable roots.

1967 In this experiment a stale seedbed technique was used over the whole area and a dense stand of weeds was available for control by application of paraquat/diquat at 1 lb a.i./100 gal seven days before the crop emerged.

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* As "Murbetex" † as "Herbon Gold"

Control plots received no further treatment. There was very little rain immediately before and for several weeks after sowing. Residual herbicide treatments (see Table 1) were applied immediately after the application of paraquat/diquat.

Further weed germination was very slow and the crop had formed a canopy across the rows before many weeds had become established. Chenopodium album, Fumaria officinalis, Galium aparine and Polygonum convolvulus were the main species able to grow above the beet canopy on all plots. Plots treated with residual herbicides maintained only slightly better weed control than those receiving no further treatment. Differences in specific or overall weed control amongst the residual herbicide treatments were very small. By harvest time the untreated plots averaged 74% weed control while the treated plots ranged from 77%-81%. The weed infestation never reached a level on any treatment at which it was considered necessary to remove the weeds by hand.

No visible growth check attributable to treatment with residual herbicides was noted and no significant differences between treatments were found in the germination count taken on 10th July, or in yields of tops and roots harvested on 21st October (Table 1). Of the total yield of beet harvested from the trial, 92% by weight was of marketable size and 80% fell within the two small whole beet grades.

1968 This was again a dry season. Details of herbicide treatments are shown in Table 2. Lenacil was applied four days after sowing and the beet emerged five days later. Weeds also emerged rapidly and by the time the first application of phenmedipham was made on 10th June at the cotyledon/first true leaf stage of the crop the weed population was already dense. By 26th June phenmedipham had given an excellent knockdown of virtually all broad-leaved weeds but completely failed to control Poa annua. The crop grew over the top of this weed and the plots remained very clean until harvest, with only a few plants of Fumaria officinalis and Tripleurospermum maritimum ssp inodorum above the crop canopy.

A later application of phenmedipham was made to two sets of plots on 27th July when the crop was 7-8 cm. high and the weeds were at the young plant stage. A high percentage of the weed population including Stellaria media and Veronica spp. was killed or checked, but Fumaria officinalis, Chenopodium album, Matricaria matricarioides and Tripleurospermum maritimum ssp inodorum showed considerable tolerance. Poa annua was again resistant. When a proportion of the resistant broad-leaved weed population grew above the crop and began to shade crop leaves, one series of plots was re-treated on 26th July to see whether worthwhile results could be achieved at this late stage of crop and weed growth (crop 27-29 cm. high, weeds flowering). The effect of the repeat treatment on the weeds was mainly to retard further spread of these resistant weeds. This took several weeks to have its full effect but the plots were considerably cleaner at harvest than those not re-treated.

By late July plots treated with lenacil had become badly overgrown with weeds and by 21st August, over 40% of the crop foliage on these plots

Table 1

Germination counts and crop yields (cwt/ac) - 1967

Treatment	Dose/ac	Stand count/2yd^2	Total Roots	Roots $\frac{3}{4}$in-$1\frac{1}{2}$in	Roots $1\frac{1}{2}$in-$2\frac{1}{4}$in	Roots $>2\frac{1}{4}$in	Tops
Control		333.7	333.6	81.3	180.8	37.3	419.9
Propachlor	3.9lb a.i.	310.0	352.8	78.0	193.3	44.9	427.7
Lenacil	2.0lb a.i.	314.3	355.3	76.7	198.6	42.0	435.6
Propham/chlorpropham/fenuron*	10 pts product	305.0	363.0	74.8	202.2	50.7	458.1
Dimexan/cycluron/chlorbufam**	10 pts product	357.3	348.1	81.7	197.5	34.3	436.7
_N_'-(benz-1,3-thiazolyl)-_N_-methylurea***	6lb product	292.7	334.4	79.9	180.7	43.0	419.9
S.E./Mean		±38.7	±19.8	±5.0	±11.6	±8.9	±22.1
Coeff of variation %		19.1	8.9	7.9	8.2	27.5	7.5

* As "Herbon Gold" ** As "Trixabon" *** Code number "Bayer 60618"

Table 2

Crop and weed yields (cwt/ac) - 1968

Treatment	Dose/ac	Total Roots	Roots $\frac{1}{2}$-$\frac{3}{4}$in.	Roots $\frac{3}{4}$-$1\frac{1}{2}$in.	Roots $1\frac{1}{2}$-$2\frac{1}{4}$in.	Tops	Weeds
Weedfree	-	248.8	26.9	148.9	64.6	549.8	-
Unweeded	-	35.9	10.1	20.7	2.9	209.4	218.7
Lenacil pre-emergence	2.0lb a.i.	101.6	20.2	52.3	19.9	379.3	131.4
Phenmedipham at cotyledon/1st leaf stage	1.0lb a.i.	265.7	23.9	156.2	78.5	557.7	20.4
Phenmedipham crop 7-8cm high	1.0lb a.i.	198.9	23.6	117.1	52.1	510.4	86.1
Phenmedipham crop 7-8cm high repeated at 27-29 cm high	1.0lb a.i. 1.0lb a.i.	173.2	20.4	107.5	39.8	468.1	48.2
S.E. Mean		±15.8	±2.9	±8.1	±10.0	±37.2	±15.8
Coeff of variation %		16.0	24.1	13.9	40.5	14.5	32.5

was shaded by weeds compared with 85% on the unweeded control plots and less than 5% on the plots treated with the earliest application of phenmedipham. The relative performance of the various herbicide treatments is clearly shown by the fresh weights of weeds harvested with the crop (Table 2).

