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POST-EMERGENCE HERBICIDE EXPERIMENTS IN PEAS AND DWARF BEANS

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Summary The results are presented of experiments with post-emergence herbicides in peas and dwarf beans. The mixture of bentazon plus MCPB at the rate of 1.5 + 1.5 lb a.i./ac proved to be a useful treatment for peas, being effective against a wide range of important weeds and generally giving equivalent control to the standard application of dinoseb-amine. It had, however, on occasions a noticeable effect on the crop and the resulting yields were not as high as those from dinoseb-amine. Cyanazine did not cause serious crop damage, except on a free-draining soil where leaching occurred, but knotgrass (Polygonum aviculare) was not adequately controlled. The results of a varietal susceptibility experiment suggest differences in reaction to all three materials. Bentazon, applied at the two to three trifoliate leaf stage, proved to be a promising 'emergency' treatment for dwarf beans.

INTRODUCTION

In recent years there has been widespread acceptance of the principle of using residual herbicides to control weeds in peas (Pisum sativum) and dwarf beans (Phaseolus vulgaris). The greater convenience and increased reliability against some of the more difficult weed species have been factors contributing towards their increased use; it is estimated that at least 60% of the acreage of peas grown in the U.K. is treated with a pre-emergence herbicide and the figure for the dwarf bean crop is probably even higher. There is now a wide choice of materials recommended for the pea crop and provided soil conditions are suitable satisfactory control can be achieved. While the choice for dwarf beans is limited, the most widely used material, dinoseb-acetate plus monolinuron, is again capable of giving excellent weed control. Peas are grown on many different soils ranging from sandy soils, where residual herbicides may not be safe, to heavy clay or organic soils where the materials may not be sufficiently active. Sowing commences in late February and continues into May, and many seedbeds may be too cloddy or dry for efficient use of soil-applied herbicides. Dwarf beans which are sown in May and early June can also encounter dry conditions. Dinoseb-amine and acetate formulations are widely used in peas as post-emergence herbicides, but are toxic, requiring medium to high volume application and the weather at spraying and shortly afterwards must be warm and dry. Stage of weed development is important, particularly for species such as Polygonum aviculare, Tripleurospermum maritimum ssp. inodorum and Matricaria matricarioides, and where there is insufficient leaf wax crops may be damaged. There is therefore a need for a safe, convenient treatment, capable of controlling weeds under cool conditions.

The mixture of aziprotryne plus simazine, reported on by Cassidy (1970), King (1970), Lawson & Rubens (1970) and Marks & Smith (1970) at the last Conference, has generally been found to be too demanding in relation to the stage of weed development to be widely used.

Experiments have been carried out in the past two seasons evaluating post-emergence treatments in peas and dwarf beans and the results are presented here.

METHOD AND MATERIALS

The experiments were of randomised block design with three or four-fold replication, plots being 0.0025 acres in area. They were carried out in commercial crops, except for those on the Thornhaugh trial ground. Applications were made with a van der Weij sprayer, fitted with cone nozzles, at medium (50 gal/ac) or low (20 gal/ac) volume. Dose rates are given in active ingredient. In 1971 the wettable powder formulation of bentazon was used, while in 1972 a tank mix using 40% liquid formulations of bentazon and MCPB was tested. Assessments were carried out for effects on the crop, control of individual weed species and overall control. The scoring system used was 0-10 where 10 was no crop damage or complete weed control. The peas were cut by hand and threshed with a plot viner. Yields of shelled peas were recorded and maturity was measured with a tenderometer. The dwarf beans were picked by hand and the weight of sound pods recorded. Samples of both crops were processed for taint tests.

The site details are shown below:-

Year	Code	Location	Soil type	Variety	Stage of crop & weed at time of application: Crop	Weeds
Peas						
1971	A	Thornhaugh	F.S.L.	Puget	8-9 leaves	Established plants
1972	B	Thornhaugh	F.S.L.	Sprite	4 leaves	Mainly 2-4 leaves
	C	Grimston	Org.C.S.L.	Superfection	5 leaves	Mainly 2-4 leaves
	D	Spalding	V.F.S.L.	Jade	5 leaves	Mainly 2-6 leaves
	E	Benwick	Peaty L.	Dart	5 leaves	Mainly 2-4 leaves
Dwarf beans						
1971	F	Thornhaugh	F.S.L.	Tendercrop	Early: Monofoliate.	2 leaves - est. plants
					Late: 2 trifoliates.	Large est. plants
	G	Holbeach	Zy.L.	Cascade	Early: Monofoliate.	2-4 leaves
					Late: 2 trifoliates	Est. plants
	H	Deeping St. Nicholas	Org.Zy.L	Bush Blue Lake	Early: Monofoliate.	2-4 leaves
					Late: 2 trifoliates.	Large est. plants
	I	Thornhaugh	F.S.L.	Tendercrop	V. early: Monofoliate.	2-4 leaves.
					Early: 1 trifoliate	2-5 leaves
					Late: Flower bud stage.	Est. plants

In 1972 the effects of post-emergence applications of dinoseb-amine, bentazon plus MCPB and cyanazine were recorded on twenty-five vining and dried pea varieties. The treatments were applied in medium volume at approximately three times normal rate i.e. 5.5, 3.0 + 3.0 and 3.0 lb/ac respectively, when the crop had from 7 to 8 leaves. There were two replicates of each variety. Assessments were carried out twelve days after treatment.

RESULTS

Peas

The crop tolerance to applications of cyanazine was generally good (Table 1) only slight chlorosis being recorded which was rapidly outgrown. At site C (organic coarse sandy loam), however, there was quite serious chlorosis and necrosis and some loss of plant. This appeared to be due to root uptake increasing the intake to the plant on this free-draining soil. The comparison of low and medium volume applications at site E suggested that there was slightly less effect on the crop from the former.

All the rates of the bentazon plus MCPB mixture caused some distortion and leaf scorch in the 1972 experiments, particularly at sites C & D (varieties Superfection and Dart respectively). The effects from the low and medium rates were generally acceptable and the crops soon outgrew most of the symptoms, although the leaflet size was somewhat reduced and the foliage had a 'bluish' hue. The high rate caused more severe effects and these were fairly persistent, leading to slight stunting. There was little apparent difference in the effect on the crop from the low and medium volume applications of the mixture at site E. Dinoseb-amine caused leaf scorch, particularly noticeable at site E on the variety Dart, but the effects were rapidly outgrown.

Table 1

Crop and weed assessments - vining peas 1971-72

Material	Rate lb/ac	Vol.	Crop damage (0-10) Site A	B	C	D	E	Weed control (0-10) Site A	B	C	D	E
Cyanazine	1.0	M	10	9	6	10	8	7	7	10	4	7
Cyanazine	1.0	L	-	-	-	-	9	-	-	-	-	7
Cyanazine	2.0	M	10	7	5	10	8	9	8	10	6	8
Cyanazine	2.0	L	-	-	-	-	9	-	-	-	-	8
Bentazon + MCPB	1.0 + 1.0	M	-	9	9	7	8	-	4	8	6	8
Bentazon + MCPB	1.0 + 1.0	L	-	-	-	-	8	-	-	-	-	7
Bentazon + MCPB	1.5 + 1.5	M	10	9	7	7	7	8	5	8	7	8
Bentazon + MCPB	1.5 + 1.5	L	-	-	-	-	8	-	-	-	-	8
Bentazon + MCPB	3.0 + 3.0	M	10	8	5	5	6	8	6	9	8	9
Bentazon + MCPB	3.0 + 3.0	L	-	-	-	-	6	-	-	-	-	9
Dinoseb-amine	1.9	M	9	8	10	10	7	9	4	7	7	9

The low rate of bentazon plus MCPB gave slightly inferior weed control compared to dinoseb at one site and similar control at the other sites. The medium rate of the mixture generally gave equivalent or better control than dinoseb and the high rate was consistently good. The high rate of cyanazine also gave effective weed control and the low rate was generally acceptable. Dinoseb gave inconsistent control of *P. aviculare*, *T. maritimum ssp. inodorum*, *M. matricarioides* and *Stellaria media*. The bentazon plus MCPB mixtures gave better control of these weeds and post-harvest assessments confirmed that the most advanced *P. aviculare* at the time of treatment, which earlier had been stunted by the low and medium rates, had not recovered. The low rate of cyanazine was poor against *P. aviculare*, rather inconsistent against *T. maritimum ssp. inodorum* and *M. matricarioides*, but good against *S. media*. The bentazon plus MCPB mixtures were better than dinoseb against *Polygonum convolvulus*, *Urtica urens*, *Fumaria officinalis*, *Viola arvensis* and *Galium aparine*, but were very weak against *Veronica spp*. and rather inconsistent against *Lamium purpureum* and *Capsella bursa-pastoris*. Cyanazine was good against

against Veronica spp., but weak against F. officinalis and Galeopsis tetrahit; dinoseb and the medium and high rates of bentazon plus MCPB mixture gave good control of this latter weed. All the treatments gave satisfactory control of Polygonum persicaria, Aethusa cynapium, Chenopodium album, Sinapis arvensis and Anagallis arvensis.

Table 2

Yield and maturity data - vining peas 1971-72

Material	Rate lb/ac	Vol.	Yield (% of untreated) Site A	B	C	D	E	Tenderometer reading Site A	B	C	D	E
Cyanazine	1.0	M	114	115	105	109	132	110	104	103	117	113
Cyanazine	1.0	L	-	-	-	-	147	-	-	-	-	117
Cyanazine	2.0	M	118	107	98	116	146	114	105	97	118	119*
Cyanazine	2.0	L	-	-	-	-	148	-	-	-	-	116
Bentazon + MCPB	1.0 + 1.0	M	-	134	82	119	139	-	105	92	122	114
Bentazon + MCPB	1.0 + 1.0	L	-	-	-	-	138	-	-	-	-	114
Bentazon + MCPB	1.5 + 1.5	M	107	126	94	106	137	113	103*	93	120	116
Bentazon + MCPB	1.5 + 1.5	L	-	-	-	-	131	-	-	-	-	119*
Bentazon + MCPB	3.0 + 3.0	M	114	113	98	113	134	115	105	94	117	113
Bentazon + MCPB	3.0 + 3.0	L	-	-	-	-	121	-	-	-	-	112
Dinoseb-amine	1.9	M	126	114	114	119	150	116	105	98	118	115
Untreated	-	-	100	100	100	100	100	115	113	96	120	110
Yield of untreated cwt/ac			22.9	19.2	37.6	53.4	33.9	-	-	-	-	-
Sig. @ P = 0.05			NS	NS	NS	NS	NS	NS	Sig.	NS	NS	Sig.
S.E. as % of gen. mean			11.2	18.8	12.2	16.6	13.3	4.7	3.1	5.1	5.2	2.2

The yield and maturity data are presented in Table 2. The greatest yield increases, compared to the untreated control, were generally given by the dinoseb-amine treatment. The bentazon plus MCPB mixture gave good yield increases where the weed infestations were severe, sites B, D & E, but the effect on the crop at site C, where the weed species present did not cause marked competition to the vigorously growing crop, apparently resulted in yield reductions at harvest. The yields from the cyanazine treatments were not as high as those from the dinoseb-amine treatment and at site C the effects on the crop recorded earlier in the season resulted in a rather poor yield from the low rate and the yield from the high rate was below that from the untreated control. None of the treatments caused any marked differences in the maturity of the produce compared to dinoseb and the greatest effect was at site B, where the severe competition from S. media and other weeds caused premature ripening on the untreated control plot, and at site E where the untreated plots were apparently somewhat delayed.

No taints were detected in any of the samples of peas taken from plots treated with bentazon and bentazon plus MCPB, or in dwarf beans taken from plots treated with bentazon in 1971.

The results of the varietal susceptibility experiment, presented in Table 3, suggest that there are varietal differences in reaction to applications of all three post-emergence treatments and that generally the sensitivity of the varieties was similar for all three chemicals. Cyanazine, however, did not produce such a wide range of effects as the dinoseb-amine or bentazon plus MCPB mixture. The most sensitive varieties were Surprise, Vedette, Hurst Beagle and Small Sieve Perfection, while the dried pea varieties Allround, Dik Trom, Greco and Greengolt were the most resistant.

Table 3

The reaction of pea varieties to post-emergence applications

Variety	Material: Dinoseb -amine	Material: Bentazon + MCPB	Material: Cyanazine	Variety	Material: Dinoseb -amine	Material: Bentazon + MCPB	Material: Cyanazine
Allround ≁	1	1	1	Orfac	2	3	3
Dark Skinned Perfection	2	2	1	Platinum	2	2	1
				Puget	2	1	2
Dart	3	3	3	Recette	3	3	2
Dik Trom ≁	1	1	1	Scout	3	3	2
Galaxie	2	3	2	Small Sieve Perfection	5	3	3
Greco ≁	1	2	1	Sparkle	3	3	2
Greengolt ≁	1	1	1	Sprite	3	3	2
Hurst Beagle	5	3	3	Superfection	4	3	2
Hurst Greenshaft	2	3	2	Surprise	5	5	4
Jade	3	3	2	Tezieridee	2	3	3
Maro ≁	2	2	1	Vedette ≁	4	4	3
Martus	3	2	1	Valley Perfection	2	2	2

Key:

≁ Dried pea varieties

Classification @
1. Highly tolerant
2. Tolerant
3. Slightly susceptible
4. Moderately susceptible
5. Very susceptible

@ Classification based on assessments for the percentage leaf area scorched by the dinoseb-amine application, the amount of scorch and distortion from the bentazon plus MCPB mixture and the amount of chlorosis and scorch from the cyanazine application.

Dwarf beans

All the bentazon applications caused some chlorosis and leaf scorch and the effects were more severe when it was applied at the early, monofoliate leaf stage. In some cases the monofoliate leaves were completely destroyed and such plants were severely retarded. Later applications resulted in varying degrees of scorch to the trifoliate leaves and not all plants were affected. Slight stunting was evident for some time, but by harvest this was generally no longer visible. Less crop damage apparently resulted from applications made when the weather was cool and overcast than from those applied in hot sunny conditions. The early applications gave excellent control of a wide range of weed species, although P. aviculare and Veronica spp. were resistant. The later applications of 1.5 or 2.0 lb/ac were slightly less effective, although control of the large established plants of T. maritimum ssp. inodorum, M. matricarioides, C. album, U. urens, F. officinalis, S. arvensis, P. persicaria, and P. convolvulus was good, and the higher rates were particularly effective.

As can be seen in Table 5 the early applications did not result in such high yields as the late ones, in spite of the weed control being slightly superior. Several of the treatments gave highly significant yield increases over the untreated controls particularly at sites G & H where weed populations were high. At site H all the bentazon treatments gave higher yields than the standard pre-emergence treatment of dinoseb-acetate plus monolinuron (results not presented), while at site G the late application of 1.5 lb/ac again gave higher yields and the 3.0 lb/ac rate gave equivalent yields. At site I the very late applications, made when the plants were in bud, reduced yields and presumably at this stage weed competition had already affected the crop and also there was less time for the crop to recover from the effects of the application before harvest.

Table 4

Crop and weed assessment - dwarf beans 1971

Material	Rate lb/ac	Application stage	Crop damage (0-10) Site				Weed control (0-10) Site			
			F	G	H	I	F	G	H	I
Bentazon	1.5	Early	4	4	6	-	7	9	8	-
Bentazon	1.5	Late	7	6	7	-	4	5	4	-
Bentazon	3.0	Early	3	4	6	-	7	8	8	-
Bentazon	3.0	Late	6	6	7	-	7	7	7	-
Bentazon	2.0	Early	-	-	-	7	-	-	-	8
Bentazon	2.0	Late	-	-	-	7	-	-	-	6
Bentazon	2.0	V. late	-	-	-	7	-	-	-	6
Bentazon	4.0	V. late	-	-	-	5	-	-	-	8

Table 5

Yield data - dwarf beans 1971

Material	Rate lb/ac	Application stage	Yield (% of the untreated) Site			
			F	G	H	I
Bentazon	1.5	Early	97	132	267 ***	-
Bentazon	1.5	Late	158 **	192 ***	265 ***	-
Bentazon	3.0	Early	130	151 *	264 ***	-
Bentazon	3.0	Late	204 ***	164 **	303 ***	-
Bentazon	2.0	Early	-	-	-	103
Bentazon	2.0	Late	-	-	-	113 *
Bentazon	2.0	V. late	-	-	-	91
Bentazon	4.0	V. late	-	-	-	80 **
Untreated	-	-	100	100	100	100
Yield of untreated cwt/ac			43.6	38.8	48.3	27.6
Sig. @ P = 0.05			Sig.	Sig.	Sig.	Sig.
S.E. as % of gen. mean			13.4	13.2	16.2	7.8

DISCUSSION

Peas

While dinoseb-amine can cause serious crop damage, in this series of experiments all the crops had acceptable leaf wax prior to treatment, as shown by the crystal violet test, and very little leaf scorch occurred. The weed control was also satisfactory, apart from the failure to control the established S. media and P. aviculare at one site. The normal rate of cyanazine was generally less effective and it was weak against P. aviculare, U. urens, F. officinalis, G. aparine and G. tetrahit. Its ineffectiveness against P. aviculare was particularly noticeable. This weed has a rather protracted emergence and whilst those plants at the cotyledon or first leaf stage were killed, the more advanced plants grew away normally and were not even checked. Very little visual effect on the crop was seen from the treatment, but yields were rather disappointing, and since insufficient weeds survived the application to cause significant competition, it could be that the material itself was having a depressing effect on the crop. It is interesting to note that the low volume applications gave higher yields than the medium ones, which had given more chlorosis earlier in the season. The serious effect on the crop on the sandy soil site, where the material was apparently leached down to the crop roots, suggests that a rate of 1.0 lb/ac is not safe on such free-draining soils.

The bentazon plus MCPB mixture applied at the rate of 1.0 + 1.0 lb/ac did not give acceptable weed control under all conditions and the results suggest that 1.5 + 1.5 lb/ac would be required to give reliable control. While the failure to control Veronica spp. detracted from the visual effectiveness early in the season, this weed was readily suppressed by a vigorous crop. The effect of the mixture on advanced P. aviculare was to retard the development to a point where crop competition either completely smothered the plants or prevented any further development.

There was no evidence that the mixture was affecting the maturity of the crop, but generally the yields were not as high as from dinoseb-amine. The effect of the treatment was particularly noticeable on the variety Superfection and the results of the varietal susceptibility experiment confirm that some varieties are more sensitive than others.

The idea of using a low toxicity herbicide mixture such as bentazon and MCPB, incorporating as it does growth hormone type materials, is very interesting and it could offer considerable advantages. The stage of weed development and weather conditions would appear to be less critical than for dinoseb and the application itself would be easier to make. Unfortunately the mixture in its present form seems unlikely to be safer on dinoseb-sensitive varieties. Further development is necessary, however, to try to minimise the effect on the crop and mixtures with reduced amounts of MCPB should be tested.

Dwarf beans

On the basis of the results obtained in dwarf beans, bentazon would appear to be a useful 'emergency' treatment for situations where conventional treatments have failed. Inter-row cultivations often leave severe weed problems in the row which can prevent such crops being harvested successfully. Bentazon, combined with inter-row cultivation to eliminate the worst of the P. aviculare and Veronica spp. which would survive the application, could provide economical control in these situations.

To avoid damaging the crop the application would need to be delayed until the plants had formed at least two trifoliate leaves and treatment when the weather was hot and sunny should be avoided. Further development work has been undertaken this season to more fully evaluate this treatment, but the results are not yet available.

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References

CASSIDY, J.C. (1970) Evaluation of pre- and post-emergence herbicides in peas. Proc. 10th Br. Weed Control Conf., 646-653.

KING, J.M. (1970) Herbicide evaluation in peas 1969-70. Proc. 10th Br. Weed Control Conf., 630-637.

LAWSON, H.M. & RUBENS, T.G. (1970) Further evaluation of pea herbicides for use in Scotland. Proc. 10th Br. Weed Control Conf., 638-645.

MARKS, T.G. & SMITH, J.M. (1970) Trials with mixtures of aziprotryne and simazine for weed control in peas. Proc. 10th Br. Weed Control Conf., 617-620.

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TRIAL RESULTS OBTAINED IN SOYA BEANS WITH 3-ISOPROPYL-1H-2,1,3-BENZOTHIADIAZIN-4(3H)-ONE 2,2-DIOXIDE (proposed common name BENTAZON)

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Summary BAS 3510 H and BAS 3517 H are post-emergence herbicides developed by the Badische Anilin- & Soda-Fabrik AG, Ludwigshafen. The active ingredient is 3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide.

The products take effect as contact herbicides, mainly via the leaf. Annual weeds in soya beans are effectively controlled by 1 kg a.i./ha.

Crop tolerance is very good at all stages of crop growth.

The best time for application is between the development of the first and third trifoliate leaves of the crop.

INTRODUCTION

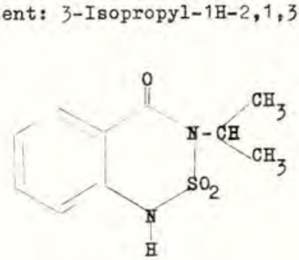
The crop compatibility of BAS 3510 H in cereal and rice and its herbicidal efficacy against broad-leaved weeds and Cyperaceae have already been discussed in various reports (Behrendt and Sipos 1969 and 1970, Fischer 1968, Luib et al. 1971, Menck and Behrendt 1972). This contact herbicide takes effect primarily through the leaf. Translocation within the plant is limited.

The present paper summarises the results obtained with 3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide in soya beans.

METHOD AND MATERIALS

Chemical name of active ingredient: 3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide.

Formula of active ingredient:



Proposed common name: Bentazon

Formulations BAS 3510 H is a wettable powder containing 50 % a.i..
BAS 3517 H is a liquid formulation containing 480 g/l a.i..

Assessment Crop compatibility and herbicidal efficacy were assessed according to a scale ranging between 1 and 10, i.e.

1 = 0 % damage to crop or weed
10 = 100 % destruction of crop or weed.

Herbicidal efficacy was assessed approximately 4 weeks after application.

Methods In the last two years approximately 50 field trials were carried out in USA and Europe on plots 20-25 m^2 in area, each with 3 or 4 replications.

BAS 3510 H and BAS 3517 H were applied post-emergence at various stages in the development of the beans and at various rates (0.5, 0.75, 1.0, 1.5 and 2.0 kg a.i./ha). Spraying took place at:

unifoliate leaf stage
1 trifoliate leaf stage
2-4 trifoliate leaf stage
full foliage
start of flowering.

RESULTS

Crop tolerance

Table 1

Crop tolerance of 3-Isopropyl-1H-2,1,3-benzothidiazin-4(3H)-one 2,2-dioxide in soya beans

kg a.i./ha	unifoliate leaf stage	1 trifoliate leaf stage	2-4 trifoliate leaf stage	full foliage	start of flowering
0.5	1.0(2)	1.0(4)	1.1(5)	1.0(1)	1.6(2)
0.75	1.0(9)	1.1(10)	1.0(8)	1.1(6)	1.3(5)
1.0	1.1(12)	1.1(14)	1.1(14)	1.1(12)	1.2(14)
1.5	1.1(3)	1.0(5)	1.0(2)	1.0(2)	-
2.0	1.2(12)	1.2(13)	1.1(11)	1.2(10)	1.4(7)
3.0	-	1.4(3)	1.2(4)	1.2(2)	-

( ) = number of trials

Since crop tolerance and herbicidal efficacy were identical for both formulations, the results may be summarised in order to save space and for more clairty.

Both BAS 3510 H and BAS 3517 H showed a high degree of crop tolerance. Occasional slight leaf burning occured when large amounts (2.0 and 3.0 kg a.i./ha) were applied, or when application took place at the start of flowering. This was, however, quickly eliminated in the normal course of growth and had no effect on further development and yield.

Herbicidal efficacy

Table 2

Herbicidal efficacy of 3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide in soya beans

kg a.i./ha	unifoliate leaf stage	1 trifoliate leaf stage	2-4 trifoliate leaf stage	full foliage	start of flowering
0.5	*99(3)	92(4)	85(6)	50(1)	60(2)
0.75	97(9)	94(19)	93(8)	84(6)	74(5)
1.0	95(12)	96(15)	94(14)	84(12)	79(14)
1.5	99(3)	99(5)	90(2)	92(2)	-
2.0	97(13)	98(14)	94(12)	85(10)	79(7)
3.0	-	98(3)	92(4)	99(2)	-

* = % herbicidal efficacy
()= number of trials

The efficacy against broad-leaved weeds varies between good and excellent, depending on the time and rate of application. 0.5 kg a.i./ha gives excellent results when applied at the unifoliate or first trifoliate leaf stage. If crop and weeds are allowed to develop further, a higher application rate (1.0 kg or more) is required.

Herbicidal spectrum

Table 3

Herbicidal spectrum of 1 kg a.i./ha 3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide in soya beans

Weed species	stage reached by soya beans unifoliate leaf stage	1 trifoliate leaf stage	2-4 trifoliate leaf stage	full foliage
Abutilon theophrasti	*99(4)	99(6)	92(4)	82(4)
Amaranthus retroflexus	94(6)	93(7)	93(6)	89(5)
Ambrosia artemisiifolia	97(3)	100(3)	97(4)	98(4)
Brassica kaber	97(2)	100(2)	100(1)	100(2)
Chenopodium album	99(4)	99(3)	92(3)	80(4)
Helianthus annuus	100(1)	100(1)	97(1)	-
Ipomoea spp.	80(3)	91(3)	95(5)	-
Polygonum pensylvanicum	97(2)	98(3)	99(3)	98(2)
Raphanus raphanistrum	-	96(7)		-
Sida spinosa	100(4)	97(4)	100(3)	99(3)
Sinapis arvensis	-	94(10)		-
Xanthium pensylvanicum	99(7)	98(7)	97(9)	91(6)

* = % herbicidal efficacy
() = number of trials

Table 3 lists the most important weeds in the soya bean growing areas of America and Europe which are generally not controlled by the normal pre-emergence herbicides.

Excellent results against Abutilon theophrasti, Amaranthus retroflexus, Ambrosia artemisiifolia, Brassica kaber, Chenopodium album, Helianthus annuus, Ipomoea spp., Polygonum pensylvanicum, Raphanus raphanistrum, Sida spinosa, Sinapis arvensis, and Xanthium pensylvanicum were obtained with as little as 0.5 and 0.75 kg a.i./ha, applied at the 1-4 trifoliate leaf stage.

DISCUSSION

Herbicides are usually applied pre-emergence to soya beans in intensive growth areas. These herbicides generally prove effective against annual grasses. Control of many broad-leaved weeds is mostly poor.

The trial results show that the post-emergence herbicides BAS 3510 H and BAS 3517 H are highly effective against these weeds and also extremely selective. BAS 3510 H and BAS 3517 H may therefore be regarded as a valuable addition to the measures used until now in soya beans. The available results show that the optimal application rate lies in the region of 1 kg a.i./ha. Application should take place between the formation of the first and the third trifoliate leaves of the crop when the weeds are at a very sensitive stage and success is guaranteed. Early destruction of the weeds ensures trouble-free development of the crop and a good yield (von Amsberg 1972, Danial and Würzer 1971).

As BAS 3510 H and BAS 3517 H may be applied at any stage of development, application may be postponed during periods of heavy rain, drought or low temperature. Even if Xanthium pensylvanicum overruns the crop, it can be controlled later.

BAS 3510 H and BAS 3517 H are foliar herbicides with contact efficacy. No rain should fall for 8 hours after treatment, or the efficacy will be impaired.

References

AMSBERG von, H. (1972): Effects of 3-Isopropyl-benzo-2-thia-1,3-diazinon-(4)-2,2-dioxyd on Soybeans and Broadleaved Weeds at Various Stages of Growth. Weed Science Society of America.

BEHRENDT, S. and SIPOS, L. (1969): Ein Thiadiazinderivat gegen breitblättrige Unkräuter in Wintergetreide. 3. Symposium über neue Herbizide, Paris.

BEHRENDT, S. and SIPOS, L. (1970): Neue Ergebnisse mit einem Thiadiazinderivat zur Bekämpfung von breitblättrigen Unkräutern in Getreide. 8. Deutsche Arbeitsbesprechung über Fragen der Unkrautbiologie.

DANIEL, J.W. and WURZER, B. (1971): A new postemergence-applied cocklebur herbicide for soybeans. SWSSA (Southern Weed Science Society of America).

FISCHER, A. (1968): New Contact Herbicides particularly for the Control of Mayweeds. Proc. 9th Br. Weed Control Conf. (1968).

LUIB, M., BEHRENDT, S. and WITTMANN, H. (1971): Résultats des essais sur riz avec la matière active herbicide Bentazon. Troisièmes Journées de Phytopharmacie Circum-Méditerranéennes, Sardaigne.

MENCK, B.-H. and BEHRENDT, S. (1972): Trials in cereals with Bentazon (3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide) in combination with hormones (BAS 3580 H and BAS 3960 H). Proc. 11th Br. Weed Control Conf. (1972).

Proc. 11th Br. Weed Control Conf. (1972)

RESULTS OF FIELD TRIALS IN THE U.K. USING BENTAZON (BAS 351H) FOR WEED CONTROL IN PEAS

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Summary Different rates of a bentazon + MCPB mixture were tested as a post-emergence herbicide treatment on a range of pea cultivars over a period of two years. Bentazon + MCPB 1.5 + 1.5 kg a.i./ha generally gave a better overall weed control and crop tolerance when compared with dinoseb. Rates of up to 3.0 + 3.0 of the mixture had no adverse effect on yield. Crop maturity was not significantly affected by any treatment except the high rate of bentazon + MCPB in one trial. In this case maturity was advanced. Taint tests carried out to date on quick frozen and canning peas have proved negative.

INTRODUCTION

Bentazon (BAS 351H) is a thiadiazinone derivative with low mammalian toxicity. The approximate LD 50 of the technical material for rats is 1100/mg/kg. Bentazon is primarily a contact herbicide with some residual action. It has a broad spectrum of weed control, with the exception of gramineae in which only the Cyperaceae are reported to be controlled. It is selective in a range of gramineae and leguminous crops, including cereals, maize, rice and soya beans. Fisher (1968), Fisher (1969) and Behrendt and Sipos (1969).

In the U.K. work at the Weed Research Organisation (Holly 1970) and the National Vegetable Research Station (Roberts & Bond 1971) in 1970 and 1971, and at the Pea Growing Research Organisation (King 1971) in 1971-72 has shown promising results with bentazon post-emergence on Dwarf and Runner Beans. Work on these crops will continue in 1973.

Trials on the Pea cultivar Puget at the Pea Growing Research Organisation in 1971 showed tolerance to 5.6 kg/ha bentazon applied post-emergence (King 1971). However, from earlier work on cereals (Jung & May 1970), it was known that certain weeds, especially Polygonum aviculare, are resistant to bentazon alone. Therefore in order to broaden the weed spectrum, it was decided to test a tank mix of bentazon + MCPB in five trials in 1971. Following encouraging results from these preliminary tests, ten trials were carried out in 1972, comparing different rates of a tank mix of equal proportions of bentazon + MCPB. A formulated mixture of bentazon + MCPB (BAS 351H/MCPB) was also included in four of the trials. In 1971 and 1972 dinoseb was used as the standard post-emergence comparison treatment. Results from the 1971 trials are not included because of an error in application rate which resulted in poor weed control.

METHODS AND MATERIALS

All trials were of a randomised block design with four replicates of each treatment and each plot measure 2 x 6.25 metres.

Treatments were applied with a van der Weij knapsack sprayer fitted with cone nozzles. Spray pressure was maintained at 2.5 kg/cm^2 and spray volume at 250 l./ha of water except for dinoseb and prometryne which were sprayed in 450 l./ha.

Weed control and crop tolerance were assessed according to the E.W.R.C. method and all treatments were assessed 2-5 weeks after application.

In 1971, crop yields were assessed by weighing the pods from five metre strips of the middle two rows of each plot. In the 1972 series, crop yield on Trial Nos 9, 10, 12, 13, 14 and 15 was assessed using a pea viner. Trial Nos 6 and 8 were harvested by taking an equal number of plants from each plot and recording the weight of pods produced. Trial Nos 7 and 11 were harvested with a Hege 425 combine after each plot had been cut and dried in the field.

In 1972, trials were assessed for maturity by a tenderometer, (three readings were taken for each plot) except in Trial No 8 in which an equal number of pods were taken at random from each plot and the weight of shelled peas was recorded. In 1971, all trials were assessed for maturity by the latter method. In addition, samples from the bentazon and bentazon + MCPB treatments were submitted for processing and taint testing.

Formulations

a) BAS 3510H is a wettable powder containing 50% w/w bentazon.
b) MCPB was formulated as an aqueous solution containing 40% w/v of the sodium salt.
c) Bentazon formulated mixture (BAS 351/MCPB) is an aqueous solution of sodium salts containing 199 g/l. bentazon and 199 g/l. MCPB.
d) Dinoseb was formulated as an emulsifiable concentrate containing 18.5 % w/v of the amine salt of dinoseb.
e) Prometryne was formulated as a wettable powder containing 50% a.i.

Table 1

Trial site details

	Trial No	Cultivar	Soil type	Application date•	Crop Stage at application	Weather conditions during week before application	
1971	1	Progress	Loamy coarse sand	18.5.71	3-4 prs.lvs	Dry, sunny	15-17°C
	2	Early Onward	Calcareous loam	18.5.71	3-4 " "	Dry, sunny	15-17°C
	3	Progress No.6	Clay loam	24.5.71	3-6 " "	Mainly dry	15-18°C
	4	Dark Skinned Perfection	V.F. sandy loam	2.6.71	5 " "	Showers	18-20°C
	5	Sprite	Silty clay loam	2.6.71	Early flowering	Showers	18-20°C

•The prometryne treatment included in the 1971 trials only, was applied pre-emergence approximately 5-6 weeks before the post-emergence treatments. On trials 4 and 5, soil moisture was at a low level during this period.

Table 2

Trial site details

	Trial No	Cultivar	Soil type	Application date	Crop stage at application	Weather conditions during week before application
1972	6	Sprite	Organic clay loam	11.5.72	5 prs.lvs	Showers 10-13°C
	7	Harrisons Glory	Peaty loam	11.5.72	5-6 " "	Showers 10-13°C
	8	Scout	Peaty sandy loam	2.6.72	8-10 " "	Showers 7-14°C
	9	Dark Skinned Perfection	Peaty loam	1.6.72	9 " "	Showers 7-14°C
	10	Dark Skinned Perfection	Peaty loam	12.6.72	7 " "	Showers 8-18°C
	11	Verdette	Clay loam	2.5.72	4-5 " "	Showers 6-10°C
	12	Hurst Green Shaft	Loam	16.5.72	4 " "	Showers 8-10°C
	13	Early Onward	Loamy coarse sand	17.5.72	5 " "	Showers 8-10°C
	14	Progress No.9	Loam	23.5.72	5-6 " "	Showers 8-15°C
	15	Early Onward	Loam	9.6.72	5-6 " "	Showers 9-15°C

Table 3

Assessment of the control (EWRC method)• of individual weed species - 1972 trials

Weed species and no. of sites occurring	Growth stage range at application	Treatments (kg a.i./ha)				
		bentazon+MCPB			bentazon/MCPB form. mixture	dinoseb
		1.0+1.0	1.5+1.5	3.0+3.0	1.5/1.5	2.0
Stellaria media	(9)••Cot - 30 cm	2.1	1.8	1.8	2.3 (4)	2.6
Polygonum lapathifolium	(1) 2 - 3 lvs	2.0	2.0	2.0	-	2.0
Polygonum persicaria	(1) 3 - 6 lvs	2.0	1.0	1.3	1.0 (1)	1.3
Polygonum aviculare	(4) 2 -10 lvs	5.0	3.5	2.3	3.3 (1)	3.2
Polygonum convolvulus	(3) Cot - 3 lvs	1.8	1.7	1.0	1.0 (1)	1.7
Urtica urens	(2) 4 -10 cm	2.4	1.5	1.2	1.5 (2)	4.2
Galeopsis tetrahit	(2) 4 - 8 lvs	4.8	3.3	2.8	1.0 (1)	1.8
Chenopodium album	(2) Cot - 8 lvs	1.2	1.0	1.2	1.0 (1)	1.2
Matricaria spp.	(2) 5 -10 cm	1.5	1.5	1.5	-	3.9
Veronica spp.	(4) 2 - 8 lvs	5.6	3.7	2.5	3.5 (1)	1.4
Spergula arvensis	(1) 4 cm	1.0	1.0	1.0	-	2.3
Senecio vulgaris	(1) 2 - 8 lvs	1.3	1.3	1.0	-	1.0
Viola tricolor	(1) 2 - 4 lvs	1.5	1.3	1.0	-	1.8

•Figures represent the mean scores on all trials where the weed occurred.
••Figures in brackets are number of sites where the weed occurred.
Note. Formulated mixture present in four trials only.

Table 4

Overall weed control assessments (EWRC method)

Trial no	Dominating weed species	Treatments (kg a.i./ha) 1971				
		bentazon	bentazon	bentazon+MCPB		prometryne
		2.0	4.0	1.0+0.8	2.0+1.6	0.75•
1	i.k.a.o.	2.3	2.8	2.8	2.0	2.0
2	h.l.m.d.e.	3.8	4.0	3.0	2.0	3.0
3	p.h.i.a.	4.0	2.0	3.0	2.0	7.0
4	h.e.a.j.d.	7.0	3.5	3.5	1.3	7.0
5••	-	-	-	-	-	-
		Treatments (kg a.i./ha) 1972				
		bentazon+MCPB			bentazon/MCPB form.mixture	dinoseb
		1.0+1.0	1.5+1.5	3.0+3.0	1.5/1.5	2.0
6	b.a.	2.0	2.0	2.0	-	2.0
7	a.g.e.i.	2.8	3.0	2.0	-	6.3
8	a.	3.0	3.0	3.3	3.8	7.0
9	c.h.f. a.g.e.	2.0	1.3	1.3	1.0	1.3
10	a.f.	3.0	2.5	1.0	2.0	6.0
11••	-	-	-	-	-	-
12	d.j.e.a.	3.3	1.8	1.0	-	2.0
13	k.j.m.d.	4.0	2.3	1.8	-	2.3
14	d.j.a.	6.0	4.5	3.0	-	3.8
15	d.j.a.	5.3	4.5	3.5	3.3	3.0

a) *Stellaria media*
b) *Polygonum lapathifolium*
c) *Polygonum persicaria*
d) *Polygonum aviculare*
e) *Polygonum convolvulus*
f) *Urtica urens*
g) *Galeopsis tetrahit*
h) *Chenopodium album*
i) *Matricaria* spp.
j) *Veronica* spp.
k) *Spergula arvensis*
l) *Fumaria officinalis*
m) *Galium aparine*
o) *Senecio vulgaris*
p) *Atriplex patula*

•Prometryne rate in Trial No 4 was 0.625 kg a.i./ha
••No weeds germinated on trial area

Table 5

Crop tolerance assessments•(1972)

Trial no	Treatments (kg a.i./ha)				
	bentazon+MCPB			bentazon/MCPB form. mixture	dinoseb
	1.0+1.0	1.5+1.5	3.0+3.0	1.5/1.5	2.0
6	1.0	1.0	1.0	1.0	1.0
7	1.0	1.0	1.0	1.0	1.0
8	1.0	1.5	2.0	2.0	3.0
9	1.0	1.0	3.0	2.0	3.0
10	1.0	1.0	1.0	1.0	1.0
11	1.3	2.8	4.5	-	3.0
12	1.0	2.0	3.8	-	5.0
13	1.0	1.8	2.8	-	4.5
14	1.0	1.0	1.0	-	2.3
15	1.0	1.0	1.8	1.3	3.3

•Assessed for leaf scorch on a 1-9 logarithmic basis.