In germination counts and crop height measurements taken on 26th June there were no significant differences between treatments already applied and the weedfree control. The application of phenmedipham on 26th July gave the beet foliage a reddish tinge. Of the total crop of nearly $12\frac{1}{2}$ tons/ac harvested on the weedfree plots, 86% by weight was in the 'baby beet' and 'sweet little beet' grades and 10% in the 'beet bud' grade. Table 2 shows that only the early treatment with phenmedipham gave yields comparable with those on weedfree plots. The later and the repeat applications differed significantly from the weedfree treatment. Total yields of roots on plots treated with lenacil was 59% lower and in unweeded plots 86% lower than on the weedfree plots. The distribution of yield in the various size grades on plots treated with phenmedipham was similar to that on the weedfree plots. The repeat application of phenmedipham, although reducing weed growth considerably was not able to bring about an increase in yield and may in fact have checked crop growth.

DISCUSSION

One of the original aims of these experiments was to evaluate the available residual herbicides in terms of possible adverse effects on plant population or on the distribution of the total yield within the various size grades. However, it quickly became apparent that a far more pressing problem was the achievement of adequate season long weed control in a crop which offers no opportunity for supplementary weeding by cultivation. None of the herbicides tried in 1966 gave season long weed control on the weed species present, although lenacil and propham/chlorpropham/fenuron lasted almost eleven weeks before hand-weeding was required.

In 1967 the burning off of weeds shortly before crop emergence and the rapid formation of a dense crop leaf canopy combined very effectively to reduce weed growth in the crop to a minimum, but once again none of the residual herbicides gave effective control of such weeds as were present. While the programme achieved the objective of reaching harvest without requiring supplementary weeding, this was not due to the efficiency of the residual herbicides, but to the stale seedbed treatment. A similar situation was reported by Stephens (1964) in earlier experiments on beet grown for the fresh market. The preparation of a stale seedbed is therefore likely to be well worthwhile whenever soil and weather conditions allow.

In 1968, although lenacil was able to let the crop become established without the early competition from the dense stand of weeds which emerged on the unweeded plots, Chenopodium album and Fumaria officinalis rapidly grew above the crop and shaded the foliage. The early application of phenmedipham, on the other hand, apparently caught the weeds at the optimum stage and the crop remained very clean until harvest. Although by the second date of application the weeds were much larger and less susceptible the level of weed control obtained was very good. The repeat application had a useful effect and might justify use as a rescue operation, when weeds begin to grow above the crop canopy, but further evidence on the tolerance of the crop to such late application is required.

These preliminary results with phenmedipham on the range of weed species present in this experiment are very promising. Further investigations are intended to study timing of application and the use of the herbicide in association with residual herbicides and with stale seedbeds. Residual herbicides by themselves do not appear to be the answer to the weed problem in this type of crop in the East of Scotland. Since phenmedipham by itself has restricted weed spectrum the answer probably lies in a combination of suitable pre- and post-emergence treatments to keep the weeds below the crop canopy.

Acknowledgments

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THE EFFECT OF NITROGENOUS FERTILIZER UPON THE SELECTIVE USE OF HERBICIDES AS AN AID TO INFLUENCING SWARD COMPOSITION

Gwyn P. Griffiths

*Dept. of Agric., University College of Wales, Aberystwyth

Summary The effect of nitrogenous fertilizer, applied before and after herbicide application, upon the selective action of paraquat and asulam was assessed by examining the subsequent changes in sward composition. The sward initially consisted of 50% *Lolium perenne* and 50% *Holcus lanatus*, and changes in its composition were detected by tiller counts. Nitrogenous fertilizer applied before spraying was found to influence the selective use of paraquat, but not asulam.

INTRODUCTION

The use of herbicides to manipulate sward composition is still very much in its infancy. The chemical suppression of an alien species has been found to be influenced by numerous factors, including cultural factors, Allen G. P. (1965), Charles A. H. and Lewis J. (1962), Elliott J. G. (1962), Kerr J. A. M. and Bailie J. H. (1965). Previous work by the author indicated that the selective suppression of *Holcus lanatus* (H.L.) when grown in mixture with *Lolium perenne* (L.P.) and sprayed with paraquat, was dependant upon the quantity of nitrogenous fertilizer applied before herbicide application, Griffiths G. P. (1966).

This report covers additional work which investigated the influence of nitrogenous fertilizer upon the selective action of both paraquat and asulam.

METHOD AND MATERIALS

A sward consisting of approximately 50% *Holcus lanatus* and 50% *Lolium perenne* (S321) was established from seed sown on 26/4/67, in boxes measuring 24 ins x 18 ins x 4 ins. Herbage was cut back on 30/6/67 and 11/7/67, leaving a two inch stubble on each occasion. A basal application equivalent to 40 units** of phosphorus and 40 units of potassium was applied to all experimental material on 14/7/67. The following rates of nitrogenous fertilizer were applied at the dates specified.

Nitrogen Treatment	Date of Application 14/7/67		Date of Application 20/8/67
N1	10 units N/ac	Sprayed 2/8/67	-
N2	50 " "		-
N3	100 " "		-
N4	10 " "		50 units N/ac
N5	50 " "		50 " "
N6	100 " "		50 " "

* Farm Protection Ltd., 33 Broad Street, Stamford, Lincolnshire.

Seventeen days after the application of nitrogenous fertilizer, one half of the experimental material was sprayed with paraquat at 5.0 oz a.i./ac and the other half with asulam*** at 36 oz a.i./ac in 28 gallons of water/ac at 30 p.s.i. on 2/8/67. Foliage was approximately four inches high and the majority of plants possessed 7 - 8 tillers. Weather conditions were dry, mild and cloudy. All treatments were replicated three times and a randomised block design was used.

Assessments of the changes in sward composition were made by counting the number of tillers in a central area measuring 12 ins x 15 ins at the following dates: 23/5/67, 18/7/67, 13/10/67, 4/6/68.

A fertilizer application equivalent to 50 units N, 40 units P, 40 units K was made to all experimental material on 8/4/68.

** 1 unit = 1.12 lbs.

*** 75% w/w soluble powder, methyl N-(4-aminobenzenesulphonyl)-carbamate as K. salt.

RESULTS

Paraquat

At the dosage applied, paraquat caused a severe reduction in the number of tillers of both species (see Table 1.) irrespective of the level of nitrogenous fertilizer used. This reduction, however, was greatest and statistically significant where the largest quantity of nitrogen was used. Nitrogenous fertilizer also had a marked effect upon the selective action of paraquat.

Asulam

At the application rate used, asulam caused only a slight decrease in the number of *Lolium perenne* (L.P.) tillers, but reduced the number of *Holcus lanatus* (H.L.) tillers by approximately 40%. This selective suppression of H.L. by asulam was not influenced by the rate of nitrogenous fertilizer applied before herbicide application.

If the number of tillers/quadrat is represented by L and H for L.P. and H.L. respectively, changes in sward composition can be detected by the following formula:

$\frac{L}{H} \times \frac{(L + H)}{1}$ i.e. if a selective suppression of H.L. is obtained, then a large product figure is obtained.

Table 2. and Fig. I. illustrate the influence of fertilizer application upon the selective performance of the two herbicides used.

The application of nitrogenous fertilizer at or above 50 units/ac before spraying with paraquat produced a sward which was either very open and thin or of inferior quality, i.e. no botanical improvement. Paraquat did, however, suppress H.L. to a greater extent than L.P. in treatments N1 and N4, with the latter treatment producing a considerable improvement in sward composition.

Although the selective suppression of H.L. by asulam was not affected by the rate of nitrogenous fertilizer applied before spraying, the number of L.P. tillers was significantly increased by treatments N4, N5 and N6 where nitrogen was applied twenty days after herbicide application. This increase, however, did not continue through to the following year.

Table 1.

<u>Number of Tillers/Quadrat</u> <u>(Mean of 3 Replicates)</u>

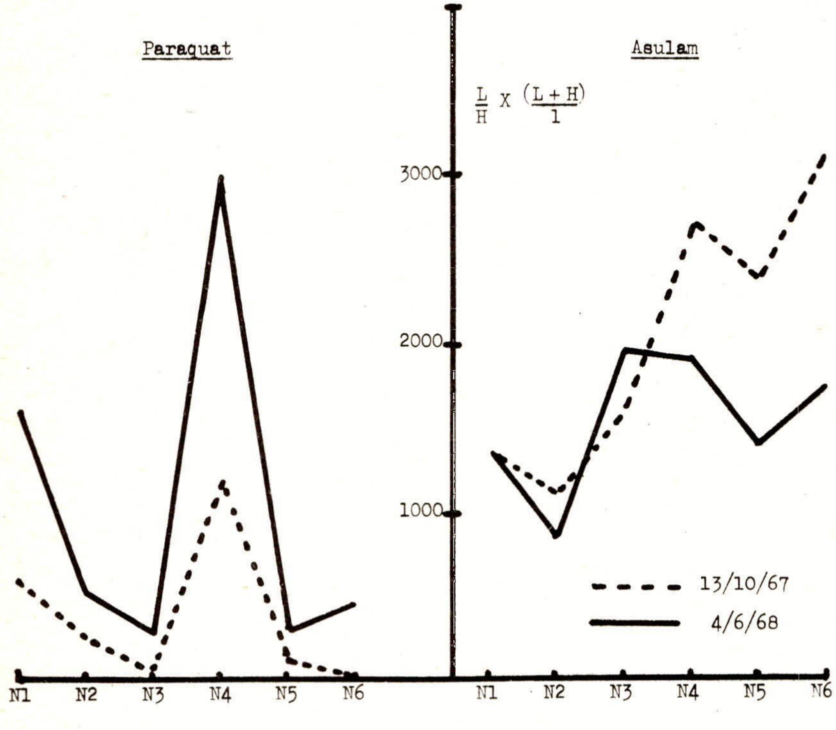
Nitrogen Treatment	Chemical Treatment: Paraquat				Chemical Treatment: Asulam			
	Number of *L. perenne* tillers/quadrat							
	23/5/67	18/7/67	13/10/67	4/6/68	23/5/67	18/7/67	13/10/67	4/6/68
N1	73.3	668.0	132.0	312.3	73.3	597.0	44[illegible].0	477.0
N2	73.3	579.3	120.3	224.0	74.7	632.3	451.0	395.0
N3	75.7	614.0	17.0	81.0	70.3	561.3	495.3	533.7
N4	75.7	621.3	285.0	397.0	73.3	544.0	566.6	538.0
N5	74.7	607.6	94.0	166.7	69.7	613.6	592.0	499.0
N6	72.3	631.0	21.0	125.7	73.0	624.3	639.0	522.3
L.S.D. (P = 0.05)			119.3				116.8	
	Number of *H.lanatus* tillers/quadrat							
N1	69.0	493.3	37.3	76.0	71.0	459.3	217.3	253.2
N2	66.7	458.0	109.0	162.7	70.7	484.0	284.0	353.7
N3	67.0	463.3	6.0	31.0	67.7	462.6	216.6	197.7
N4	70.0	441.6	87.0	59.3	64.0	500.0	149.0	207.0
N5	69.3	508.0	263.0	238.7	71.0	490.0	194.0	270.0
N6	67.0	427.0	20.3	47.3	64.7	457.6	161.3	219.0
L.S.D. (P = 0.05)			154.9				NS.	