Table 6

Yield of peas expressed as a percentage of the untreated

Trial no	Cultivar	Treatments (kg a.i./ha) 1971 trials				
		bentazon	bentazon	bentazon+MCPB		prometryne
		2.0	4.0	1.0+0.8	2.0+1.6	0.75
1	Progress	112	121	114	125	132
2	Early Onward	121	107	111	92	118
4	Dark Skinned Perfection	182•	180•	179•	187•	152•
5	Sprite	106	130•	111	104	93•
		Treatments (kg a.i./ha) 1972 trials				
		bentazon+MCPB			bentazon/MCPB form. mixture	dinoseb
		1.0+1.0	1.5+1.5	3.0+3.0	1.5/1.5	2.0
6	Sprite	108	117	112	-	114
7	Harrisons Glory	95	91	101	-	100
8	Scout	102	100	114	106	108
9	Dark Skinned Perfection	99	96	100	96	106
10	Dark Skinned Perfection	107	101	108	102	112
11	Verdette	100	99	95	-	103
12	Hurst Green Shaft	108	97	97	-	107
13	Early Onward	94	107	101	-	78
14	Progress No.9	114	130	132	-	151
15	Early Onward	111	108	102	114	104

•Significantly different from untreated
L.S.D. P = 0.05 Trial 4 (52); Trial 5 (16)

Table 7

Maturity assessments (1972 trials)
based on the mean of 12 tenderometer readings

Trial no	Cultivar	untreated	Treatments (kg a.i./ha)				
			bentazon+MCPB			bentazon/MCPB form.mixture	dinoseb
			1.0+1.0	1.5+1.5	3.0+3.0	1.5/1.5	2.0
6	Sprite	97	102	97	96	-	98
8	Scout*	100	126	104	124	116	90
10	Dark Skinned Perfection	130	133	130	132	131	136
12	Hurst Green Shaft	129	128	126	121	-	129
13	Early Onward	108	110	112	116**	-	104
15	Early Onward	93	98	96	98	97	91

*Assessed by weight of shelled peas
**Significantly different from untreated L.S.D. P = 0.05 (4.7)
(No other significant differences between treatments occurred).

DISCUSSION

1971 trials

In all five trials the two rates of bentazon + MCPB(1.0+1.8 and 2.0+1.6 kg a.i./ha) generally gave the most effective weed control. (Table 4). Bentazon alone, particularly at 2.0 kg a.i./ha showed a narrower spectrum of weed control, being ineffective against *Polygonum aviculare* and *Veronica* spp. Prometryne gave good weed control only when there was adequate soil moisture after application.

Neither bentazon nor bentazon + MCPB gave any significant reduction in yield, and in trials 4 and 5 significant increases occurred, owing to weed competition in the untreated plots, (Table 6). No phytotoxic symptoms or delay in maturity were observed with any treatment. In 1971, no taints in quick frozen or canning peas were detected from rates of bentazon up to 4 kg a.i./ha and bentazon + MCPB up to 2.0 and 1.6 kg a.i./ha respectively.

1972 trials

The mean weed control assessments for all trials (Tables 3 & 4) show that the 1.5 + 1.5 kg/ha rate of bentazon + MCPB generally gave good control of all weeds occurring in the trials, even those which were in an advanced growth stage when sprayed. The exceptions were in Trial No 14 where *Polygonum aviculare* had reached 15-20 cms before application, and Trial No 15 where heavy rain occurred within one hour of spraying. The bentazon/MCPB formulated mixture, based on the sodium salt, gave similar weed control to the equivalent rate of the tank mix of bentazon + MCPB. The high rate of bentazon + MCPB (3.0 + 3.0 kg/ha) only gave a marginal increase in weed control in the majority of trials. At the 1.0 + 1.0 kg/ha rate of bentazon + MCPB, *Veronica* spp, *Galeopsis tetrahit* and *Polygonum aviculare* were not adequately controlled, especially those weeds in an advanced growth stage. Dinoseb controlled most weeds except in Trial Nos 7 & 8 where large *Stellaria media* dominated and Trial No 10 where *Urtica urens* was the dominant weed. In general bentazon + MCPB 1.5 + 1.5 kg/ha gave better overall weed control than dinoseb. (Table 4).

Weather conditions in spring 1972 were generally cold, windy and wet and not conducive to the development of a protective wax layer on the pea leaves. On some trials a slight scorch was observed on the older leaves following the use of the bentazon + MCPB tank mix 1.5 + 1.5 kg/ha and 3.0 + 3.0 kg/ha. However, the tank mix of bentazon + MCPB at 3.0 + 3.0 kg/ha always gave less damage than dinoseb except in Trial No 11 (variety Verdette), where there appeared to be a varietal reaction to the mixture resulting in severe scorch and chlorosis with the high rate. A transient twisting of the growing tip of the peas occurred on all trials with all rates of bentazon + MCPB. However, none of the treatments in any of the trials showed any significant yield differences.

On all trials where maturity assessments were made (Table 7) there were no significant differences between treatments except in Trial No 13 with the high rate of bentazon + MCPB. This showed as an advancement of maturity which is contrary to the reputed effect of MCPB on peas. Taint test results from the 1972 trials are not yet available.

From the encouraging results of these trials it is proposed that further large scale grower trials be carried out in 1973, applying the 1.5 + 1.5 kg/ha rate of the tank mix of bentazon + MCPB.

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References

BEHRENDT S. and SIPOS L. (1969) A thiadiazine derivative against broadleaved weeds in winter cereals. E.W.R.C. 3° Symposium on New Herbicides 1969 1 117 - 123.

FISHER A. (1968) New contact herbicides for the control of mayweeds. Proceeding of the British Weed Control Conference 2 1042 - 1045.

FISHER A. (1969) New herbicides for the control of broadleaved and grassy weeds. E.W.R.C. 3° Symposium on new herbicides 1969 1 67 - 75.

HOLLY K. (1970) Personal communication. Unpublished work carried out at Weed Research Organisation.

JUNG K.U. and MAY H.C. (1970) Field trials in the U.K. with 3 - isopropyl - 2, 1, 3 - benzo thiadiazinan (4) - 2, 2 - dioxide. (BAS 351H) for the control of broadleaved weeds in cereals.
Proceedings of the British Weed Control Conference 1 44 - 49.

KING, J.M. (1971) Pea Growing Research Organisation. Annual Report 1970-1971.

ROBERTS. H.A. and BOND W. (1971) National Vegetable Research Station. Private communication.

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THE EVALUATION OF NEW RESIDUAL HERBICIDES TO CONTROL MONO-COTYLEDONOUS AND DICOTYLEDONOUS WEEDS IN PROCESSING PEAS

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Summary The results of two trials carried out by Siegfried in 1972 are reported, in which 5 residual compounds have been tested and compared with dinoseb and dinoseb + MCPB.

Pre-emergence applications of herbicides were made and gave promising results. The weed control of the residual herbicides were considerable higher than those of dinoseb and dinoseb + MCPB. The compounds naproamid (1.5 kg/ha a.i.) and S 1445* (6 kg/ha a.i.) proved to be very interesting materials. Naproamid and S 1445 gave exellent control of Galium aparine. Prynachlor and EPTC caused crop damage, the other compounds caused no phytotoxicity. Compared with dinoseb the yields could be considerably increased with the residual herbicides.

INTRODUCTION

Satisfactory results of weed control in peas were obtained till now in Switzerland by the post-emergence application of contact and hormone-type herbicides (dinoseb, MCPB and dinoseb + MCPB). However special climatic conditions at the period of application can cause crop damage. Some varieties of peas may also be susceptible to contact compounds. With contact herbicides grass weeds can not be controlled. Some dicotyledonous weeds (Galium aparine) may cause severe difficulties if they can not be controlled at the right stage. Yield reduction and troubles at harvest can also be caused by the application technique of post-emergence herbicides (wheelings from tractors). The recent development of new residual herbicides may open new ways of weed control in peas. The main advantage of such compounds is the posibility to control mono- and dicotyledonous weeds prior to emergence. Compounds which can be applied before or immediatly after sowing also eliminate the disadvantage of mechanical damage.

METHODS AND MATERIALS

The treatments were made with a propane powered precision field plot sprayer equipped with a 2 m spray boom and with four 140° Birchmeier fan jet nozzles. At each site the plots were replicated 4 times and were 10 m^2 (2 x 5 m). The water volume used on each plot was 1000 l/ha.

* S 1445 represents a combination of a Aryl-1,2,4-oxadiazolidin-Compound and a Alkylester of the Terephthalic acid.

Site	Variety	Date of spraying	Date of sowing	Soil type
Wilchingen SH	No. 600	pre-em. 27.4.72 post-em. 15.5.72	27.4.72	medium sandy loam
Seuzach ZH	No. 461	pre-em. 14.4.72 post-em. 17.5.72	16.4.72	

EPTC was used 8 days before sowing

6 weeks after the post-emergence treatment weed counts were made, the weed species specificated and the number of weeds/m^2 recorded. At the same time the phytotoxicity of each compound was also recorded. Yield assessments were obtained from the site at Wilchingen. Before harvesting, the percentage weed control was again recorded (Figure 1).

Materials used:

Compound	Formulation	Treatment	Remarks
EPTC	72 % e.c.	pre-em.	incorporated be-
naproamid	50 % w.p.	pre-em.	fore sowing
prynachlor	500 g/l e.c.	pre-em.	immediately af-
methabenzthiazuron	70 % w.p.	pre-em.	ter sowing
S 1445	trial compound	pre-em.	
dinoseb	40 % w.p.	post-em.	4-6 leaf stage
dinoseb + MCPB	12 % + 28 % w/v	post-em.	of weeds

RESULTS

Figure 1

Percent weed control (mean of two sites) before harvest

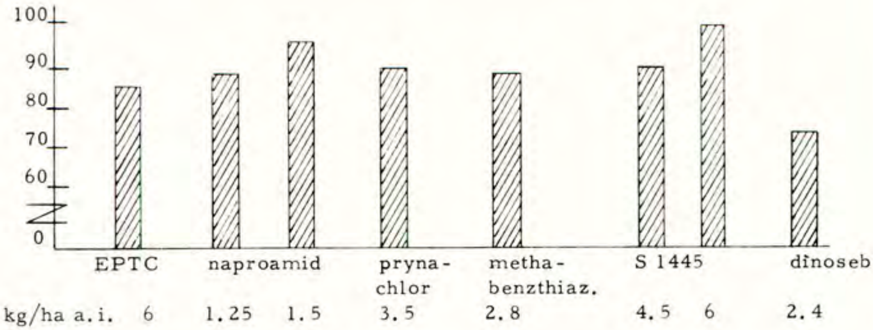

Table 1

Percent weed control at two sites Wilchingen (W) and Seuzach (S) 6 weeks after post-em. treatment

Compound	Treatment	Dose kg/ha a.i.	Sites	Predominant weed species: C. bursa pastoris	C. album	G. aparine	L. purpureum	M. chamomilla	P. persicaria	S. media	Veronica spp.	Gramineae spp.	Total weed population/m^2	∅ percent weed control	Phytotoxicity
EPTC	pre-em.	5.6	W	50	90	-	100	86	57	83	-	73	32	85	6
	incorp.		S	90	86	71	100	-	71	50	44	83	17	78	4
Naproamid	pre-em.	1.25	W	60	80	-	49	95	100	100	-	100	35	84	1
	incorp.		S	50	100	86	100	-	71	100	89	83	11	86	1
Naproamid	pre-em.	1.5	W	90	100	-	64	97	100	100	-	100	19	91	1
	incorp.		S	80	100	100	100	-	86	100	100	100	3	96	1
Prynachlor	pre-em.	3.5	W	100	80	-	92	96	14	100	-	87	18	92	3
			S	100	100	14	84	-	71	100	100	100	11	86	4
Methabenz-tiazuron	pre-em.	2.8	W	90	100	-	56	95	71	100	-	100	26	88	1
			S	90	86	57	74	-	86	100	78	100	13	84	1
S 1445	pre-em.	4.5	W	100	100	-	97	98	86	100	-	80	7	97	1
			S	100	100	29	89	-	57	100	100	83	12	85	1
S 1445	pre-em.	6	W	100	100	-	100	98	57	100	-	87	7	97	1
			S	100	100	86	100	-	100	100	100	100	1	99	1
Dinoseb	post-em.	2.4	W	50	100	-	97	89	43	100	-	0	43	80	1
			S	70	100	69	58	-	14	100	100	0	43	46	1
Untreated			W	0	0	0	0	0	0	0	0	0	219	0	1
			S	0	0	0	0	0	0	0	0	0	79	0	1

The figures are based on four counts, they are expressed as % weed control (Abbott) of the weed population on the untreated plots.

Table 2

Percent weed control, mean of the sites Wilchingen and Seuzach, 6 weeks after post-em. treatment

Compound	Treatment	Dose kg/ha a.i.	Predominant weed species: C. bursa pastoris	C. album	G. aparine	L. purpureum	M. chamomilla	P. persicaria	S. media	Veronica spp.	Gramineae spp.	Total weed population/m²	Ø Percent weed control	Phytotoxicity
EPTC	pre-em. incorp.	5.6	70	86	71	100	86	64	69	44	75	25	83	5
Naproamid	pre-em. incorp.	1.25	55	86	86	50	95	86	100	89	92	23	85	1
Naproamid	pre-em. incorp.	1.5	85	100	100	63	97	93	100	100	100	11	93	1
Prynachlor	pre-em.	3.5	100	86	14	84	96	43	100	100	92	15	90	3
Methabenz-tiazuron	pre-em.	2.8	90	93	57	42	95	59	100	78	100	20	87	1
S 1445	pre-em.	4.5	100	100	29	92	98	71	100	100	79	10	93	1
S 1445	pre-em.	6	100	100	86	100	98	79	100	100	92	4	97	1
Dinoseb	post-em.	2.4	60	100	29	76	89	29	100	100	0	43	71	1
Untreated	-											149	0	1

The figures are based on four counts, they are expressed as % weed control (Abbott) of the weed population on the untreated plots.

Table 1 shows the weed cont rol given by each compound at Wilchingen and Seuzach.

a) Wilchingen: At the time of treatment, the conditions for the application of residual herbicides were ideal. The field in which the trial was carried out was badly infested with the following weed species:

Chenopodium album
Lamium purpureum
Matricaria chamomilla
Polygonum persicaria
Stellaria media

The compound naproamid (1.5 kg/ha a.i.), S 1445 (4.5 and 6 kg/ha a.i.) and prynachlor (3.5 l/ha a.i.) gave exellent weed control. The weed control of S 1445 was 16.8 % above dinoseb. Naproamid (1.25 kg/ha a.i.) gave poor control against Capsella bursa pastoris and Lamium purpureum. At 3 kg/ha a.i. naproamid Lamium purpureum proved to be still resistant. Methabenzthiazuron gave poor results against Lamium purpureum and Polygonum persicaria. Polygonum persicaria was also resistant to prynachlor. EPTC and dinoseb controled Lamium purpureum very well, but Capsella bursa pastoris and Polygonum persicaria were only sligthly damaged by these two herbicides.

b) Seuzach: This trial gave the opportunity to investigate the effectivness of the compounds against Galium aparine. Other predominant weeds were:

Veronica herderaifolia
Chenopodium album
Lamium purpureum

The average weed control of the residual herbicides was much better than the contact herbicides. The best weed control was again obtained with S 1445 (6 kg/ha a.i.) and naproamid (1.5 kg/ha a.i.).

S 1445 (4.5 kg/ha a.i.) and prynachlor proved to be ineffective against Galium aparine and Polygonum persicaria. The control of Galium aparine, Lamium purpureum and Veronica hederaifolia with methabenzthiazuron was unsatisfactory. Dinoseb was inferior against Polygonum persicaria and Galium aparine.

Table 3

Harvesting control in Wilchingen (mean of 4 replications)

Compound	Dose kg/ha a.i.	Yield kg/10 m^2	Percent yield difference from untreated	Percent yield difference from dinoseb
EPTC	5.6	2.685	- 31.9	- 40.9
naproamid	1.5	5.095	+ 29.0	+ 12.2
prynachlor	3.5	4.250	+ 7.9	+ 6.4
methabenztiazuron	2.8	5.020	+ 27.4	+ 10.6
S 1445	6	5.060	+ 28.0	+ 11.5
dinoseb	2.4	4.540	+ 15.0	0
untreated	-	3.940	0	

DISCUSSION

As mentioned before, the conditions for the application of residual herbicides were ideal. All residual herbicides showed a considerably higher weed control than the contact herbicides. The most sucsessful herbicides were naproamid (1.5 kg/ha a.i.) and S 1445 (6 kg/ha a.i.). Though S 1445 (4.5 kg/ha a.i.) showed a good weed control, the resistance of Galium aparine is a disatvantage. With the exeption of naproamid all residual herbicides had some difficulty in controlling Polygonum persicaria sucsessfully. This weed proved to be very resistant to the contact herbicides. Galium aparine was very well controlled by naproamid and S 1445 (6 kg/ha a.i.) while it was more or less resistant to the other herbicides and lower concentrations of S 1445.

In both trials EPTC and prynachlor caused phytotoxicity to the crops while prynachlor caused only slight stunting of the peas at the early development stage. EPTC reduced the germination of the peas, the damage being very severe.

With the exeption of EPTC, a clear yield increase of the residual herbicides was observed compared with dinoseb. Prynachlor showed the lowest yield increase. This was probably due to the slight stunting of the crop at the early development stage.

Compared with the untreated plots, the herbicides caused no delay in crop maturity.

The ability of the residual herbicides to control mono- and dicotyledonous weeds before emergence gives these compounds good prospects for the future. The investigation of these new residual herbicides in peas will be continued next year.

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EXPERIMENTS TO INVESTIGATE THE USE OF CYANAZINE* AS A HERBICIDE ON LIGHT SOILS AT SUCCESSIVE GROWTH STAGES OF PEAS UNDER VARYING RAINFALL CONDITIONS

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Summary The performance of cyanazine, 2-(4-chloro-6-ethylamino-s-triazin-2-ylamino)-2-methyl-propionitrile, on light soils under varying rainfall conditions is reported from six trials in 1971-72.

Pre-emergence and post-emergence treatments covered 5 stages of crop growth.

Applying cyanazine at 0.87 kg/ha pre-emergence followed by 0.52 kg/ha post-emergence gave better weed control that the standards used under dry conditions in 1971 with adequate crop safety. At the high rates of cyanazine in 1972 rainfall exerted greater influence on selectivity and to a lesser extent on weed control than did soil type.

On fen and skirt fen soils best weed control was achieved when crops were sprayed when 20 cm high.

INTRODUCTION

The pre and post emergence use of 2(4-chloro-6-ethylamino-5-triazin-2-ylamino)-2-methyl-propionitrile, has been fully described by Sandford et al (1970) following tests in the U.K. as DW 3418 and WL 19805 and in USA as SD 15418.

Lack of weed control with residual herbicides is generally associated with soil moisture status at or immediately following application. Experiments in 1971 and 1972 examined the effects of applying various rates of cyanazine pre-emergence supplemented by reduced dosages post-emergence in order to overcome the effects of abnormally wet conditions early in the season on selectivity on 'light' soils and reduction in weed control under drought conditions.

The effects of applying cyanazine at various stages of growth of the pea crops from 10% emergence to 20 cm high were also investigated.

METHOD AND MATERIALS

Details of site location, varieties, drilling dates, spraying dates and rainfall data for the fortnight following spraying are presented in Table 1 and soil analyses in Table 2.

(* Provisional common name)

Table 1

Site details

Year	Location	Variety	Drilled	Sprayed Pre-em	Sprayed Post-em	Rain after spraying (mm) Pre-em	Rain after spraying (mm) Post-em
1971	A.Sloley,Nfk	D.S.P.	March 20	April 6	May 17	4.2	7.5
	B.Southrepps,Nfk	Sprite	March 10	March 28	March 16	0.3	28.0
	C.King's Lynn,Nfk	Greengolt	April 5	April 27	June 2	7.4	-
	D.Thorney,Cambs	D.S.P.	April 27	-	May 12		7.3
				-	May 20		36.0
				-	June 4		Tr.
1972	E.Wrentham,Sfk	Swan	March 24	April 6	May 2	18.7	26.5
	F.Shottesham,Nfk	Jade	March 16	March 30	May 7	20.0	25.7
	G.Wells,Nfk	Sprite	March 3	March 14	May 2	5.6	21.9
	H.Bungay,Sfk	Tezieridée	March 10	March 16	April 27	13.5	24.0
	I.Stonea,Cambs	Sprite	Feb. 25	-	May 8		15.6
	J.Whittlesea,Cambs	Sprite	Feb. 25	-	May 8		15.6

Table 2

Mechanical analyses of soils from 10 sites

	Site	Clay (%)	Silt (%)	Sand (%)	o.m. (%)	pH
1971	A	8	50	42	2	7.1
	B	11	51	38	1	7.4
	C	21	36	43	2	8.3
	D	10	35	58	14	7.1
	E	4	9	87	1	7.3
1972	F	10	17	73	2	7.0
	G	10	9	81	2	8.3
	H	15	13	72	1	7.8
	I	5	29	66	34	6.2
	J	18	29	53	17	7.3

Although the treatments were not idential in the two years, they are presented below in composite tables for ease of cross reference.

Table 3

Treatments in split application series on 'light' soils (Kg/ha)
(Figures in brackets indicate treatment nos for tables 5, 6 and 7)

Treatments	1971 series Pre-em.		1971 series Post-em.	1972 series Pre-em.		1972 series Post-em.
Cyanazine pre-em.	1.75		Nil (7)	1.75		Nil (7)
Cyanazine at 10% emergence	1.75		Nil (8)	NOT INCLUDED		
Cyanazine split	1.31	+	0.52 (1)	1.31	+	0.52 (1)
Cyanazine split	0.87	+	0.52 (3)	0.87	+	1.05 (4)
Cyanazine split	0.87	+	0.67 (5)	0.87		Nil (2)
Cyanazine post-em.	Nil		1.05 (6)	Nil		1.05 (6)
Prometryne	1.42		Nil (9)	1.42		Nil (9)
Dinoseb amine	NOT INCLUDED			Nil		2.08 (10)
Untreated control	Nil		Nil (11)	Nil		Nil (11)

Table 4

Treatments in post-emergence/timing experiements on fen soils (Kg/ha)
(Figures in brackets indicate treatment nos for tables 8 and 9)

Treatment	Crop height 2.5 cm	Crop height 10 cm	Crop height 20 cm 1971	Crop height 20 cm 1972
Cyanazine	1.12 (2)	1.12 (2)	-	1.05 (1)
Cyanazine	1.40 (3)	1.40 (3)	-	1.40 (3)
Cyanazine	1.68 (4)	1.68 (4)	1.68 (4)	-
Cyanazine	1.91 (5)	1.91 (5)	1.91 (5)	-
Cyanazine	-	-	2.24 (7)	2.10 (6)
Cyanazine	-	-	2.80 (8)	4.20 (9)
Dinoseb amine	2.08 (10)	2.08 (10)	2.08 (10)	2.08 (10)
Untreated control	Nil (11)	Nil (11)	Nil (11)	Nil (11)

In the 'split application' series the effect of 1.05 kg/ha applied post-emergence was examined only at site E in 1972 and at site C in 1971, all dose rates being increased by 20% due to the higher clay fraction.

In the post-emergence series at site D the untreated controls were eliminated on May 20 by treating with dinoseb amine thereby increasing the number of dinoseb replicates to 8, and the untreated control was not harvested at site I.

With the exception of the above all treatments were replicated four times in a randomised block design where plots measured 10 m^2.

Chemicals were applied in a water volume of 450 l. per ha using an Oxford Precision Sprayer operating at a pressure of 2.45 kg/cm^2 and fitted with Allman "OO" gauge brass jets. Cyanazine was formulated as a 50% suspension concentrate. Weed control was assessed as percentage ground cover 4-8 weeks after emergence and again as the crop neared maturity. Crop effects were assessed using the E.W.R.C. scale, all data being subsequently analysed statistically.

At harvest, haulm and pods were weighed before vining using minature viners and pre-cleaners after which the yield of shelled peas and tenderometer readings were recorded.

RESULTS

Split applications on 'light' soils

The results for this series on weed cover, crop effects and yield are summarised in tables 5,6 and 7 respectively.

With the exception of site C where weed control results were confounded by *Agropyron repens* (17 plants/m^2), *Avena fatua* (11 plants/m^2) and *Polygonum convolvulus* (74 plants/m^2) cyanazine at 1.75 kg/ha reduced the total weed cover to 2% compared to 14% for prometryne confirming the excellent results obtained in trials up to 1970.

Results from the loam site (C) indicate that the straight pre-emergence rates were low for the soil type but that even on this soil splitting the applications improved the degree of weed control.

Combining 1.31 kg/ha of cyanazine applied pre-emergence with 0.52 kg/ha post-emergence reduced weed cover to 2.3% with improved kill of Polygonum convolvulus.

In 1972 favourable moisture conditions gave adequate weed control with 0.87 kg/ha pre-emergence at all sites except F & G where Viola arvensis and Polygonum aviculare totalled 8% and 7% cover. All but a little Polygonum aviculare at site F was erradicated by the post-emergence treatment.

At all four sites in 1972 the pre-emergence treatments, and cyanazine applied post-emergence at 1.05 kg/ha at site E, gave better weed control than dinoseb amine which failed to control Viola arvensis, Poa annua and Senecio vulgaris.

Table 5

Total weed cover (%) on 'light' soils

Treatment (see table 3)	1971			1972			
	A	B	C	E	F	G	H
1	8	3	44	2	0	1	1
2	-	-	-	2	8	7	3
3	11	1	47	-	-	-	-
4	-	-	-	0	2	2	0
5	8	2	60	-	-	-	-
6	15	13	50	11	-	-	-
7	7	1	74	2	0	0	2
8*	9	1	59	-	-	-	-
9	20	43	62	8	4	8	0
10	-	-	-	23	23	19	13
11	65	59	85	78	35	48	33
LSD (P= 0.05)	7		22	2	2	2	
(Greatest Val. Sig.) (lower than control)	(59)		(67)	(37)	(18)	(28)	

* Applied at 10% emergence

Crop Effects

When observed these were chlorosis and necrosis but in general recovery was good by the second assessment. Rainfall appeared to exert more effect than soil composition and splitting the dose improved the crop tolerance to cyanazine compared to the straight 1.75 kg/ha pre-emergence.

Applications at 10% emergence reduced selectivity. At site E, which had the highest sand and lowest organic matter content, the effect of maintaining the level of herbicide in the soil by post-emergence treatments was accentuated by relatively high (26.5 mm) rainfall following application.

Table 6

Crop effects on 'light' soils (E.W.R.C. scale)

a = assessment 4-8 weeks after emergence.
b = assessment near maturity.

Treatment (see table 3)	1971 A a	A b	B a	B b	C a	C b	1972 E a	E b	F a	F b	G a	G b	H a	H b
1	5.0	2.0	6.0	2.5	-	3.0	4.2	4.2	3.0	2.5	2.0	2.3	3.0	2.0
2	-	-	-	-	-	-	1.6	3.5	3.5	1.8	1.8	3.3	3.3	2.0
3	3.0	1.8	2.5	2.3	-	3.0	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	4.2	4.8	5.3	3.5	1.8	3.3	2.5	1.8
5	2.0	2.3	4.0	2.3	-	2.0	-	-	-	-	-	-	-	-
6							2.5	3.3	-	-	-	-	-	-
7	5.0	2.5	5.8	2.8	-	2.3	5.3	1.8	5.5	3.3	2.5	3.3	4.0	2.0
8*	6.2	1.5	7.2	4.0	-	5.5	-	-	-	-	-	-	-	-
9	2.8	1.8	3.0	2.0	-	2.0	3.3	3.5	3.3	1.8	2.0	1.8	3.0	1.8
10	-	-	-	-	-	-	2.8	2.4	4.5	2.5	1.0	2.3	1.0	1.3
11	1.2	1.0	2.8	2.0	-	1.5	1.3	1.3	2.3	1.5	1.5	1.8	1.0	1.3
LSD (P= 0.05)							1.4	1.8	2.3	1.4	1.2	1.5	1.6	1.3
LSV higher than control (P= 0.05)							2.4	2.7	4.1	2.7	2.5	3.0	2.3	2.3

* Applied at 10% emergence

Table 7

Yields of shelled peas as % of untreated control
(Figures in brackets are tenderometer readings)

Treatment (see table 3)	1971 A	B	C	1972 E	H	G	F
1	104(100)	105(103)	115	121(110)	97(115)	134(93)	103(100)
2	-	-	-	122(113)	97(112)	134(94)	91(102)
3	106(104)	109(100)	125	-	-	-	-
4	-	-	-	105(109)	99(114)	130(97)	86(103)
5	104(103)	117(103)	101	-	-	-	-
6	100(100)	108(99)	104	130(119)			
7	93(99)	101(98)	130	116(109)	89(115)	124(93)	94(102)
8	92(98)	96(101)	104	-	-	-	-
9	102(105)	117(98)	130	120(108)	101(116)	133(95)	98(102)
10	-	-	-	132(119)	92(115)	128(95)	88(102)
11	100(101)	100(97)	100	100(128	100(113)	100(94)	100(101)
LSD (P=0.05)	22(7)	20(-)	18	23(6)	12(4)	17(2)	18(3)

Yields and maturity

Effects were marginal and rarely significant (Table 7). However, in 1971 plots treated at 10% emergence gave the lowest yield of shelled peas though this was not statistically significant. The split treatments of cyanazine in 1971 gave marginal yield increases over the 1.75 kg/ha rate. This was repeated in 1972 where the post-emergence rate was 0.52 kg/ha. At sites E & F yields were marginally lower where 1.05 kg/ha was applied as a 'follow-up', reflecting crop damage scores of 4.2 & 5.3.

There were few significant changes in maturity, the most marked resulting from the presence of 82% weed cover in the control at site E which advanced the maturity (Tenderometer value 128).

Quality

No taints were recorded by the Fruit and Vegetable Preservation Research Association in frozen and canned samples where cyanazine was applied at 1.75 kg/ha pre-emergence or when 0.87 kg/ha was followed by 0.67 kg post-emergence.

Post-emergence/time experiments on fen soils

Results from this series are presented in Tables 8 and 9.

Weed control and crop effects

Weed control was acceptable from the 1.91 kg/ha rate of cyanazine applied to crops at 2.5 cm and 10.0 cm high. The 17% cover from this rate (Table 8) represented 15 weeds/m2 compared to 35/m2 for dinoseb, comprising mainly *Polygonum convolvulus* and *Polygonum persicaria*.

The dose responses from increasing rates of cyanazine were less from T2 compared with T1 and less from T3 compared with T2. Weed control was highly effective at the last timing, this effect being confirmed by the work in 1972 when the spectrum was dominated by *Polygonum persicaria*, *Veronica hederifolia*, *Matricaria matricariodes* and *Poa annua* (site J), and *Urtica urens*, *Galeopsis tetrahit*, *Stellaria media*, *Poa annua* and *Polygonum aviculare* and *Aethusa cynapium* at site I where *Poa annua* was virtually uncontrollable varying from 40% to 60% cover, and consequently excluded from the data in Table 8.

Table 8

Mean weed cover % and crop effect from application at 3 crop growth stages (T1=2.5 cm; T2=10.0 cm; T3=20 cm high) 1971-72
(Figures in brackets represent effect on the crop)

Treatment (see table 4)	T1 Site D	T2 Site D	T3 Site D	T3 Site I*	T3 Site J
1	-	-	-	13 (4.0)	6 (4.3)
2	37 (1.0)	33 (1.0)	-	-	-
3	32 (1.0)	31 (1.2)	-	18 (3.8)	7 (3.8)
4	23 (2.5)	16 (1.5)	7 (5.2)	-	-
5	17 (3.0)	16 (1.8)	9 (5.0)	-	-
6	-	-	-	7 (4.8)	5 (5.5)
7	-	-	5 (5.5)	-	-
8	-	-	11 (7.0)	-	-
9	-	-	-	8 (6.0)	5 (6.8)
10	37 (1.8)	18 (1.3)	20 (5.5)	36 (2.8)	18 (2.5)
11				60 (1.0)	84 (1.0)
LSD (P=0.05)	2	2	2	2.2	(0.8)
Least value sig. higher than control				2.8	1.6

* Broad leaved weeds only

Table 9

Yields of shelled peas as % of dinoseb amine treatments from application at 3 crop growth stages (Figures in brackets are tenderometer readings)

Treatment (see table 4)	T1 Site D	T2 Site D	T3 Site D	T3 Site I	T3 Site J*
1	-	-	-	152 (98)	104 (93)
2	96 (105)	94 (108)	-		
3	98 (105)	103 (110)	-	116 (91)	102 (92)
4	107 (105)	103 (106)	105 (107)	-	-
5	101 (108)	95 (106)	96 (104)	-	-
6	-	-	-	139 (90)	102 (94)
7	-	-	102 (104)	-	-
8	-	-	101 (106)	-	-
9	-	-	-	134 (90)	90 (94)
10	100 (103)	100 (105)	100 (108)	100 (91)	110 (92)
U.T.C.				Discarded	100 (93)
LSD (P=0.05)(1)	23 (12)	13 (14)	15 (10)	37 (-)	14 (3.0)
(2)	20 (11)	12 (12)	13 (8)	-	-

* Expressed as % of untreated control.

(1) To compare any 2 treatments and (2) to compare any treatment with control.

Crops effects, in the form of marginal chlorosis, and thinning were minimal when cyanazine was applied to crops at 2.5 cm and 10.0 cm high. These effects increased to range from 3.9 to 6.9 when the treatments were applied at the 20 cm stage, though there appeared no related reduction in the yield of shelled peas.

Yields and maturity

There were no significant differences in either yield nor maturity from crops treated in the 2.5 cm to the 10.0 cm stages nor at Site J in 1972. At Site I plots treated with 1.05 kg/ha significant out yielded the dinoseb treated plots.

DISCUSSION

Since it is impossible to predict the degree of soil moisture that will be available for the uptake of a soil acting herbicide the technique of splitting the pre- and post-emergence treatments demonstrated:-

1. Increased margin of crop safety and subsequent yield benefits when moisture is plentiful as in Site E in 1972.

2. On most light soils 0.87 kg/ha alone gave adequate weed control even in the presence of Polygonum aviculare but in soils with more than 85% sand and very low organic matter percentage breakdown of the pre-emergence application appears to be so slow that a supplementary treatment should not exceed 0.52 kg/ha.

3. Improved weed control when Polygonum convolvulus is present and when weed control is limited by the availability of soil moisture.

Cyanazine should not be applied to emerging peas (10% stage) since crop effects reflected yield depression. This period of susceptibility is relatively short, the peas showing good resistance on skirt fen soils when 2.5 cm high.

On fen and skirt fen soils weeds tend to emerge in successive flushes and control was most effective when cyanazine was applied late i.e. when the peas were 20 cm high although rates above the current recommendation of 1.05 kg/ha were necessary to control Matricaria matricorioides, Chenopodium album and Polygonum convolvulus. On the skirt fen soils the level of control suggested that some root uptake had occurred.

Crop effects on the fen sites were not reflected in yield depression nor in changes in maturity.

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References

CHAPMAN, T., JORDAN, D., PAYNE, D.H., HUGHES, W.J., and SCHIEFERSTEIN, R.H. (1968) WL 19805 - a new triazine herbicide. Proc. 9th Br. Weed Control Conf. (1968), 2, 1018 - 1025.

SANDFORD, H., ALLEN, N.G., O'FAHERTY, D., and FOYE, S.H.C. (1970) The pre- and post-emergence use of 2-(4-chloro-6-ethylamino-S-triazine)-2-methyl-proprionitrile. Proc. 10th Br. Weed Control Conf. (1970), 2, 621 - 629.

BELL, N.M.G. (1970) Bladex - a multi crop, broad spectrum herbicide. Proc. 7th int. Congress of Plant Prot. Paris.

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CONTROL OF GRASS WEEDS IN FIELD BEANS (VICIA FABA); THE POSSIBILITIES FOR INTER-ROW TREATMENT

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Summary Field beans were drilled in 18 in. rows to allow various inter-row treatments to be applied. Inter-row cultivation, paraquat + diquat and dalapon treatments were not sufficiently selective in their control of Agropyron repens, Agrostis gigantea and Avena fatua. Some loss of yield was incurred as a result of increasing row width from 6 in. to 18 in.

INTRODUCTION

Field beans, commonly grown as a break between cereal crops, often allow the build up of grass weeds, notably Avena fatua and the rhizomatous grasses Agropyron repens and Agrostis gigantea. Beans are generally less competitive than cereals (Cussans 1968) thus allowing increases in seed or rhizome to infest subsequent cereal crops.

Possibilities for using herbicides for the selective control of grass weeds in field beans have been described in previous reports, (Holroyd and Wilson 1968, Wilson and Cussans 1970). Results have generally been unsatisfactory, and no reliable herbicide is available at present at a cost acceptable to the farmer.

The technique of growing beans in narrow rows with the use of simazine is convenient for farmers, but allows severe build up of resistant weeds. It seemed possible that, in the presence of such weeds, any loss in yield that could occur as a result of increasing row width could be more than offset by using an inter-row treatment to reduce weed competition.

Experiments are reported here in which both cultural and chemical inter-row treatments were applied. In two experiments, beans infested with grass weeds were treated, while in another experiment, the tolerance of beans to these treatments was investigated in the absence of grass weeds. In a further experiment, the response of beans to various seed rates and row spacings was investigated.

METHODS AND MATERIALS

Weedy Experiments

Two experiments were set up in mid-March at Spelsbury and Tackley in Oxfordshire. The experiment at Spelsbury was on loam overlying limestone, and Tackley on a clay loam soil. At Spelsbury there was a heavy infestation of A. repens and some A. gigantea growing on the ploughed surface. The area was re-ploughed in early March and rotary cultivated just before drilling to break up the clumps of rhizome present. Tackley was lightly infested with A. repens and some A. fatua emerged later.

Each experiment was laid out as a randomised block design with 5 treatments replicated 5 times. Plots of 60 ft x 7.5 ft were used. Before drilling, fertiliser

(45 lb P_2O_5/ac, 45 lb K_2O/ac) was applied to each experiment and cultivated in. Beans, var. Maris Bead, were drilled at a seed rate of 226 lb/ac in 18 in. rows, except for one treatment where the same seed rate was drilled in 6 in. rows. After drilling, both experiments were sprayed with simazine 0.75 lb/ac.