Table 2.

$$\frac{L}{H} \times \frac{(L + H)}{1}$$

Nitrogen Treatment	Chemical Treatment: Paraquat 13/10/67	Chemical Treatment: Paraquat 4/6/68	Chemical Treatment: Asulam 13/10/67	Chemical Treatment: Asulam 4/6/68
N1	599.1	1595.6	1376.8	1375.3
N2	253.1	532.4	1167.2	836.1
N3	65.2	292.7	1627.4	1974.5
N4	1218.6	3054.8	2722.1	1936.3
N5	127.6	283.1	2398.5	1421.2
N6	42.7	459.8	3170.4	1767.9

Figure I.



NITROGEN TREATMENTS

DISCUSSION

As the biological properties of paraquat and asulam are so dissimilar, the former being a contact herbicide with very rapid action and the latter being translocated from both leaves and roots to meristematic regions and relatively slow acting, the influence of nitrogenous fertilizer upon their performance may be expected to differ.

At the dosage rates used, paraquat gave the greatest reduction in tiller number where the largest quantity of nitrogenous fertilizer was applied before spraying. This was probably because this rate of nitrogenous fertilizer stimulated luxurious leaf growth of both species, and hence increased the retention of the paraquat applied. At the low rate of nitrogenous fertilizer, L.P. showed some indication of greater tolerance to paraquat than did H.L. The greatest improvement in sward composition was obtained by applying 10 units N before spraying and 50 units N twenty days after spraying.

Asulam produced a remarkable improvement in sward composition, and its selective action was not influenced by the rate of nitrogenous fertilizer applied before spraying. The application of nitrogenous fertilizer after spraying, however, did significantly increase the quantity of L.P. in the sward; but this increase did not continue through to the following season.

Acknowledgments

The author wishes to thank Professor W. Ellison for providing the experimental facilities, Dr. J. L. Hammerton for his advice and May & Baker Ltd. for supplying the asulam.

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PASTURE IMPROVEMENT USING LOW RATES OF PARAQUAT

D. G. Sharp

Plant Protection Limited, Haslemere, Surrey.

Summary The composition of New Zealand pastures based on perennial ryegrass and white clover can be favourably altered using low rates of paraquat. When applied during the summer, the resultant pastures have been shown to have a reduced weed incidence, improved late winter/early spring production, summer fattening capability, and indications of an improved response to applied phosphate fertilizers. Higher rates have produced clover "crops" which have led to increased clover seed production, or at least equivalent lamb fattening capability compared to rape.

INTRODUCTION

In New Zealand, facing an economic recession due to problems in the marketing of its basic agricultural commodities, the need to improve farm productivity is accepted. One of the essential steps to be taken to achieve this increased productivity is the improvement of existing pastures.

New Zealand improved pastures are based on perennial ryegrass/white clover but very few indeed would approach a pure species pasture, the majority being typically invaded with weed grass species such as *Agrostis* spp., *Holcus lanatus*, *Poa* spp., *Hordeum murinum* and *Bromus mollis*, and also to a lesser extent by broadleaved species. Some form of phosphatic fertilizer is applied annually though nitrogen is seldom used, reliance being placed on clovers as the nitrogen source.

The most generally accepted method of increasing pasture productivity is to increase the application of phosphatic fertilizers and combine this with increased stocking. The method has been largley successful though there have been notable failures in Taranaki where productivity in high rainfall and free draining situations is being limited by *Agrostis* invasion. Even in the areas where it has been used with success it has limitations mainly due to the increased skill required to maintain grazing pressure at higher stocking intensities, and also due to the gradual nature of the productivity increase which necessitates outlay on extra fertilizer long before the required productivity level is achieved.

At a previous Conference the promising role of paraquat in alternative methods of pasture improvement has been described by Blackmore (1964). Since that time a strong field research effort has been made by ICI(NZ) Limited in co-operation with Plant Protection Limited to obtain quantitive data to substantiate this promise, and this paper presents some of the general conclusions arising from the work.

RESULTS

Autumn Pasture Renovation In contrast to pasture establishment, the term pasture renovation is intended to mean the improvement of an existing pasture by the insowing of selected species, with or without the aid of a pre-spray with herbicide. When using paraquat as an aid to sowing, in medium to high fertility conditions, and with a pasture having a perennial ryegrass/white clover base, it has been found of advantage to use low rates of paraquat applied in the autumn followed shortly after by the application of a low rate of ryegrass seed (12 - 20 lb/acre). The work described is confined to the summer rainfall areas. The factors investigated have included spray rate (2 - 8 oz/acre), rate of applied phosphate, seeding method, broadcast or direct drilled, and time of seeding. Different strains of ryegrass have been used including Ariki and Manawa (H1) as well as New Zealand perennial ryegrass.

It was shown that renovation in March/April leads to lowered production in the first winter, the depression increasing with the rate of paraquat applied (Williams, 1967). There was a tendency for treatment to produce an open pasture particularly with the higher rates which led to an ingress of broadleaved weeds. By early spring treated plots were producing more than the untreated in line with the improved productivity of the species introduced and had a higher component of ryegrass coupled with a reduction of weed grasses. One trial was carried through into its second winter and showed an increase in winter dry matter production of 44% in its second year, an increase which indicates something more than improved grass establishment or improved productivity due to the introduced species, and suggests increasing pasture vigour (Williams, 1968).

Where earlier renovation was carried out in February, a similar improvement in pasture composition occurred but without an increase in broadleaved weeds and with little or no reduction in winter production. Early spring production was again increased (20%). Drilling when compared to broadcasting led to improved ryegrass establishment, improved winter production, but resulted in a depression of clover in the following spring. Early spring production was not affected by the method of seeding. The general effect of treatment was to produce an initial clover dominant phase which disappeared in the following year to leave a pasture with a clover content similar to the untreated, but with an improved ryegrass component (Williams, 1968).

Pasture Manipulation Pasture manipulation refers to the application of low rates of paraquat (1 - 4 oz/acre) to a perennial ryegrass/white clover pasture during late spring or summer in order to improve pasture composition by the selective suppression of the more susceptible, and less desirable species.