After the beans emerged, inter-row treatments were applied to the plots with 18 in. rows. Three herbicide treatments were applied at 30 lb/in.^{2} and 35 gal/ac using an inter-row sprayer. This was pushed by hand and had shields on skids set 16 in. apart to protect the beans from spray drift. A further treatment, inter-row cultivation, was carried out using a tractor mounted steerage hoe. Both the paraquat + diquat and the cultivation treatments were repeated on the regrowth resulting from the first treatment. Dates at which the treatments were applied are shown below:

	Spelsbury	Tackley
Dalapon 4 lb/ac	5th May	13th May
Dalapon 8 lb/ac	5th May	13th May
Paraquat 4 oz + diquat 4 oz/ac	21st April, 13th May	28th April, 12th May
Cultivation	21st April, 5th May	28th April, 12th May

At Spelsbury, the stand of beans on the 18 in. row plots was assessed on 23rd June. Three rows of beans in the centre 10 ft of each plot were counted. The height of the beans was also assessed, when 12 bean plants were selected at random from each plot and measured.

Both experiments were harvested in early September. At Spelsbury, bean plants from the centre 30 ft of each plot were pulled by hand, taking the centre three rows drilled at 18 in. and the centre nine rows drilled at 6 in. The beans were subsequently threshed, dried, and yields at 85% dry matter calculated. At Tackley the 60 ft plots were combine harvested, taking the same number of rows as at Spelsbury. Before combining the discard rows were removed by hand. The threshed beans were subsequently dried and the yields at 85% dry matter calculated.

Weed free Experiments

Two experiments were set up on a sandy loam soil at Begbroke, one to examine the tolerance of beans to inter-row treatments, and the other to examine the response of beans to varying seed rates and row widths.

Tolerance Experiment

Fertiliser (67 lb P_2O_5/ac, 67 lb K_2O/ac) was applied to the ploughed surface and cultivated in before setting up the experiment on 11th March. A randomised block design was used, with six treatments replicated six times, and a plot size of 60 ft x 7.5 ft. Beans, var. Maris Bead, were drilled at a seed rate of 250 lb/ac in 18 in. rows. An 8 in. band of simazine 0.75 lb/ac over the rows, was applied at the time of drilling to five treatments. The remaining treatment was a standard overall application of simazine 0.75 lb/ac with no subsequent inter-row treatment.

The inter-row treatments were identical to those previously described for the weedy experiments with the addition of a lower rate of dalapon. Cultivation plots were steerage hoed on 21st April and 5th May, a mixture of paraquat and diquat each at 4 oz/ac was applied on 28th April and 12th May and dalapon 2,4 and 8 lb/ac was applied on 5th May. In addition the dalapon plots received an inter-row application of the paraquat and diquat mixture on the 12th May.

The experiment was combine harvested on 8th September. It was decided to omit harvesting one replicate in which the beans on all the plots had remained very stunted for some reason unconnected with the experiment. Final yields from the five replicates were calculated at 85% dry weight.

Seed rate and row width Experiment

Fertiliser (67 lb P_2O_5/ac, 67 lb K_2O/ac) was applied to the ploughed surface and cultivated in. Beans, var. Maris Bead, were drilled on 11th March. Two seed rates were used, approximately 180 lb/ac and 250 lb/ac. Each of these was drilled at 3 row spacings, 6 in., 9 in. and 18 in. In addition a double row treatment was drilled at each seed rate with two rows 4 in. apart, separated by 14 in. All 8 treatments were fully randomised with four replicates and plots of 60 ft x 7.5 ft. Simazine 0.75 lb/ac was applied to the whole area on 17th March.

The emerged beans were counted on 22nd April, counting the centre 10 ft of each plot taking the centre 3 single or double rows at 18 in., 6 rows at 9 in. and 9 rows at 6 in. These same rows were harvested by hand on 7th September but taking the centre 30 ft of each 60 ft plot. The beans were threshed, cleaned and fresh and dry weights of threshed beans recorded. Final yields at 85% dry weight were calculated.

General note

In all experiments where 6 in. and 18 in. row widths were compared, the 18 in. spacing was obtained by fitting a manifold to the drill coulter to collect the seed from three drill outlets. By this means the same drill setting was used for both row widths.

RESULTS

Table 1

Yields of beans from the inter-row experiments (cwt/ac)

Row width	Inter-row Treatment	Spelsbury	Tackley	Begbroke
6 in.	Nil	12.9	12.8	-
18 in.	Dalapon 2 lb/ac	-	-	15.9
18 in.	Dalapon 4 lb/ac	6.6	8.8	16.9
18 in.	Dalapon 8 lb/ac	4.6	7.0	14.2
18 in.	Paraquat 4 oz/ac + diquat 4 oz/ac	12.7	10.6	20.8
18 in.	Cultivation	11.6	10.3	20.0
18 in.	Nil	-	-	22.5
	S.E.	±1.13	±0.68	±0.94

All treatments with 18 in. rows reduced yields to varying extents. Beans grown in 6 in. rows with no grass weed control resulted in higher yields at Spelsbury and Tackley.

Slight damage to the beans was sustained at the first date of inter-row cultivation. Some plants were covered with soil, particularly at Spelsbury where the large quantities of rhizome present tended to build up on the hoe blades. The resulting stand reduction is shown in Table 2.

Table 2

Spelsbury - Numbers and heights of beans in June and final grass weed control at harvest

Row width	Inter-row treatment	Plants/30 ft row	Mean height (in.)	Weed rating at harvest
6 in.	Nil	-	28.4	8.8
18 in.	Dalapon 4 lb/ac	149	27.2	3.8
18 in.	Dalapon 8 lb/ac	149	25.6	3.0
18 in.	Paraquat 4 oz/ac + diquat 4 oz/ac	148	27.2	7.6
18 in.	Cultivation	132	26.0	7.0
	S.E.	± 9.2	± 0.55	0 = no weeds 10 = complete cover

At each experiment dalapon caused considerable reductions in yield at all rates. Damage resulted from root uptake of the chemical and symptoms first appeared in May and persisted through until harvest. The affected plants were stunted and often the leaves remained inrolled with the leaf blades adhering to each other.

Grass weed control with paraquat + diquat and with cultivation looked promising in the spring after two consecutive applications. The height of the beans prevented further re-treatment after mid-May. The grass weeds made further growth during the summer on these plots, and at Spelsbury the infestation at harvest was almost as dense as on the untreated 6 in. row plots (Table 2). The effect of dalapon was more persistent resulting in a lower infestation at harvest.

Table 3

Stands and yields of beans sown at varying seed rates and row widths - Begbroke

Rows	Intended seed rate lb/ac	Plants/yd^2 22 April	Yield cwt/ac	Yield g/plant established
6 in.	180	142	18.5	17.5
9 in.	180	158	19.9	16.9
18 in. single	180	163	18.3	15.0
18 in. double	180	136	16.8	16.5
6 in.	250	185	20.9	15.2
9 in.	250	222	20.0	12.1
18 in. single	250	215	17.9	11.2
18 in. double	250	196	18.1	12.4
S.E.		± 6.7	± 0.75	

The seed rate/row width experiment at Begbroke (Table 3) shows that again close drilled beans outyielded those at wider spacings. This effect was more marked at the higher seed rate. The initial establishment of the beans varied within each intended seed rate and this is difficult to explain completely. Differing drill settings were used for the 18 in. and 9 in. rows but identical amounts of seed were sown in the 18 in. and 6 in. rows. Yield per plant established shows a greater yield advantage for the 6 in. rows over rows drilled at 18 in.

DISCUSSION

The increase in row width from 6 in. to 18 in., necessary to allow for inter-row treatments, was accompanied by a reduction in yield of between 2 and 3 cwt/ac at Tackley and at the high seed rate in the Begbroke experiment. In neither experiment was there appreciable weed competition. These reductions are of the same order as those recorded in some Agricultural Development and Advisory Service experiments (Roebuck 1970).

Previous work with A. repens (Cussans 1970) would suggest that losses from a severe grass weed infestation would exceed those incurred as a result of increasing the row width. In order to justify drilling at a wider row spacing, however, a really selective inter-row treatment would be needed. The inter-row treatments reported here either gave only temporary weed control or severely damaged the beans. A more selective inter-row treatment is necessary to justify drilling in wide rows in a weedy situation.

Acknowledgements

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References

CUSSANS, G. W. (1968) The growth and development of Agropyron repens (L.) Beauv. in competition with cereals, field beans and oilseed rape. Proc. 9th Br. Weed Control Conf. (1968), 131-136.

CUSSANS, G. W. (1970) A study of the competition between Agropyron repens (L.) Beauv. and spring sown barley, wheat and field beans. Proc. 10th Br. Weed Control Conf. (1970), 337-343.

HOLROYD, J. and WILSON, B. J. (1968) Herbicides for the control of Agropyron repens in field beans. Proc. 9th Br. Weed Control Conf. (1968), 176-180.

ROEBUCK, J. F. (1970) Private communication.

WILSON, B. J. and CUSSANS, G. W. (1970) The selective control of annual and perennial grass weeds in field beans (Vicia faba L.) by EPTC, chlorpropham and simazine. Proc. 10th Br. Weed Control Conf. (1970), 529-536.

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RESULTS OF DIFFERING TECHNIQUES IN THE APPLICATION OF DICHLOBENIL 7.5% GRANULES IN FORESTRY

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Summary The conventional tree square application of herbicides to young forest trees grown in the row carries disadvantages which are aggravated by the use of granular herbicides. In assessing the effect of dichlobenil granules (Casoron G) within a dose range of 3.0 to 5.25 lbs a.i./ac applied as a 3ft continuous band or a 4ft divided band, in comparison with tree square treatment at 4.1 lbs a.i./ac and tree square paraquat, crop response improved with increasing dose following band treatment and considerably so using the divided band technique. The advantages to be derived from these techniques are discussed and confirm that rates up to 5.25 lbs a.i./ac offer a safe and effective method of weed control under young forest trees.

INTRODUCTION

Results from previous work have shown that dichlobenil, formulated as a 7.5% granule (Casoron G) may be used with safety under young forest trees at 4.1 lbs a.i./ac. The conventional tree square technique of herbicide application however suffers from two serious disadvantages. Firstly, in practice, it is extremely difficult, especially with granular formulations, always to apply the correct dose around the base of each individual tree, and unless each individual dose per tree is carefully measured, the operator has no means of checking that the correct rate per ac. has been applied. Secondly, untreated surrounding growth may later in the season fall over the treated squares to disrupt and often seriously distort tree growth.

In an endeavour to overcome these problems, we compared in 1970, two types of band application at varying rates - a 3ft single band and a 4ft divided band - with conventional tree square treatment at 4.1 lbs a.i./ac, on five trials, all located in the west.

On trials 1 and 2, dichlobenil was applied as a 3ft single band at 3.0 and 4.1 lbs a.i./ac and as a 4ft divided band at 3.0, 4.1 and 5.25 lbs a.i./ac. These treatments were compared with dichlobenil at 4.1 lbs a.i./ac and paraquat applied once in mid summer both as tree squares. The remaining trials were laid down on a windbreak site, the treatments comprising divided band application at 3.0, 4.1 and 5.25 lbs a.i./ac dichlobenil which was compared with tree square paraquat. Other relevant details are presented in Table 1.

Table 1

Trial No.	Location	Soil Type	Tree Species/Year Planted
1	Ditton Priors, Salop	Clay loam	Picea abies (1968)
2	Coleford, Glos	Sandy loam	Pseudotsuga menziesii (1968)
3	Kingston Deverill, Wilts	Upper chalk	Thuja plicata (1968)
4	" " "	" "	Pinus sylvestris (1968)
5	" " "	" "	Fagus sylvatica (1968)

METHODS AND MATERIALS

a) Design

Trials were of randomised block design with four replicates, each plot containing 20 trees.

b) Treatments

Table 2

Trial No.	Treatments in lbs a.i./applied ac			
	Dichlobenil			Paraquat *
	Sq.	B	D/B	Sq.
1:2	4.1	3.0, 4.1	3.0, 4.1, 5.25	1.0
3:4:5			3.0, 4.1, 5.25	1.0

Sq. = Tree Square. B = Single 3ft Band. D/B = Divided 4ft Band.
*Weed growth on control plots received one application of paraquat mid summer, applied tree square.

c) Application

All applications were made between the end of February and mid April. Tree square treatment with dichlobenil was made to an area of 1 sq. yd. around each tree by means of a hand dispenser of pepper pot design. Single band application was made directly over the tops of the tree rows to a width of 1 yd. using a Horstine Farmery motorised knapsack applicator. To obtain the 4ft divided band, a blanking device was placed in the fish tail outlet of the Horstine Farmery applicator (or alternatively could be made by substituting a Y-piece). With either device the granule stream is deflected in such a manner that the dose at the centre of each band (12" wide) is approximately $\frac{1}{3}$ of that at each side of the band (18" wide) and is then aligned over the centres of the tree rows. Paraquat was applied as a directed spray to an area of 1 sq. yd. around each tree, using a hand knapsack sprayer.

d) Assessments

i) Tree Health.

Tree health was assessed at the end of the growing season using the undermentioned scale adopted by the Forestry Commission.

1 = tree in full health
2 = some yellowing of needle tips
3 = reduction in total needle colour
4 = as for 3 above but with some necrosis
5 = tree dead.

ii) Tree Survival.

Assessed as a percentage of the original plant at the end of the season.

iii) Tree Growth.

Total tree height and the increase in tree height (new growth) were measured at the end of the season.
Results in terms of new growth were found to be analogous to those of total tree height and have not therefore been presented.

iv) Statistical Analysis.

The Duncan's Multiple Range Test was applied to the results to obtain levels of statistical significance which relate only to that particular trial in which they occur.

RESULTS

i) Tree Health

Table 3

(1 = tree in full health, 5 = tree dead)

Treatment		Trials 1	Trials 2	Mean 1 & 2	Trials 3	Trials 4	Trials 5	Mean All trials
Paraquat	Sq	2.2	1.3	1.75	1.1	1.1	1.0	1.34
Dichlo. 3.0	B	1.8(3)	1.8	1.80	-	-	-	-
3.0	D/B	1.8(3)	1.9	1.85	1.7	1.6	1.0	1.60
4.1	Sq	2.4	1.8	2.10	-	-	-	-
4.1	B	1.6(2)	1.6	1.60	-	-	-	-
4.1	D/B	1.7(2)	1.5	1.60	1.0	1.6	1.0	1.36
5.25	D/B	1.3(1)	1.2(4)	1.25	1.3	1.4	1.0	1.24

Sq. = Tree Square. B = Single 3ft Band. D/B = Divided 4ft Band.

(1) Sig. better than dichlobenil at 4.1 (tree square) and paraquat $p = 0.01$
Sig. better than dichlobenil at 3.0 (band and divided band) $p = 0.1$
(2) Sig. better than dichlobenil at 4.1 (tree square) $p = 0.01$
(3) Sig. better than dichlobenil at 4.1 (tree square) $p = 0.05$
(4) Sig. better than dichlobenil at 3.0 (divided band) $p = 0.1$

Results (Table 3) show:-

1. Improved tree health from both methods of band application (all rates) in comparison with tree square. (Trial 1).

2. Divided band application at 5.25 lbs provided superior tree health than at 3.0 lbs. (Trials 1 and 2).

ii) Tree Survival

Table 4

(% of original number of trees planted)

Treatment		Trials 1	Trials 2	Mean 1 & 2	Trials 3	Trials 4	Trials 5	Mean All trials
Paraquat	Sq	96.0(1)	91.5	93.8	95.8	100.0	100.0	96.7
Dichlo. 3.0	B	83.5(2)	84.8	84.2	-	-	-	-
3.0	D/B	80.0(3)	82.5	81.3	81.3	100.0	100.0	88.8
4.1	Sq	70.3	91.3	80.8	-	-	-	-
4.1	B	86.8(2)	92.0	89.4	-	-	-	-
4.1	D/B	84.3(2)	92.5	88.4	98.6	96.4	100.0	94.4
5.25	D/B	93.5(1)	97.5(4)	95.5	91.5	94.9	100.0	95.5

Sq. = Tree Square. B = Single 3ft Band. D/B = Divided 4ft Band.

(1) Sig. greater than dichlobenil at 4.1 (tree square) $p = 0.01$
Sig. greater than dichlobenil at 3.0 (divided band) $p = 0.05$
(2) Sig. greater than dichlobenil at 4.1 (tree square) $p = 0.05$
(3) Sig. greater than dichlobenil at 4.1 (tree square) $p = 0.1$
(4) Sig. greater than dichlobenil at 3.0 (divided band) $p = 0.1$

Results (Table 4) show:-

1. Both methods of band application for all rates of dichlobenil and paraquat (tree square) improved tree survival in comparison with dichlobenil tree square treatment. (Trial 1).

2. Tree survival from dichlobenil applied as a divided band at 5.25 lbs was greater than divided band application at 3.0 lbs in trials 1 and 2.

iii) Tree Growth

Table 5

(Total tree height, "/tree)

Treatment		Trials 1	Trials 2	Mean 1 & 2	Trials 3	Trials 4	Trials 5	Mean All trials
Paraquat	Sq	17.1	28.5(3)	22.8	21.5	30.7	30.3	25.6
Dichlo. 3.0	B	16.0	26.5	21.3	-	-	-	-
3.0	D/B	17.0	22.3	19.7	20.5	22.0	25.1	21.4
4.1	Sq	15.5	25.3	20.4	-	-	-	-
4.1	B	15.1	24.4	19.8	-	-	-	-
4.1	D/B	17.0	28.2(3)	22.6	24.9	25.4	27.4	24.6
5.25	D/B	17.7(1)	31.3(2)	24.5	24.0	29.1	25.7	25.6

Sq. = Tree Square. B = Single 3ft Band. D/B = Divided 4ft Band.

(1) Sig. greater than dichlobenil at 4.1 (tree square and band) $p = 0.1$
(2) Sig. greater than dichlobenil at 3.0 (divided band) $p = 0.01$
Sig. greater than dichlobenil at 4.1 (band) $p = 0.05$
Sig. greater than dichlobenil at 4.1 (tree square) $p = 0.1$
(3) Sig. greater than dichlobenil at 3.0 (divided band) $p = 0.1$

Results (Table 5) show:-

1. Dichlobenil at 5.25 lbs (divided band) increased tree growth in comparison with 4.1 lbs applied as single band or tree square. (Trials 1 and 2).

2. In trial 2, paraquat and the two higher rates of dichlobenil applied as a divided band increased tree growth in comparison with the divided band application of dichlobenil at 3.0 lbs.

DISCUSSION

Earlier work which corroborates that of Aldhous and Atterson(1) and Aldhous, Brown and Atterson(2) who used the related chlorthiamid, has shown that although dichlobenil 7.5% granules may be used with safety at 4.1 lbs a.i./ac when applied on a conventional tree square basis, for reasons described heretofore, band application to trees normally planted in the row would provide additional benefits in the form of more even application and hence greater overall tree safety, and would also enable operators to check accurately the dose being applied. A band of adequate width would further overcome the smothering effects of tall weeds which often occur as the season advances.

The results of these trials confirm the advantages to be derived from band application in terms of improved tree health, growth and survival, which, in many cases show a statistically significant improvement, and where not, then definite trends in this direction.

Rate for rate, the best results were obtained from the wider divided band, the narrower conventional band in turn being better than tree square treatment. It is also probable that the small amount of weed herbage left in the tree rows with the divided band technique provides valuable light shading to the young trees during hot summer months. Another result of band treatment not shown in the data here presented was the reduction of tree smothering by tall weeds. It was noted that by mid summer, tall weeds such as Pteridium aquilinum and grasses tended to fall over the treated areas and smother the young trees. This effect was very pronounced where application was made tree square, was less pronounced on the 3ft bands and was at a minimum on the wider 4ft divided bands.

It thus follows that band treatment has these advantages over tree square application. Firstly, a continuous band of adequate width applied by suitable equipment reduces the dangers of localised overdosing associated with tree square treatment, and secondly, reduces the smothering effect of tall weeds. Band application therefore provides wider crop tolerance margins or, alternatively, enables the use of a higher dose for improved weed control should the need arise. These advantages are further enhanced by the use of a 4ft divided band which, in addition, also provides valuable summer shading in a hot season for the young trees.

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References

ALDHOUS, J.R. and ATTERSON, J. (1967). Weed control in the forest. Rep. Forest Res. Lond., 70-73.

ALDHOUS, J.R., et al (1968) Weed control in the forest. Rep. Forest Res. Lond., 75-82.

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FURTHER EXPERIMENTS WITH 2,6-DICHLOROTHIOBENZAMIDE (CHLORTHIAMID) IN PLANTED AREAS OF SOFTWOODS

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Summary. In trials during the period 1969-1972 chlorthiamid as a 7½% granule gave a silviculturally acceptable level of selective weed control of grasses and herbaceous weeds, when applied by knapsack granular applicator to Sitka spruce (*Picea sitchensis*) and Norway spruce (*Picea abies*), at rates of 3.4, 4.2 and 5.0 kg active ingredient (a.i.) per treated hectare. On fertile sites a second application in a further year was required, in the second application 2.5 kg a.i. per treated hectare was also acceptable. Application in successive years resulted in a partial colonisation by resistant species; the best results from all rates came from application in alternate years. An initial application in year 1 of 4.2 kg a.i. per treated hectare applied during the period January-April, followed by an application in year 3 of either 4.2 or 3.4 kg a.i. per treated hectare from December-April or 2.5 kg a.i. per treated hectare from February-April gave the best weed control. In some months an application of 5 kg a.i. per treated hectare was unnecessarily superior.

INTRODUCTION

Effective and economic weed control is a necessity during the establishment period of newly planted trees; the present cost of hand labour, and the large acreages involved, make chemical weed control methods essential.

Previous experiments reported by Aldhous (1964) de Gouville and Allen (Columa Conference 1965) Allen (1966) and Brown (1968) showed that chlorthiamid, as a granule containing 7½% active ingredient, gave an effective control of weeds in young plantations of certain species when applied at 4.2 kg a.i. per treated hectare during the period February-March. The rate of 4.2 kg a.i. per treated hectare was considered to be the maximum amount that could be applied and still leave an acceptable safety margin to the trees.

The work described in this paper was designed to investigate the minimum amounts that could be applied in order to achieve an adequate degree of weed control and at the same time, by comparing timing and frequency of application over a 3 year period, to be able to allow greater flexibility when planning weeding programmes.

METHODS AND MATERIALS

In the three trials reported a 7½% a.i. granular formulation of chlorthiamid was used. Applications were carried out at monthly intervals in trial No 1 from December-April and in trials 2 and 3 from January-April. A Horstine Farmery airflow granular applicator was used to apply a continuous band over the trees of approximately 1 metre in width. The plot size was a single row of trees 31 metres long (comprising approx. 20 trees), the rates applied were 0, 2.5, 3.4, 4.2 and 5.0 kg a.i. per treated hectare. Blocks I were treated in years 1 and 3, II in years 1 and 2 and III in years 1, 2 and 3.

SITE DETAILS

NO:	1	MAIN WEEDS
LOCATION:	Perthshire	Juncus effusus, Pteridium aquilinum, Chamaenerion angustifolium, Senecio jacobaea, Urtica dioica, Rununculus repens, Dryopteris filix-mas.
SPECIES:	Norway Spruce (Picea abies)	
PLANTED:	1968	
DATE 1st APPL	Dec. 1969	
SOIL TYPE:	Surface Water Gley	

NO:	2	MAIN WEEDS
LOCATION:	Perthshire	Festuca ovina, Lathyrus pratensis, Rumex acetosa, Rumex acetosella, Chrysanthemum leucanthemum, Cirsium arvense, Stellaria graminea, Geranium molle, Galium saxatile, Arenaria norvegica, Trifolium spp., Veronica spp.
SPECIES:	Sitka Spruce (Picea sitchensis)	
PLANTED:	Dec. 1968	
DATE 1st APPL	Jan. '70	
SOIL TYPE:	Brown Earth	

NO:	3	MAIN WEEDS
LOCATION:	Perthshire	Phleum pratense, Trifolium dubium, Vicia sepium, Sonchus oleraceus, Galeopsis tetrahit, Rumex crispus, Vicia cracca, Prunella vulgaris.
SPECIES:	Sitka Spruce (Picea sitchensis)	
PLANTED:	Dec.'68	
DATE 1st APPL	Jan.'70	
SOIL TYPE:	Brown Earth	

Grasses commonly occurring on all three sites were Dactylis glomerata, Agrostis tenuis, Holcus lanatus, Holcus mollis, Anthoxanthum oderatum, and Deschampsia caespitosa.

RESULTS

Tree Height Increments

Increments were measured annually at the end of the growing season, it was only possible to statistically analyse two blocks, II and III, in the years 1970 and 1971 when both had received identical treatments. The results confirm the previous findings reported by Allen (1966) where it was found that an efficient control of weeds resulted in little or no height increment response but in a bulkier tree with a much greater volume of needles, the trees in the control plots tended to be thin and straggly. Tables I, II and III. Tables IV, V and VI show the 1972 increments expressed as a mean of the 3 sites for each of the 3 application regimes. As only a single block was involved each month at each site no statistical analysis was possible. The tables however show that the marked increase in volume of needles in the treated plots has commenced to have a beneficial effect upon height increments, this is particularly apparent in blocks I and III where at the end of 1972 season the weed control was the most effective.

Weed Control

Weed control was assessed at the end of each season. A figure of silvicultural acceptability was arrived at and is expressed as 30% weed cover on the scale in figures 1-6. Owing to the layout of the trials it was only possible to carry out a statistical analysis on Blocks II and III using the 1971 figures. The results for Site I are listed in Table VII. Weed control was significantly better following the

April treatment than in the preceding months. All rates of chlorthiamid were significantly better than the controls, with the upper two being significantly better than the lower two. The effect of timing is shown in that 2.5 kg a.i. per treated hectare applied in April has given better weed control than 5.0 kg applied in December and 4.75 kg a.i. per treated hectare in February is equivalent to 3.4 kg applied in April. Percentage weed cover at site No 2 is shown in Table VIII. There was no effect due to time. All chlorthiamid treatments were significantly better than the controls. The figures for site No 3 are shown in Table IX. All chlorthiamid treatments were significantly better than the control. There was also a significant improvement in weed control with time.

Six figures are presented in the Appendix which show the mean weed control scores of the three sites and which also compare results from the different regimes of chlorthiamid application. These show the effects of the different application regimes.

Figure No 1 shows weed control scores after the first year of application when three blocks in each trial were treated monthly.

5 kg and 4.2 kg ha a.i. gave an acceptable degree of weed control applied from January - April. There was no advantage to be gained from applying the higher rate. 3.4 kg ha a.i. gave acceptable weed control when applied in February or March, the 2.5 kg a.i. per treated hectare rate failed to give an acceptable weed control irrespective of application time.

Figure No 2 shows the mean scores from one block from each site treated in 1970, untreated in 1971 and assessed in Autumn 1971. There has been no residual effect of the previous year's treatment, all rates failing to give an adequate degree of weed control, in the year subsequent to application. The site partially reverted to the original susceptible weed flora. This was sufficient to prevent colonisation by resistant species. The effect of the reversion is shown in Figure No 5.

Figure No 3 shows the assessment in Autumn 1971 following two consecutive years of application. The 5.0 kg a.i. per treated hectare rate gave an acceptable weed control from December - April, the 4.2 kg a.i. per treated hectare from January - April, the 3.4 kg in March and April and the 2.5 kg in April only. Every treatment while being acceptable is worse than the corresponding treatment on figure No 5 although at the time of assessment both regimes had received identical rates of chlorthiamid. The reason for these differences is that application in two consecutive years resulted in a complete suppression of susceptible weeds and hence a rapid colonisation by resistant species notably Anthoxanthum odoratum which, although not competing with the trees to the same extent as some of the other grasses present, did result in an acceptable but poorer weed control score. Figure No 4 shows the same two consecutive years of application as shown in Figure No 3, after being left untreated for one year and then assessed in Autumn 1972. Only the 5.0 kg rate applied in January or April or the 4.2 kg per treated hectare rate applied in April gave an acceptable weed control, this being entirely due to the presence of resistant colonising species.

Figure No 5 shows the mean of the same plots as figure No 2 after retreatment in 1972 with the same rates as in 1970. The 5.0 kg a.i. per treated hectare, 4.2 kg and 3.4 kg a.i. per treated hectare gave an acceptable degree of weed control when applied from December to April, while the 2.5 kg a.i. per treated hectare gave acceptability from January - April.

Figure No 6 shows the weed control figures following 3 consecutive years of application, as might be expected all rates gave an acceptable degree of weed control from January - April, with the 5.0 kg ha a.i. rate also being acceptable in December. The results in this figure compared with those in Figure No 5, because of recolonisation, show that little has been gained by an extra year's application.

DISCUSSION

Application of chlorthiamid by knapsack granule applicator, either as a continuous band or as a spot treatment has become a standard practice in many planted areas of numerous species (ref. Cherry M. 'A Quiet Revolution in Forestry', Big Farm Management No 7 1972).

The trials reported show that on sites of strong weed growth it is necessary to make 2 applications, preferably in alternate years, that a sliding scale of application can be used and that timing of application can be flexible enough to suit the majority of forestry weeding programmes. The results indicate that the initial application should be 4.2 kgs a.i. per treated hectare applied in the period January - April or 3.4 kg a.i. per treated hectare during the period March - April. There was little to be gained from applying 5.0 kg ha a.i. and 2.5 kg ha a.i. failed to give an adequate degree of weed control at any of the application times.

If a second application was made the subsequent year, this resulted in a colonisation by resistant species, but if the areas were left untreated the subsequent year, although there was some reversion to the original weed growth, the young trees benefited from the weed suppression in the initial year and had a markedly greater volume of needles than those in the untreated plots. A second application in the third year on fertile sites gave adequate weed control when applied during the period December - April at the 3.4 and 4.2 kg a.i. rates per treated hectare, while the 2.5 kg rate was acceptable from February - April. With no application time or regime was 5 kg a.i. per treated hectare justified.

Tree height increments followed the trend reported by Allen in 1966 where removal of weed competion resulted in smaller increments because of the removal of the 'drawing up' effect of the weeds. Clean weeded trees however, in addition to having a greater survival rate, due to the removal of the hazard of of autumnal 'fall in' of smothering weed growth, had a markedly greater volume of needle production. By the end of 1972 this was commencing to have a beneficial effect upon the height increments, which should accelerate with time.

Acknowledgements

The Authors wish to acknowledge the help received from the Forestry Commission and Fountain Forestry Ltd. in providing sites. Thanks are due to Mr. P.F. Hunt, Shell Research Ltd., who carried out the statistical analysis and to G. H. Mackenzie and R.G. Jones for assistance in applications and assessments.

References

Aldhous J.R. 'The effect of 2,6 -dichlorothiobenzamide in species planted in the forest'. Seventh British Weed Control Conference Vol. 1 267-275 (1964).

de Gouville B. & Allen M.G. 'Weed control in young forest plantation with chlorthiamid' Columa Conference, Paris (1965).

Allen M.G. 'Experiments with 2,6 -dichlorothiobenzamide (chlorthiamid) in planted areas of soft and hard woods' 8th British Weed Control Conference 135-140 (1966)

Brown R.M. 'The effect of chlorthiamid on young forest trees' 9th British Weed Control Conference 975 - 980 (1968).

Cherry M. 'A quiet revolution in forestry' Big Farm Mangement No. 7 1972.

APPENDIX

TABLE I. TREE HEIGHT INCREMENTS (CMS) SITE I 1970 & 1971

Chlorthiamid. Kg ha a.i.	MONTH OF APPLICATION Dec. '70	Dec. '71	Jan. '70	Jan. '71	Feb. '70	Feb. '71	Mar. '70	Mar. '71	Apr. '70	Apr. '71	TREAT MENT.	Mean
0(Control)	7.5	15.5	8.5	16.0	8.5	15.5	8.5	14.5	9.0	14.5	8.4	15.2
2.5	8.5	15.0	8.5	16.0	8.5	15.5	9.0	13.5	7.5	12.5	8.4	14.5
3.4	7.5	15.0	9.0	15.0	9.0	15.5	8.0	13.0	9.5	14.0	8.6	14.5
4.2	9.0	16.5	9.0	14.0	8.5	11.0	10.0	12.5	7.5	12.5	8.8	13.3
5.0	8.5	13.0	8.0	13.0	8.0	13.5	8.5	9.5	7.5	12.0	8.1	12.2
Time Means	8.2	15.0	8.6	14.8	8.5	14.2	8.8	12.6	8.2	13.1	'70	'71

P = 0.05
1970 L.S.D. between control mean and a treatment mean = 2.3 N.S.
1971 " " " " " " " " = 2.7 Significant 4.5 ac a.i. (only.
1970 L.S.D. between time means = 3.2 N.S.
1971 " " " " = 3.9 N.S.

TABLE II. TREE HEIGHT INCREMENTS (Cms) SITE 2 1970 and 1971

Chlorthiamid. Kgs. ha a.i.	MONTH OF APPLICATION Jan. '70	Jan. '71	Feb. '70	Feb. '71	Mar. '70	Mar. '71	Apr. '70	Apr. '71	TREATMENT.	MEAN
0(Control)	12.0	9.5	13.0	7.0	9.0	7.0	15.0	9.0	12.3 '70	8.1 '71
2.5	16.5	14.0	18.5	13.0	14.0	11.0	13.0	10.0	15.5	12.0 *
3.4	16.0	14.5	15.5	12.5	16.5	10.5	16.0	11.5	16.0	12.3 *
4.2	17.5	14.5	16.0	10.5	19.0	12.5	13.5	11.5	16.5 *	12.3 *
5.0	15.5	11.5	20.0	13.0	14.5	11.5	13.0	8.0	15.8	11.0 *
Time Means	15.5	12.8*	16.6	11.2	14.6	10.5	14.1	10.0		

P = 0.05
1970 L.S.D. between control mean and a treatment mean = 4.0 * = significant
1971 " " " " " " " " = 2.2 * = "
1970 L.S.D. between time means = 4.8 N/S.
1971 " " " " = 2.6

*Jan. significantly better than April.

TABLE III. TREE HEIGHT INCREMENTS (Cms) SITE 3 1970 and 1971

Chlorthiamid. Kgs. ha a.i.	MONTH OF APPLICATION Jan. '70	Jan. '71	Feb. '70	Feb. '71	Mar. '70	Mar. '71	Apr. '70	Apr. '71	TREATMENT	MEAN
0(Control)	16.0	22.0	13.0	23.0	18.5	23.0	13.0	23.0	15.1 '70	22.8 '71
2.5	12.0	17.5	16.5	25.0	15.5	22.5	10.0	19.5	13.5	22.1
3.4	11.0	18.5	12.0	21.5	16.0	23.0	13.5	23.0	13.1	21.5
4.2	15.0	19.5	16.5	24.0	12.0	19.0	12.0	16.5	13.9	19.8
5.0	12.5	17.5	15.5	20.0	14.5	21.0	11.5	17.5	13.5	19.0
Time Means	13.3	19.0	14.7	22.7	15.3*	21.7	12.0	19.9		

P = 0.05
1970 L.S.D. between Control mean and treatment mean = 2.6 N.S.
1971 " " " " " " " = 4.3 N.S.
1970 L.S.D. between time means = 3.1
1971 " " " " = 5.1 N.S.

1970 * time means March significantly better than April.

TABLE IV. 1972 TREE HEIGHT INCREMENTS (Cms) (MEAN OF THREE SITES)

BLOCKS I i.e. APPLIED 1970 and 1972 (MEASURED AUTUMN 1972)

Chlorthiamid. Kg ha. a.i.	MONTH OF APPLICATION Dec.	Jan.	Feb	Mar.	Apr.
0(Control)	24.9	21.9	32.1	27.0	24.6
2.5	28.7	26.2	32.7	24.8	28.0
3.4	27.4	31.7	28.4	32.2	32.9
4.2	23.4	30.3	31.1	28.0	28.2
5.0	27.3	29.7	27.6	26.3	34.8

TABLE V. 1972 TREE HEIGHT INCREMENTS (Cms) (MEAN OF THREE SITES)

BLOCKS II i.e. APPLIED 1970 and 1971 (MEASURED AUTUMN 1972)

Chlorthiamid. Kgs. ha. a.i.	MONTH OF APPLICATION Dec.	Jan.	Feb.	Mar.	Apr.
0(Control)	29.5	27.0	24.5	22.5	23.9
2.5	32.2	32.0	29.5	25.4	26.8
3.4	32.4	30.3	32.1	29.2	25.7
4.2	36.5	23.9	27.9	28.3	32.0
5.0	29.1	29.2	28.2	24.2	24.8

TABLE VI. 1972 HEIGHT INCREMENTS (Cms) (MEAN OF THREE SITES)

BLOCKS III (i.e. APPLIED 1970, 1971 and 1972 (MEASURED AUTUMN 1972)

Chlorthiamid. Kgs. ha. a.i.	MONTH OF APPLICATION Dec.	Jan.	Feb.	Mar.	Apr.
0(Control)	24.5	31.3	20.8	24.1	29.3
2.5	22.8	28.8	32.3	28.5	28.1
3.4	27.0	33.7	29.6	26.4	31.9
4.2	21.6	26.5	26.9	28.5	26.5
5.0	29.2	25.3	33.2	27.5	28.5

TABLE VII. % WEED COVER ON 6.9.71. Site No 1

Chlorthiamid. Kgs. ha. a.i.	TIME OF APPLICATION Dec.	Jan.	Feb.	Mar.	Apr.	Mean	Detransformed
0(Control)	85.9	85.0	90.0	80.8	89.7	86.3	99.6
2.5	41.5	40.2	43.9	46.7	25.5	39.5	40.5
3.4	39.2	39.8	45.0	37.5	21.5	36.6	35.6
4.2	46.7	27.2	21.5	23.1	16.9	27.1	20.7
5.0	32.8	29.3	34.1	37.1	12.9	29.2	23.8
Time Means	49.2	44.3	46.9	45.0	33.3		

X Data transformed by arc sin $(\sqrt{\frac{x}{100}})$ and analysed in degrees)

Detransformed	57.4	48.8	53.3	50.1	30.2

P = 0.05

L.S.D. between Control mean and treatment mean = 8.4

L.S.D. " time means = 12.0

TABLE VIII — % WEED COVER ON 8.9.71. Site No 2

Chlorthiamid. Kg ha a.i.	Jan.	Feb.	Mar.	Apr.	TREATMENT	DETRANSFORMED
	TIME OF APPLICATION					
0(Control)	80.8	85.0	90.0	90.0	86.4	99.6
2.5	45.0	36.9	42.1	42.1	40.2	41.7
3.4	38.9	34.7	35.3	35.3	35.1	33.1
4.2	27.2	31.6	33.4	33.4	30.2	25.3
5.0	31.3	24.6	31.3	31.3	29.9	24.9
Time Means	44.6	42.6	43.9	46.4		

Data transformed by arc sin $(\sqrt{\frac{x}{100}})$ and analysed in degrees.