Table 1.

Pasture composition changes following the application of 2oz paraquat per acre

Species		Clover		Ryegrass		*Agrostis* spp.		*Holcus lanatus*		Other grasses	
Paraquat rates (oz/acre)		0	2	0	2	0	2	0	2	0	2
Location	Date of Application										
Pio Pio [1]	13.11.67.	25	63	43	34	24	8	81	12	-	-
Hodderville [2]	9.11.66.	32	41	14	14	-	-	17	8	-	-
	9. 1.67.	27	42	14	17	-	-	21	4	-	-
	21. 2.67.	16	33	13	15	-	-	23	5	-	-
Inglewood [3]	4.10.67.	250	400	100	100	660	580	-	-	270	90

1 Total hits per 100 points (Williams, 1968) 3 months after application

2 Cover hits per 50 points (Palmer, 1967) 2 months after application

3 Dry matter production (lb/acre), 3 months after application (Palmer, 1968)

The application of 2 oz/acre paraquat on medium to high fertility sites has been shown to bring about a consistent swing to clover, with maintenance of the ryegrass component and a marked reduction of weed grasses including Agrostis spp. The consistency of this effect is illustrated in Table 1 which details the composition changes occurring at three sites on five occasions. The control of some broadleaved weeds as a result of treatment was noted. In one trial (Williams 1968) control of Scotch thistle (Cirsium lancelotum) occurred and the control of common daisy (Bellis perennis) has been noted in farmer applications. Imrie (1968) has also reported control of giant buttercup (Ranunculus acer). However, perennials, such as docks (Rumex sp.) and plantains (Plantago sp.) increase, taking advantage of the initial freedom from competition.

The general control of weed species by the application of these low rates of paraquat is higher than would be obtained if the same spray rates were used on a single species on its own. It is evident that the spray alters the balance of interplant competition allowing the more tolerant species, white clover and to a lesser extent ryegrass, to exert a stronger competitive effect, resulting in their eventual dominance over suppressed species.

In a trial comparing different times of application (early November, early January, late February) the speed of pasture recovery in the eight weeks following spraying and the resultant pasture composition change were recorded (Palmer, 1967). Pasture composition changes were not greatly affected by the time of spraying though speed of recovery was highest in January and lowest in November, resulting in losses of production of 12% and 37% respectively (Williams, 1968). This can be explained in terms of the seasonal growth pattern of clover as compared to grasses and the consequent inter species competition. Peak growth of grasses would have coincided with the first spray and peak growth of clover with the second, while at the third spray clover growth would be rapidly falling and grass growth increasing slightly.

As the immediate effect of a spray is to produce an increase in the proportion of clovers it might be expected that applied phosphates would be more effectively used. A trial has investigated this aspect and there are indications that this is occurring, a treatment of 2 oz/acre paraquat plus 6 cwt. super-phosphate giving equal productivity to 12 cwt. superphosphate on its own, and having the advantage of producing an improved species composition (Palmer, 1968).

There is a great deal of information showing that an increase in clover content of the pasture will give increased lamb live weight gain (Joyce and Newth, 1967), and in two seasons, one a drought year, it has been confirmed that higher live weight gains can be obtained from paraquat treated pastures having an enhanced clover content (Palmer, 1967, Williams, 1968). Stock response has to date only been studied in the summer period. Of particular note are the findings of a stocking trial at Reporoa where treatment with 3 oz paraquat gave an improved live weight gain despite the fact that dry matter production on the treated areas was approximately 25% less than the untreated for the period of the test (Palmer, 1967).

The implication of these findings has been taken further by Blackmore (1967) who compared live weight increases of lambs on a clover "crop" following a paraquat application to others fed on rape, a crop commonly grown for lamb fattening. He obtained an increased live weight gain from the clover fed lambs despite the lower dry matter availability from the clover crop.

Little work has been done so far in areas without a reliable summer rainfall. However Leonard (1964) has shown that improved clover seed yields can be obtained in such areas by the application of rates up to 4 oz/acre and the use of paraquat for this purpose has been accepted into farm practice. It is of interest that in one of his trials, despite a dry period following application which led to a lack of seed for harvesting, acceptable pasture improvement was obtained. A comparison has also been carried out under these conditions comparing lamb production on clover produced by paraquat, with that on rape, and similar carcass yields were obtained

(Taylor, 1968), confirming Blackmore's findings in the more favourable situation.

DISCUSSION

It is evident that the technique of pasture renovation with paraquat is very different from the "chemical ploughing" techniques using high rates of application of paraquat, or TCA and dalapon/'Amitrole' mixtures. In these cases the general aim is to take a low productivity sward, to completely remove the existing species, and renew with introduced species. The low rate paraquat technique on the other hand is aimed at medium to high fertility situations with conditions following spraying conducive to the quick recovery of the existing and preferred introduced species, particularly clover. The essential nature of the quick clover recovery to the success of pasture renovation has been illustrated in the extension of the technique on farms. The conditions needed for success are medium to high fertility situations, summer rainfall with a minimum of 35"/annum, a close grazed sward at spraying and a spray timing early enough to allow complete ground cover before the winter, all of which ensure a speedy reliable recovery from the spray by the selected species.

Farm scale usage has been described by Abraham (1967) and he draws attention to the difficulty of ensuring close grazed conditions in the early autumn on a fat lamb farm, due to the lack of stock at that time. On ecological grounds autumn appears a logical time to introduce new species due to the reduced competition from clover. In the one trial where seeding was investigated in the spring, no effect of seeding was found. However, in the majority of New Zealand pastures it is not necessarily the introduction of new species that is generally required but an improvement in the availability of the existing introduced species. On the evidence available the pasture manipulation method offers a reliable way of selecting for both ryegrass and clover, the preferred pasture constituents. This method fits more readily than autumn pasture renovation into the farm systems particularly the fat lamb farm, as it can be applied in the early summer as grazing pressure comes off the pastures when fat lambs are sent off the farm, leaving the pastures in a heavily grazed condition.