Detransformed	49.4	45.8	48.1	52.5

P = 0.05
L.S.D. between control mean and treatment mean = 6.2
L.S.D. " time means = 7.5

TABLE IX — % WEED COVER ON 6.9.71 Site No 3

Chlorthiamid. Kgs. ha a.i.	Jan.	Feb.	Mar.	Apr.	TREATMENT	DETRANSFORMED
	TIME OF APPLICATION					
0(Control)	90.0	90.0	85.0	90.0	88.8	100
2.5	45.9	39.2	29.7	23.4	34.6	32.2
3.4	34.6	31.3	24.9	18.4	27.3	21.0
4.2	30.0	27.2	22.8	18.4	24.6	17.3
5.0	22.0	20.3	18.4	14.8	18.9	10.4
Time Means	44.5	41.6	36.2	33.0		

Data transformed by arc sin $(\sqrt{\frac{x}{100}})$ and analysed in degrees.

Detransformed	49.1	44.1	34.8	29.6

P = 0.05
L.S.D. between control mean and treatment mean = 3.6
L.S.D. " time means = 4.3

PERCENTAGE WEED COVER FOLLOWING CHLORTHIAMID TREATMENTS

Fig.I	Dec.	Jan.	Feb.	Mar.	Apr.	Kg.ai/ha Treated	Dec.	Jan.	Feb.	Mar.	Apr.	Fig.II
	100	98	97	96	95	0	100	99	100	100	99	
	54	46	32	42	32	2.5	94	96	99	99	97	
	46	34	32	25	22	3.4	95	96	98	99	95	
	44	19	26	19	18	4.2	92	93	97	96	96	
	36	27	16	19	19	5.0	86	95	95	96	92	
Fig.III												Fig.IV
	100	100	100	100	100	0	90	84	76	76	92	
	46	48	42	36	24	2.5	50	64	56	54	56	
	42	38	36	27	19	3.4	40	50	64	76	34	
	52	22	22	19	16	4.2	70	34	54	50	28	
	30	23	20	24	13	5.0	60	30	44	40	30	
Fig. V												Fig.VI
	80	97	97	93	84	0	95	84	95	93	95	
	50	30	18	20	10	2.5	40	23	25	20	13	
	20	27	12	15	7.5	3.4	40	20	17	18	9.0	
	20	25	6.5	7.5	9.0	4.2	40	7.5	7.5	10	5.0	
	30	13	7.5	4.0	6.5	5.0	30	7.5	4.0	8.5	6.0	

PERCENTAGE WEED COVER FOLLOWING CHLORTHIAMID TREATMENTS.

x———— - 2·5 KGS. A.I / TREATED HECTARE.*
x— — — - 3·4 " " " *
x· · · · · - 4·2 " " " *
x—·—·— - 5·0 " " " *

S.A. = SILVICULTURAL ACCEPTABILITY.

FIG. 1 APPLIED 1970 - ASSESSED 1970.

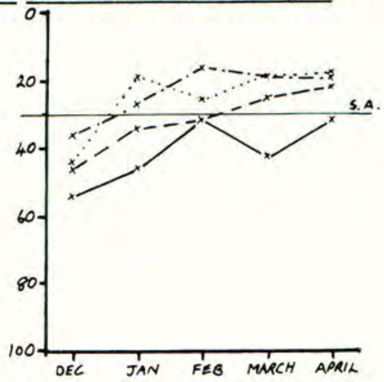


FIG. 2. APPLIED 1970 - ASSESSED 1971.

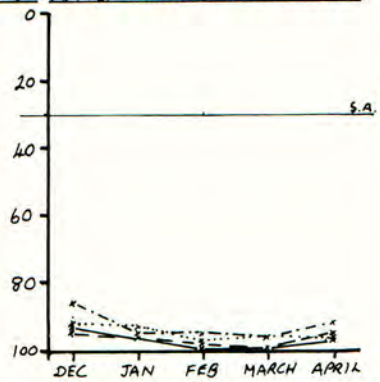


FIG. 3. APPLIED 1970 & '71 - ASSESSED 1971

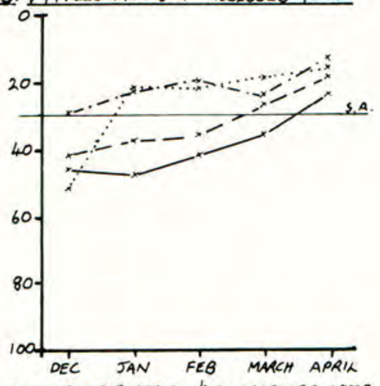


FIG. 4. APPLIED 1970 & '71 - ASSESSED 1972

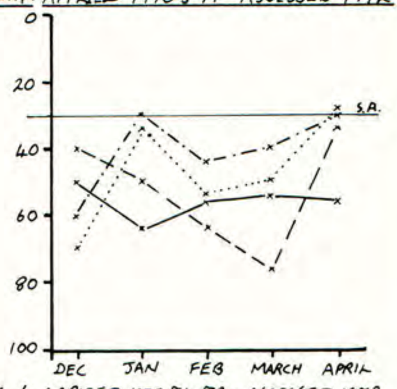


FIG. 5. APPLIED 1970 & '72 - ASSESSED 1972

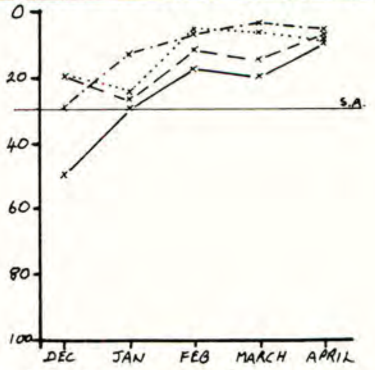
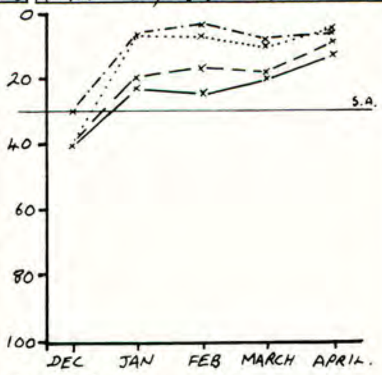


FIG. 6. APPLIED 1970, 71 & 72 - ASSESSED 1972



* ALL ASSESSMENTS CARRIED OUT IN THE AUTUMN.

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FURTHER TRIALS WITH ATRAZINE FOR CONTROLLING GRASS WEEDS IN BRITISH FORESTRY

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Summary Experiments and trials in 1971 and 1972 in Southern Britain showed that atrazine w.p. at 6 kg a.i./ha applied in March or May provided adequate control of Deschampsia caespitosa and Dactylis glomerata, but that May applications were best. The addition of a non-phytotoxic oil to the spray liquid at 5% of its volume improved control, but slightly increased crop damage.

Granular atrazine at 3.8 to 7.7 kg/ha provided good control of fine and soft grasses, although control was not quite as good as that provided by the wettable powder formulation when equivalent rates were tested.

In all experiments and trials damage to coniferous crops from atrazine at rates of from 4 to 6 kg a.i./ha was generally slight, although May applications, particularly at 6 kg a.i./ha, caused some reductions in height and health compared with March applications. Norway spruce and Western hemlock seemed particularly sensitive.

Revision of existing recommendations for the use of atrazine in British forests is suggested.

INTRODUCTION

Results of experiments from 1967 to 1970 were reported to the 10th British Weed Control Conference (Brown, 1970). These results showed that atrazine could adequately control a range of perennial fine and soft grasses at 2.2 to 4.5 kg a.i./ha when applied from February to May as a wettable powder, and that all the coniferous crop species tested tolerated these rates as an overall spray without serious damage.

The experiments and trials reported below (1) examine ways of improving the control of perennial coarse grasses commonly found in British forests (e.g. Deschampsia caespitosa , (2) test the reliability of atrazine both as a wettable powder and as a granule for controlling fine and soft grasses, (3) check the tolerance of the main coniferous species used in British forestry.

METHODS AND MATERIALS

(a) General

(i) Sites: All were in southern England; the exact location of each is given below in the description of each series of experiments and trials. All sites were below 200 m a.s.l., relatively unexposed, and with level or nearly level topography.

Mean annual rainfall ranged between 600 and 1200 mm. Forest soil types varied from free draining acidic brown earths with sandy texture to incipient gleys with loamy clay or clay texture. Some experiments took place on recently cultivated podzols with sandy texture and gleys with clay texture (old nursery sites).

Forest sites had generally been cleared of trees from one to three years prior to the experiment, and were uncultivated except that two sites (at Kings and Bere Forests) had been shallowly space ploughed at about 2 m spacing to provide a 30-40 cm wide strip bared of the grass mat ("screefed") into which the new crop trees were planted. Accumulation of decomposing organic matter at the soil surface was negligible (less than 1.0 cm) and the organic matter of the uppermost soil horizons was estimated to be between 7 and 15% of air dry weight. Well established perennial grasses dominated the weed flora. Herbaceous and woody broadleaved weeds were also present in varying frequencies from site to site.

Experiments specifically testing the tolerance of conifers to overall applications of atrazine were carried out on recently cultivated nursery sites, whose soils contained approximately 5% organic matter in their upper horizons (see below).

(ii) Experiments and Trials: Experiments were laid out as randomised blocks with three or four replications, the crop being planted for the purpose in February or March 1971, just before treatments were applied. In user trials simple, unreplicated treatments were each applied to an area of about 0.4 ha in normal forest crops planted from one to three years prior to treatment.

(iii) Materials: Atrazine was applied as either a 50% w.p. or as a 4% granule to a 1 m wide strip with the rows of trees situated centrally in the strip. No attempt was made to protect the trees from the spray or granules. Wettable powders were applied in 300 to 600 litres/ha of water using knapsack sprayers at low pressure. Granules were applied using a modified knapsack mistblower. All the rates given in this paper are expressed in terms of the active ingredient.

(iv) Assessments: Weed control was assessed by visually estimating the percentage live cover in each plot in mid-summer (July) following treatment and again at the end of the first growing season. In most cases, control was also scored for efficiency.

Three types of assessment were made on the tree crop. Tree height was measured at the beginning of the experiment (initial height), and at the end of the first and second growing season (1972 trials had not, of course, reached their second season). The percentage survival was assessed at the end of the first and second growing season. The crop was also inspected at intervals during each growing season and any symptoms of damage that had appeared scored for presence or absence, or for severity.

In experiments all trees in each plot were assessed, but in user trials the large number of trees in each plot necessitated sampling (see below). Plot means were calculated for all assessments and used to compare the effect of treatments on crop growth and health, using analysis of variance techniques (1972 assessments could not be processed in time for this paper).

(b) Further details of each series of experiments and trials

(i) 1971 forest experiments

Objects: To see if the control of coarse grasses could be improved by using either slightly higher rates of atrazine than hitherto recommended or by adding non-phytotoxic oil to the spray, without reducing crop tolerance.

Location and crop species: Hursley Forest, Hampshire; Western hemlock and Grand fir. Neroche Forest, Somerset; Sitka spruce. Shipbourne Forest, Kent; Scots pine and Western red cedar. Kings Forest, Suffolk; Corsican pine and Scots pine.

Experiment: Atrazine was applied in mid-March or mid-May at 4 or 6 kg/ha, with or without the addition of a mineral non-phytotoxic oil (plus emulsifier) to make up 5% of the spray volume. Two control plots which were hand-weeded according to normal forest practice were included in each replication. Treatments were replicated four times. Each plot contained 10 trees of each species in a single row at 1 m spacing.

(ii) 1971 tolerance experiments

Objects: To test a wide range of common forest species for tolerance to overall applications of atrazine.

Location and crop species: Alice Holt Forest, Hampshire; Corsican pine, Scots pine, Norway spruce, Japanese or Hybrid larch, Douglas fir, Western hemlock, Grand fir, Red cedar and beech. Because of a shortage of Japanese larch, this species was planted on the sandy sites and Hybrid larch on the clay sites (see below).

Four sites were chosen for the experiment: two with light, sandy soil, one of which had no weeds (SO) and the other a well developed layer of mainly grass (SW); two sites with heavy clay soil, one similarly without weeds (CO) and one with a well developed layer of grass (CW). Sites without weeds had been freshly cultivated in February prior to planting.

The main soil characteristics of these four sites are given in Table 1.

Table 1

Main characteristics of soils in 1971 tolerance experiments

Site	Analyses of representative sample from top 15 cm		
	pH	% loss on ignition	% clay (limiting particle size 0.005 mm diameter)
SO	3.6	5.2	8.4
SW	4.4	4.3	8.2
CO	5.2	4.8	35.6
CW	5.0	4.5	26.0

Experiment: Atrazine at 4 or 6 kg/ha was applied in mid-March or mid-May. A control which was hand-weeded as necessary was also included. Controls on weed-free sites were kept weed-free; controls on sites with weeds were weeded to normal forest standards.

Treatments were replicated four times. Ten trees of each species were included in each plot as a single row at 0.5 m spacing. Spacing between rows was 1.0 m.

(iii) 1972 user trials

Objects: To gain experience of forest scale use of atrazine.

Location and crop species: Alice Holt Forest, Hampshire; Corsican pine planted winter 1969/70. Bere Forest, Hampshire; Corsican pine planted winter 1970/71. Hursley Forest, Hampshire; Corsican pine planted winter 1968/69. Salisbury Forest (Ministry of Defence) Wiltshire; Austrian pine planted winter 1969/70.

Trial: Atrazine was applied between 22nd and 28th March as a wettable powder at 4.5 kg/ha only and as granules at a nominal 4.5 or 6.7 kg/ha. Lack of experience with the granule distributor and difficulties with the flow of granules meant that actual rates varied a little from those planned. Excess granules were also used to lift the rates applied to some plots to much higher levels than originally planned (9.6 to 10.0 kg/ha). Treatments were applied to plots of about 0.4 ha in a normal forest plantation. Fifty healthy trees, selected to represent the area of each treatment, were marked for assessments. Weed control was assessed in the square metre round each of these trees.

RESULTS

(a) Weed control

Table 2 summarises assessments made in late summer on the 1971 forest experiments (when it was possible to judge whether further weeding would be required during the season).

Table 2

Summary of late summer assessments of weed control in 1971 experiments

Site	Hursley		Neroche		Shipbourne	Kings[3]	
Main grass species	Deschampsia caespitosa		Dactylis glomerata		Dactylis glomerata	Holcus lanatus	
Date of assessment	26/7	17/9	2/8	2/8	8/9	23/7	23/7
Assessment	% cover[1]	score[2]	% cover[1]	score[2]	% cover[1]	% cover[1]	score[2]
No spray	100	1.0	54	1.0	99	100	1.2
March 4 kg	71	2.0	40	2.8	53	85	1.6
4 kg + oil	68	2.0	45	2.5	60	71	2.2
6 kg	50	3.5	34	3.3	33	66	2.4
6 kg + oil	43	4.3	21	3.9	28	50	2.8
May 4 kg	61	2.8	36	3.0	48	93	1.2
4 kg + oil	49	3.8	24	3.6	28	73	2.4
6 kg	49	3.8	16	3.9	13	84	1.8
6 kg + oil	31	5.0	21	4.4	15	66	3.0

Notes: 1 % cover = % live cover of all weeds. Most weeds were grasses but a small percentage of broadleaves were present also. At Neroche, assessments refer to Dactylis glomerata only. 2 Scores: 1 = little control; weeding essential to 5 = excellent control; no weeding required. 3 Rates at Kings were reduced to half; i.e. 2 and 3 kg/ha.

Applications in May gave better control than applications in March at three sites out of four. There was a shorter period between assessment and May applications than March applications, but assessments and reports later in the year confirmed this result and showed that, in general, May applications provided superior persistence.

The addition of non-phytotoxic oil to the spray liquid improved control at most sites. A weed control score of over 3.0 indicates satisfactory control; 4 kg/ha of atrazine alone did not quite achieve this, but when oil was added the May applications of this rate gave satisfactory control. However, 4 kg/ha of atrazine plus oil did not generally give as good control as 6 kg/ha of atrazine alone.

Further confirmation that atrazine can provide excellent control of fine and soft grasses was obtained from the series of user trials in 1972 (see results in Table 3).

Table 3

Summary of weed control scores in 1972 user trials

Site	Alice Holt		Bere		Hursley		Salisbury	
Initial % live cover of fine/soft grasses	80%		80%		60%		80%	
Date of assessment	July	Aug/Sept	July	Aug/Sept	July	Aug/Sept	July	Aug/Sept
No spray	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
W.p. @ 4.5 kg/ha	4.5	4.2	4.7	4.8	4.6	4.5	4.6	4.0
Granules @ 3.8-5.5 kg/ha	4.7	4.7	4.9	4.8	-	-	4.0	3.6
Granules @ 5.7-7.7 kg/ha	4.4	4.6	4.8	4.7	4.4	4.5	4.9	4.9
Granules @ 9.6-10.0 kg/ha	-	-	-	-	4.9	5.0	4.9	5.0

Note: Scoring system: 1 = none, 2 = poor, 3 = marginally acceptable, 4 = good 5 = excellent.

Granular atrazine provided adequate control of fine and soft grasses at all sites even at the lower rates. Inspection notes on all trials reported that control from wettable powder atrazine was better than from the equivalent rate of granular atrazine, but this difference is not as well reflected in Table 3 above.

The following species of grass were well controlled by 4.5 kg/ha of atrazine as a wettable powder or granule wherever they occurred:-

Holcus lanatus, Bromus erectus, Anthoxanthum odoratum, Cynosurus cristatus, Agrostis spp. (including Agrostis tenuis) and Poa spp. (including P. pratensis).

Holcus mollis, D caespitosa and Dactylis glomerata were only controlled adequately by the highest rates of atrazine (6.7 kg/ha and over), and even then not so completely as the fine/soft grasses treated at 4.5 kg/ha.

(b) Tolerance of crop trees

The effect of atrazine treatments on height growth during 1971 in the 1971 forest experiments was generally small (see Table 4).

Table 4

End of first growing season (1971) adjusted mean heights+ (cm) in 1971 forest experiments

Treatment		Site and species						
		Hursley		Neroche	Shipbourne		Kings	
		Western hemlock	Grand fir	Sitka spruce	Scots pine	Red cedar	Corsican pine	Scots pine
No spray		43.5	34.8	43.7	23.3	18.2	17.3	13.4
March	4 kg	43.8	36.4	44.4	24.0	16.2	16.3	13.9
	4 kg + oil	48.0	36.0	40.5	19.9	18.0	17.2	13.0
	6 kg	47.6	35.4	42.7	21.7	19.9	15.9	12.3
	6 kg + oil	45.3	36.6	41.0	22.1	17.2	15.3	13.7
May	4 kg	42.2	36.2	47.1	23.6	16.4	19.9	12.2
	4 kg + oil	41.3	35.2	36.9	21.8	16.8	18.2	11.8
	6 kg	40.7	35.4	43.9	23.1	15.7	16.1	15.2
	6 kg + oil	36.2	35.3	39.5	22.1	15.1	16.7	13.2
Experimental S.E.		1.98	0.69	2.10	0.78	1.74	1.30	1.12
				Retabulation by factors				
No oil		43.6	35.6	44.5 **	23.1 **	17.0	17.0	13.4
oil		42.7	35.8	39.5	21.5	16.8	16.8	12.9
4 kg		43.8	35.9	42.2	22.3	16.8	17.9	12.7
6 kg		42.5	35.4	41.8	22.2	17.0	16.0	13.6
March		46.2 ***	36.1	42.1	21.9	17.8	16.2	13.2
May		40.1	35.3	41.9	22.6	16.0	17.7	13.9
S.E. for 2 factor comparison		0.85	0.29	1.08	0.40	0.92	0.54	0.52

Notes: + "Adjusted heights" are heights weighted for differences in heights at planting.