Considered solely as a selective spray to improve pasture productivity the application of 2 oz/acre paraquat produces a consistent improvement not just in pasture composition but also in live weight gain. In some farm systems this improvement may be difficult to manage though this was not the case as described by Imrie (1968), who used the method on a dairy farm with an <u>Agrostis</u> problem. The lower the rate used the less is the swing in pasture composition, the less time the pasture is out of action, and as a result the easier the method will be to fit into any farm system. Results are available on the effect of 1 oz paraquat in two trials and both show an improvement in pasture composition with increased clover component (Taylor, 1968 and personal communication). It could be that with a rate as low as this, an annual paraquat spray could be considered as a means of maintaining pasture composition and productivity supplementary to the present practice of annual fertilizer applications, and the maintenance of stock pressure.

Apart from pasture improvement there are many other possibilities for the use of low rates of paraquat. Mention has already been made of clover seed production and the replacement of the rape crop with a clover crop. Leonard (1967) has suggested that where a low rate of paraquat has been used in the summer there will be little difficulty in grazing down the sward in the early autumn in preparation for direct drilling, due to stock preference for sprayed pastures. This would allow the introduction of winter growing species such as Manawa (H1), Ryecorn, or Westerwolds tetraploid ryegrass, with or without the aid of paraquat, which could be used either as a partial replacement for the traditional brassicae crop or as a lambing crop. On intensive farms this could lead to a two crop/annum rotation of grass and clover. Another interesting aspect of paraquat usage is illustrated by work at the Winchmore Irrigation Research Station where wheat yields were higher when existing pasture was sprayed with paraquat to produce a clover crop for lamb fattening before ploughing and seeding (Drewitt, 1967). It is thought that the reduced mat allowing more effective cultivations, reduced weed seed production, and higher nitrogen return to the soil from the increased clover content could have been contributary factors leading to this favourable effect.

Acknowledgements

In putting forward the above suggestions the author wishes to make special acknowledgement of the pioneering work on paraquat techniques carried out by L. W. Blackmore of the New Zealand Department of Agriculture.

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THE RESPONSE OF A PERMANENT PASTURE TO SEASONAL APPLICATIONS OF METHYL N-(4-NITROBENZENE SULPHONYL)-CARBAMATE

G. P. Allen and A. K. Oswald

A.R.C. Weed Research Organization, Begbroke Hill, Kidlington, Oxford.

Summary The response of a long established and weed infested perennial ryegrass pasture to 0, 1, 2 and 4 lb a.i./ac methyl N-(4-nitrobenzene sulphonyl)-carbamate applied in April, May, July and August, 1967 is described in terms of botanical composition and yield. Perennial ryegrass was more resistant to the herbicide than were *Poa trivialis*, *Agrostis stolonifera* and *Holcus lanatus* at all spraying dates and it increased in ground cover and yield. The yield of total herbage was reduced but subsequently the treated plots recovered and the herbage then contained more ryegrass than the unsprayed sward. The optimal treatment for selective grass control was considered to be between 2 and 4 lb a.i./ac. The sward recovered more slowly after treatment in April and late August than in May or July but the selectivity was not markedly affected.

INTRODUCTION

Preliminary studies with methyl N-(4-nitrobenzene sulphonyl)-carbamate (MB8882), Holroyd, Oswald and Blair (1966), indicated useful selectivities between established grass species grown in pure stands or simple mixtures. *Lolium perenne* - perennial ryegrass was relatively resistant but the weed grasses *Holcus lanatus*, *Agrostis tenuis* and *Poa trivialis* were found to be more susceptible. Treatments were applied in both 1965 and 1966 during late July and October. The former date appeared the more promising one for a selective encouragement of *L. perenne*.

The object of the experiment reported here was to confirm the differences in the reaction of the species under farming conditions and to investigate the optimal dose and time of application for selective grass control.

METHOD AND MATERIALS

The experiment was located at Farthinghoe, Northants, O.S. Grid. Ref. SP529389, on a N.E. facing slope, 500 ft O.D. The soil is an imperfectly drained, sandy clay. The average annual rainfall is 25 in. The pasture which was sown many years ago had been used for sheep and cattle grazing. The percentage area of the ground covered by each of the main species assessed by point quadrat on 13th April, 1967 was *Lolium perenne* 50%, *Agrostis stolonifera* 23%, *Poa trivialis* 24%, *Holcus lanatus* 11%, *Trifolium repens* 5%. The ryegrass had a close spacing in the sward - an apparent necessity for successful, selective grass control in pasture Elliott and Allen (1964)

The experiment contained a fully randomised block design of three replicates, with plots 2.5 x 12 yd.

Treatments

Methyl N-(4-nitrobenzene sulphonyl)-carbamate at 0, 1, 2 and 4 lb a.i./ac was applied on 17th April, 16th May, 20th July and 25th August, 1967. The chemical was applied in 20 gal/ac aqueous spray solution containing 0.1% Agral 90. The solutions were sprayed at 30 lb pressure / in^2 through No. 00 ceramic fan jets fitted to the 7.5 ft boom of an Oxford Precision Sprayer.

The conditions at spraying and the subsequent management of the sward

Application on 17th April

Conditions: Sward grazed by sheep up till 10th April. Herbage dry, 2-3 in. high. Temp. (T) 16°C. Relative humidity (RH) 85%. Cloud cover (CC) 0.

Management: Herbage cut on 13th June 1967. 40 units nitrogen fertiliser (N)/ac applied on 12th July. Cut on 22nd August, 19th October 1967 and 12th June 1968.

Application on 16th May

Conditions: Sward recovering from a cut on 9th May. Herbage wet, 3-6 in. high. T 13°C. RH 83%. CC 80%.

Management: Herbage cut 11th July 1967. 40 units N/ac applied on 12th July. Cut 7th September and 19th October 1967 and 12th June 1968.

Application on 20th July

Conditions: Cut on 10th July. Herbage dry, 3 in. high. T 20.5°C. RH 86%. CC 70%.

Management: Cut 19th October 1967 and 12th June 1968.

Application on 25th August

Conditions: Cut on 18th August. Herbage dry, 4 in. high. T 22°C. RH 78%. CC 90%.

Management: Cut on 12th June 1968.

60 units/ac P_2O_5 and K_2O were applied to the whole trial on 25th July, 1967 and 4 cwt/ac of a 20 : 10 : 10 fertiliser applied overall on 13th March, 1968. MCPB K salt was applied at 1.5 lb a.e./ac to the whole trial on 16th June, 1967 and again on 23rd April, 1968 in order to control broadleaved weeds. The whole experiment was grazed by sheep during January, 1968.

Assessments

The reduction in the bulk of green vegetation following treatment was scored in comparison with that on the unsprayed control (Fig. 1). Point quadrats were used to assess the percentage of the ground area covered by each species immediately prior to and at intervals following each application (Table 2). The first contact only with each species was recorded using the method described by the Grassland Research Institute (1961). In all yield assessments (Table 1) a motorscythe was used to cut a 3ft wide swathe down the centre of each plot length, leaving a stubble approx. 2 in. high. All the cut material was weighed fresh. Random samples of the cut herbage were weighed and kept in cold storage until they were removed for sorting into species, which were dried at 100°C for at least 6 hrs and then weighed.

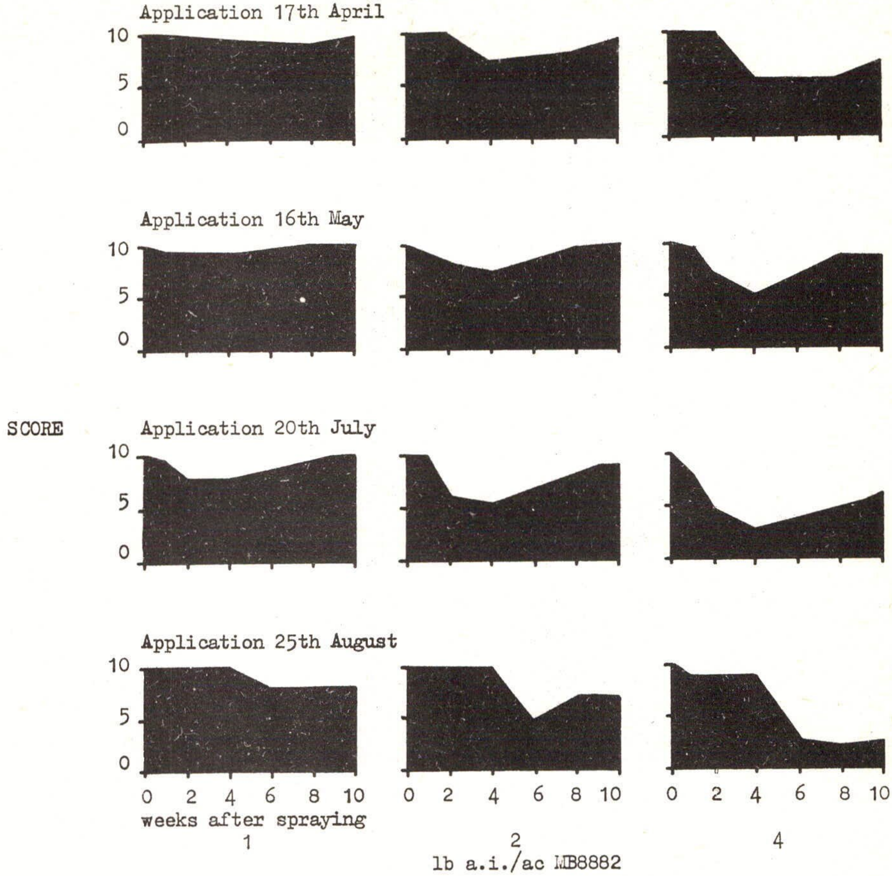
RESULTS

The main periods of sward change following the application of a herbicide have been distinguished by Elliott (1960). In this experiment the events following spraying showed a similar pattern.

1. The phase of direct herbicidal action and the resumption of normal growth (Fig.1)

A comparison of the graphs shows that a reduction in the bulk of green foliage was positively correlated with the increase in the dose of herbicide applied. The longevity of direct herbicidal action was related to the date of spraying and ranged from 4 weeks in April, May and July to 6-8 weeks in late August. Furthermore there were differences in the speed of response to the herbicide. Reaction was most rapid in May and July, less in April and slowest in late August. Dose for dose, the reduction in bulk of green foliage appeared to be greater the later the herbicide was applied.

Figure 1.



Herbicidal effects on the sward during 10 weeks after applications of MB8882 on 17th April, 16th May, 20th July and 25th August, 1967 scored for relative amounts of green foliage 0 = absence 10 = amount comparable with unsprayed control.

During this phase, indicated by the descending line of the graph, chlorosis of the sward developed and declined. The growth of grasses was suppressed and much of the chlorotic herbage died. Broad-leaved species were not apparently affected by the treatments. Towards the end of the period the weed grasses formed a largely dead matrix in which the resistant plants particularly those of perennial ryegrass were recovering. At this stage the selective effects became readily apparent.

2. The recovery of the treated sward
   a) Herbage production (Table 1).

Yields taken 8-9 weeks after the April and May and 13 weeks after the July treatments confirmed the impressions gained from the scores (Fig. 1). Treatment generally reduced the yield of total dry matter and the reduction was positively correlated with an increase in the dose of herbicide used. Moreover, although there was a tendency for ryegrass to be reduced after the applications in April and July this species actually formed a greater proportion of the total yield of herbage at each dose level. The reduction of weed grasses was correspondingly greater with increased dose of herbicide. Less marked reductions in the total yield were noted at the first harvest of the plots sprayed in May. In addition the yield of ryegrass on treated plots was equivalent to or greater than that on the unsprayed controls. No information was gained about the effect of the treatments on the yield of herbage at the first utilisation of the plots sprayed in August, but it was observed that reductions in yield were maintained into the Spring of 1968 due to the slow growth made during Autumn, Winter and early Spring.

At the second and subsequent harvests of treated plots total yield was comparable with that on the controls and the yield of ryegrass was equivalent to or appreciably greater especially at the higher doses.

Table 1.

Yield (lb dry matter /ac) of total herbage T and *Lolium perenne* L following applications of MB8882 on 17th April, 16th May, 20th July and 25th August, 1967

		lb a.i./ac MB 8882			
		0	1	2	4
Application: 17th April, 1967					
Cut 13th June, 1967	T	1341	930	502	265
	L	681	541	335	193
Cut 22nd August, 1967	T	2445	2516	2820	2363
	L	865	1293	1745	1732
Cut 19th October, 1967	T	819	802	973	886
	L	460	500	712	688
Cut 12th June, 1968	T	5005	4791	5337	4834
	L	2482	2348	2839	2958
Application 16th May, 1967					
Cut 11th July, 1967	T	3077	3441	1665	1893
	L	1476	2109	1432	1651
Cut 7th September, 1967	T	1910	1760	2151	1780
	L	812	966	1140	1242
Cut 19th October, 1967	T	3508	2916	3195	3832
	L	2094	2097	2521	3411
Cut 12th June, 1968	T	4939	4712	4780	4900
	L	2252	1880	2763	3293
Application 20th July, 1967					
Cut 19th October, 1967	T	1708	1186	624	218
	L	611	641	421	174
Cut 12th June, 1968	T	4876	4590	4095	5103
	L	2087	2253	2514	3047
Application 25th August, 1967					
Cut 12th June, 1968	T	4866	4889	4704	4720
	L	2058	3608	3175	3540

b) Botanical composition (Table 2).

The selective effects indicated by the yields were confirmed by assessments of the percentage area of ground covered by each species. In all instances perennial ryegrass showed relatively greater resistance to the treatments than did the weed-grasses. Perennial ryegrass subsequently increased in all plots treated in April, May and July to a level above that found in corresponding unsprayed controls. Agrostis stolonifera, Poa trivialis and Holcus lanatus were reduced in ground cover compared with control. All grass species were suppressed for longer the later the date of spraying. White clover - Trifolium repens showed no marked response to any treatment.

Table 2

The percentage area of ground covered by the main species before and after applications of MB 8882 in April, May, July and August, 1967. First contacts per species per 100 points per plot. Means of 3 replicates.

Application date and dose lb a.i./ac	Assessed	Lolium perenne	Agrostis stolonifera	Poa trivialis	Holcus lanatus	Trifolium repens
17th April, 1967	13th April, 1967	50	23	24	11	5
0	21st June, 1967	45	41	34	21	11
1		61	28	29	13	15
2		77	12	25	15	7
4		74	14	11	7	14
0	14th November, 1967	40	35	28	23	6
1		53	25	26	11	12
2		61	17	18	10	4
4		72	7	11	7	12
18th May, 1967	12th May, 1967	49	33	35	14	6
0	4th August, 1967	56	39	33	26	16
1		62	38	33	19	10
2		76	30	17	12	22
4		83	18	7	4	9
0	14th November, 1967	50	35	26	22	8
1		51	26	22	17	5
2		51	35	15	15	13
4		69	21	9	7	3
20th July, 1967	18th July, 1967	62	28	31	18	10
0	14th November, 1967	34	23	24	23	6
1		50	19	22	5	12
2		62	10	16	3	15
4		50	6	6	1	10
25th August, 1967	22nd August, 1967	62	24	33	16	14
0	14th November, 1967	74	36	35	25	14
1		77	16	13	5	16
2		66	7	2	1	8
4		29	4	1	1	12

DISCUSSION

The results confirm the experience in preliminary evaluation that Lolium perenne is more resistant than are Poa trivialis, Holcus lanatus and Agrostis (A. stolonifera in this case) to the herbicide methy N-(4-nitrobenzene sulphonyl)-carbamate.

The optimal dose for the selective suppression of the weeds and subsequent promotion of the ryegrass was between 2 and 4 lb a.i./ac. The speed with which the component species and hence the sward recovered from treatment depended on the date of spraying and the species reaction to growing conditions subsequent to spraying as well as to the degree of suppression caused then by the herbicide. Consequently, although the selectivity was not affected markedly the herbicide worked more slowly in April and late August than in May or July.

The magnitude of the selectivities obtained is comparable with that achieved with dalapon used at similar rates on this type of mixed pasture Allen (1965, 1968) but does not reflect the strong seasonal effect found with dalapon. As with dalapon it is not clear how much of the selective effect is due to differences in inherent susceptibility to the herbicide on the one hand and differences in specific growth rate and the reversal of competition stresses after treatment on the other. Thus, until further work is undertaken to integrate the selective effects of the herbicide with fertiliser and rational management, its full value as a weed control measure cannot be ascertained.

The information gained on herbage yield may be relevant to the suppression which can occur following the use of the closely related compound methyl N-(4-aminobenzene sulphonyl)-carbamate - asulam, for the control of docks - Rumex spp. in pasture.

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