** Difference significant at P = 0.01 level
*** " " " P = 0.001 level

In the 'no oil' versus 'oil' comparison, the significant differences in Sitka spruce at Neroche may have been partly due to the oil increasing the speed with which atrazine gave control, exposing the trees to damage from a late frost.

Scores on the occurrence of frost damage in this experiment support this hypothesis, although typical atrazine damage symptoms (needle browning) were observed in plots receiving the higher rate of atrazine plus oil. No such explanation can account for similar significant differences occurring in Scots pine at Shipbourne, where no damage symptoms were observed. Western hemlock was reported to be affected (reduced needle length) by the addition of oil to 6 kg/ha of atrazine at Hursley, but this did not produce any significant differences in the 'no oil' versus 'oil' comparison, although the figures suggest that 6 kg/ha atrazine plus oil applied in May has reduced height growth.

The significantly smaller heights of Western hemlock in the plots sprayed in May compared with plots sprayed in March at Hursley is further evidence that the height growth of this species may be reduced by applications of atrazine in the early part of the growing season - April to June (see also Brown, 1970).

The rate of atrazine appeared to have little effect on crop growth, at whichever date it was applied.

Crop survival and health assessments taken during the first growing season after treatment add nothing to the information gained from examining adjusted end-of-first-season heights. The two instances where symptoms of herbicide damage were observed have been mentioned above.

Table 5 gives a summary of the statistically significant differences occurring in adjusted end of 1971 heights in the 1971 tolerance experiment at Alice Holt. Significant differences occurring in comparisons between atrazine treatments are not considered to have invalidated comparisons in the same species between control and the mean of all atrazine treatments together.

Table 5

Species showing statistically significant differences in adjusted end-of-1971 mean heights - 1971 tolerance experiment

Comparison	Site SO	SW	CO	CW
Control v treated:				
C > T	Red cedar*		-	Scots pine*
C < T	-	Beech** Corsican pine** Norway spruce*** Japanese larch*** Douglas fir*** Western hemlock** Grand fir** Red cedar**		
Between treatments				
Rates: 4 > 6	-	-	-	Norway spruce*
4 < 6	-	Corsican pine* Red cedar*	Beech*	
Dates: March > May	-	Norway spruce* Western hemlock* Grand fir**	-	Norway spruce*
March < May	Corsican pine*	-	-	-

Notes: Abbreviations: C = control (hand-weeded); T = mean of all atrazine treatments.
*,**,*** - Differences significant at P = 0.05, 0.01 or 0.001 level respectively.

Where trees on control plots are significantly taller than those on treated plots or where trees given 4 kg/ha are significantly taller than those given 6 kg/ha, atrazine may have depressed height growth. In the four cases occurring in Table 5, only Norway spruce showed any clear symptoms of recognizable atrazine damage, and scores for needle browning and needle loss on this species in August 1971 showed it to be worse affected by 6 kg/ha than 4 kg/ha, and by a May than a March application on both clay sites. Norway spruce appeared undamaged on sandy sites.

It was not possible to analyse 1972 assessments on height in time for this paper, but the data indicates clearly that the three species for which the mean height of control plots was significantly larger than that of treated plots at the end of 1971 will not display these differences at the end of 1972.

Where trees on control plots are significantly smaller than those on treated plots or where trees given 4 kg/ha are significantly smaller than those given 6 kg/ha, the crop may have responded to atrazine or the weed control it has provided. All such instances are on the SW site except one with beech on the CO site. Both SO and SW sites were fertilised during the experiment because they were considered too infertile to grow satisfactory crops. Grass weeds on the SW site responded markedly to these fertiliser applications producing a thick mat of grass, but plots receiving atrazine remained almost free of grass weeds and were invaded by mainly Hypochaeris glabra and Rumex acetosella. There seems no doubt that these significant differences represent a genuine response to weed control. The lack of responses on the SO site suggest that responses to atrazine itself, such as have been reported for triazine herbicides (Gast & Grob, 1964) played little part in these differences.

Significant differences in the March versus May comparison tend to suggest that most species tolerate atrazine less well in May than in March. This was supported by height differences in this comparison in other species (Scots pine and Western hemlock on the SO site, Japanese larch and Douglas fir on the SW site, and Red cedar on the CW site) which did not quite reach significance at the $P = 0.05$ level. In all these cases except one (Western hemlock on the SO site) the trees on May treated plots were still taller than those on control plots. Scores during the 1971 growing season on Norway spruce on the CO and CW sites, Japanese/Hybrid larch on the SO, CO and CW sites, Douglas fir on the CO and CW sites and beech on the CO and CW sites also showed that needle or leaf browning was present to a greater extent on plots treated in May than on plots treated in March. Only Corsican pine (see Table 5), beech on the CW site (adjusted end-of-1971 heights almost significant at $P = 0.05$ level) and Grand fir on the SO site (needle browning score) showed the opposite trend.

There were few differences in survival at the end of 1971 (see Table 6).

Only Norway spruce, hybrid larch and Douglas fir produced significant differences in comparisons suggesting atrazine damage (i.e. $C > T$ and $4 > 6$). Again, comparisons between March and May suggested that May applications were more damaging than March.

The beech in control plots on the SW site was badly damaged by frost compared with those in sprayed plots, presumably because of the presence of grass in the control plots. Therefore, comparisons for beech on this site are unreliable.

Table 6

Species showing statistically significant differences in end of 1971 % survival 1971 tolerance experiment

Comparison	Site			
	SO	SW	CO	CW
Control v treated:				
C > T			Norway spruce*	Norway spruce* Hybrid larch*
C < T		Western hemlock* Beech***	Douglas fir*	
Between treatments				
Rates: 4 > 6	Douglas fir*			Norway spruce***
4 < 6	-	-	-	-
Dates: March > May		Beech**	Norway spruce*** Beech**	Hybrid larch**
March < May	-	-	-	-

DISCUSSION

The results of the 1971 forest experiments show that Deschampsia caespitosa and Dactylis glomerata can be adequately controlled by atrazine alone, provided rates are greater than 4 kg/ha. Previous investigations (Brown, 1970) showed that 4.5 kg/ha failed to provide adequate control of the same species, so it appears that 5 kg/ha or preferably 6 kg/ha should be used when one of these species is the major weed problem. Other coarse grasses may require a similar rate.

Adding a small quantity of non-phytotoxic oil to a spray solution containing only 4 to 5 kg/ha may be an alternative approach. However, if the quantity of oil needs to be 5% of the solution by volume (as tested in these experiments), the cost of the oil may be as great as the additional atrazine required to give satisfactory control but involve slightly higher risk of crop damage (see below).

The success of May applications is interesting. Previous results had shown that most established perennial grasses acquire a resistance to atrazine by June, and suggested that May applications would give less satisfactory control than earlier applications. However, these results confirm May as a suitable month for atrazine applications.

The good control from granular atrazine in the 1972 forest trials confirms that this formulation is suitable for forest grass weed control provided that the major problem is due to species which are fairly sensitive to atrazine (fine and soft grasses). Applications in these trials were made in late March, but successful applications in previous trials have usually been in February or March.

The only indication of damage from atrazine alone in the forest experiments and trials was in the reduced height growth of Western hemlock at Hursley in plots receiving 6 kg/ha of atrazine in May. Although only a few species showed symptoms of damage or a small reduction in growth when oil was included in the spray, especially in May applications, there appears to be little reason to accept this additional risk to the crop if satisfactory results can be obtained with atrazine alone.

The tolerance experiment at Alice Holt confirmed that, generally, atrazine can be applied to most common conifer species up to 6 kg/ha with little or no damage, although the safety of May applications are questionable, particularly at the higher rate of 6 kg/ha. In particular, Norway spruce and Western hemlock seem rather more sensitive than most other species to applications of atrazine in May. The organic matter level on all four sites was lower than would normally be found in the forest soils, and therefore trees on normal forest sites should be less susceptible to atrazine damage than indicated here.

There was little clear and consistent difference between the sites in the tolerance experiment, except for the responses on the sand with weeds site. These responses were unusually large, and should not be taken as typical of responses to weed control on forest sites in Great Britain.

Prescriptions for the use of the wettable powder formulation of atrazine should now be modified to suggest applications from 4 to 6 kg/ha, the lower rates to be used for fine and soft grasses and the higher rates for coarse grasses. Intending users should be warned that applications of the wettable powder formulation at the higher rates after the start of the growing season (April/May) may lead to slight but not serious damage and that such applications should not be made on Norway spruce and Western hemlock. The use of the granular formulation of atrazine at 6 kg/ha may also be recommended for controlling fine and soft grasses only, but until further evidence is available on the efficacy of applications made in April and May, these recommendations should be for February and March applications only.

References

BROWN, R. M. (1970). Atrazine and Ametryne for grass weed control in British Forestry. Proc. 10th Br. Weed Control Conf., 718-726.

GAST, A. and GROB, J. (1964). Triazines in top fruit and viticulture. Proc. 7th British Weed Control Conf. 217-226.

Proc. 11th Br. Weed Control Conf. (1972)

EFFECT OF HERBICIDES WHEN APPLIED TO NARCISSUS AND TULIP PRE AND POST-FLOWERING

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Summary When lenacil, linuron and pyrazone/chlorbufam were applied to narcissus and tulip just pre and post-flowering differences in crop tolerance and weed control were recorded. Lenacil applied at 2 lb a.i./ac to tulip caused crop injury and yield reduction pre and post-flowering. No crop damage or yield reduction occurred when it was applied to narcissus pre and post-flowering. However, weed control was poor, particularly when weeds were present at the time of application and in seasons in which *Veronica* spp. were predominant. The application of linuron at 0.5 lb a.i./ac pre and post-flowering resulted in serious crop injury and yield reduction to both narcissus and tulip. Pyrazone/chlorbufam 2 lb and 4 lb a.i./ac damaged tulip when applied pre-flowering. However the 2 lb a.i./ac rate proved safe when applied post-flowering and the weed control was good. Both rates were safe when applied to narcissus pre and post-flowering and weed control was good.

INTRODUCTION

The application of herbicides pre or just post crop-emergence between December and early February is recommended for weed control in narcissi and tulips. However, the 5 to 6 month period over which herbicides applied at this time have to remain effective, combined with soil disturbance which results from weathering and cultural operations in the crop, i.e. roguing and flower cropping, can often lead to considerable weed growth between late April and early June. This is at the time when narcissi and tulips are increasing in weight and bulb numbers and consequently competition from weeds can result in a serious reduction in bulb yield. Later weed growth does not normally reduce yield and it can usually be removed mechanically before lifting. However, late germinating weeds, notably *Polygonum* spp. which are not easily removed by mechanical means, can cause problems where complete harvesting methods are used. As it was thought that the weed control could be extended by the application of a herbicide later in the growing season, work was started to determine the effects of herbicides on bulb growth and yield when applied just pre and post-flowering.

The herbicides linuron and pyrazone/chlorbufam were selected for their combined contact and residual action and lenacil for its effectiveness against *Polygonum* spp.

This paper reports in full the results obtained with these 3 herbicides between 1968 and 1971 and includes the first year's results which have been summarised (Turquand 1968).

METHOD AND MATERIALS

All experiments were randomised block design with 4 replicates. Plot size was standardised with 200 narcissus and tulip bulbs of uniform size and weight being planted in a flat bed 8 ft long by 3 ft wide.

The bulbs used were from stocks grown on the Experimental Horticulture Station for a number of years. Narcissi were hot water treated at 112°F for 3 hours before planting.

An Oxford Precision Sprayer applying 100 gal/ac of water was used for all herbicides.

Standard herbicide formulations were used throughout.

Pentachlorophenol at 7½ lb a.i./ac was used in December pre-crop emergence to kill germinated weeds and prevent weed germination before the experimental treatments were applied.

The herbicides were applied over the bulb foliage and flowers, no attempt was made to direct the spray onto the soil.

Time of Herbicide Application

Narcissus

	1968	1969	1970	1971
Pre-flowering	26 March	9 April	17 April	23 March
Post-flowering	10 April	29 April	1 May	-

Tulip

	1968	1969	1970
Pre-flowering	22 April	29 April	-
Post-flowering	22 May	27 May	18 May

Pre-flowering treatments were applied to narcissi when the flower buds were at the goose-neck stage and to tulips when the flower buds were out of the foliage but before the petals showed colour.

Post-flowering applications were given to narcissi and tulips after removal of the flower heads, some 6 to 12 days after the full flower date.

Treatments were checked for visual damage and weed growth was assessed by scoring at intervals during the growing season. After lifting, plot weights and the number of bulbs in grades were recorded.

Bulbs from each treatment were forced in the winter after lifting and records of flowering date, percentage marketable and flower quality were taken, since it had been found that forcing conditions sometimes showed residual differences which might pass unnoticed in the field.

RESULTS

Table 1

The effect on yield of lenacil applied just pre and post-flowering to narcissus cv. Fortune and tulip cv. Rose Copland

Year	Rate of Application lb a.i./ac	Time of Application	Narcissus Mean Yield lb/plot	% Weed cover late June	Tulip Mean Yield lb/plot	% Weed cover late June
1968	2.0	Post-flowering	40.5	5*	19.9	20*
	-	Cultivated	40.6	1	21.6	1
	-	Untouched Control	38.8	80	18.4	100
Mean			39.5		18.7	
s.e. of individual means (27 d.f.)			± 0.57		± 0.70	
Least significant difference P = 5%			1.67		2.04	
s.d. as % of mean			2.9		7.5	
1969	2.0	Pre-flowering	28.0	20	12.2	20
	2.0	Post-flowering	27.1	40	16.3	20
	-	Cultivated	26.6	10	20.2	1
	-	Untouched Control	27.4	80	19.8	100
Mean			26.8		17.4	
s.e. of individual means (27 d.f.)			± 0.53		± 0.32	
Least significant difference P = 5%			1.55		0.93	
s.d. as % of mean			3.9		3.6	
1970	2.0	Pre-flowering	27.0	1	-	-
	2.0	Post-flowering	26.9	0*	-	-
	-	Cultivated	26.8	1	-	-
	-	Untouched Control	26.2	100	-	-
Mean			27.2			
s.e. of individual means (27 d.f.)			± 0.47			
Least significant difference P = 5%			1.37			
s.d. as % of mean			3.4			
1971	2.0	Pre-flowering	35.2	10*	-	-
	-	Cultivated	32.8	10	-	-
	-	Untouched Control	33.0	100	-	-
Mean			33.5			
s.e. of individual means (27 d.f.)			± 0.91			
Least significant difference P = 5%			2.64			
s.d. as % of mean			5.4			

*Handweeded early June.

Effect on the Crop

When applied to tulip post-flowering in the dry spring of 1968 no visible damage was observed and no reduction in bulb yield occurred. However, when used in the wetter conditions of 1969 the pre and post-flowering treatments caused visual damage which showed as yellow blotches and streaks on the tulip foliage. This was accompanied by a significant reduction in bulb yield of both treatments. Furthermore, when bulbs from the pre-flowering treatment were forced in 1970 they gave a lower percentage of marketable flowers than the 2 control treatments. It was concluded from these results that lenacil could damage growth and seriously reduce yield of tulips and consequently work was discontinued.

In the 3 seasons that lenacil was applied to narcissi pre and post-flowering no visual damage was noted and no reduction in bulb yield occurred. Nor were there any adverse effects when bulbs were subsequently forced.

Weed Control

In 1968, weeds, chiefly Stellaria media, Veronica spp. and Polygonum spp. had germinated before the post-flowering treatments were applied. These and other weeds not controlled by the lenacil had to be removed by hand at the beginning of June to prevent competition with the bulbs. In 1969 as a result of the cold wet spring, weed growth was negligible until the end of May. However, Veronica spp. grew vigorously in June, particularly on the narcissus post-flowering treatment. Conditions were similar in 1970 when weed growth was slight until the beginning of June. However, weed control was poor on the narcissus post-flowering treatment, the chief weeds being Stellaria media and Polygonum spp. and the treatment had to be hand weeded in the middle of June. Very few weeds were present when the pre-flowering treatment was applied to narcissi in 1971, even so weed control was poor with Stellaria media predominant at the beginning of June when the treatment was hand weeded.

Table 2

The effect on yield of linuron applied just pre and post-flowering to narcissus cv. Fortune and tulip cv. Rose Copland

Year	Rate of Application lb a.i./ac	Time of Application	Narcissus Mean Yield lb/plot	% Weed cover late June	Tulip Mean Yield lb/plot	% Weed cover late June
1968	0.5	Pre-flowering	36.2	20*	15.4	20*
	0.5	Post-flowering	38.9	40*	17.4	40*
	-	Cultivated	40.6	1	21.6	1
	-	Untouched Control	38.8	80	18.4	100
Mean			39.5		18.7	
s.e. of individual means (27 d.f.)			± 0.57		± 0.70	
Least significant difference P = 5%			1.67		2.04	
s.d. as % of mean			2.9		7.5	
1969	0.5	Post-flowering	22.8	1	11.9	20
	-	Cultivated	26.6	10	20.2	1
	-	Untouched Control	27.4	80	19.8	100
Mean			26.8		17.4	
s.e. of individual means (27 d.f.)			± 0.53		± 0.32	
Least significant difference P = 5%			1.55		0.93	
s.d. as % of mean			3.9		3.6	

*Handweeded early June.

Effect on the Crop

When applied to tulip pre-flowering in 1968 both foliage and flowers were severely damaged. Leaves were pale green or yellow and the flower stems were short compared with the control plots. The flowers were bleached or green and did not develop full colour. The yield of the pre-flowering treatment was reduced significantly. The post-flowering treatment did not damage the foliage or reduce bulb yield but when the application was repeated in 1969 severe foliage damage occurred and the bulb yield was reduced significantly.

In 1968 the treatment applied to narcissus pre-flowering caused slight yellowing of the foliage and bulb yield was reduced significantly. When applied post-flowering no visible damage was noted and bulb yield was not reduced. However, when the post-flowering treatment was repeated in the wet season of 1969 the bulb yield was reduced significantly even though no visual symptoms of damage were noted.

These results indicated that linuron was too damaging when applied pre and post-flowering to narcissus and tulip and work was therefore discontinued.

Weed Control

When the treatments were applied pre and post-flowering in 1968 a wide range of small weeds were present, chiefly Stellaria media, Veronica spp. and Polygonum spp. The Veronica spp. and Polygonum spp. continued to grow after the linuron was applied and hand weeding was necessary at the beginning of June. Linuron gave a better weed control after the pre-flowering applications when the weeds were small than when applied post-flowering. In 1969, weed growth was negligible even when the post-flowering treatments were applied, consequently good weed control was maintained until the end of June.

Table 3

The effect on yield of pyrazone/chlorbufam applied just pre and post-flowering to narcissus cv. Fortune and tulip cv. Rose Copland

Year	Rate of Application lb a.i./ac	Time of Application	Narcissus Mean Yield lb/plot	% Weed cover late June	Tulip Mean Yield lb/plot	% Weed cover late June
1968	2.0	Pre-flowering	39.6	1*	17.9	5*
	2.0	Post-flowering	40.3	1*	20.0	20*
	4.0	Pre-flowering	40.0	1	17.1	1
	4.0	Post-flowering	39.6	1	18.4	5
	-	Cultivated	40.6	1	21.6	1
	-	Untouched Control	38.8	80	18.4	100
Mean			39.5		18.7	
s.e. of individual means (27 d.f.)			± 0.57		± 0.70	
Least significant difference P = 5%			1.67		2.04	
s.d. as % of mean			2.9		7.5	
1969	2.0	Pre-flowering	26.7	1	18.8	1
	2.0	Post-flowering	27.1	1	19.4	10
	4.0	Pre-flowering	27.3	1	18.2	0
	4.0	Post-flowering	27.7	1	18.1	10
	-	Cultivated	26.6	10	20.2	1
	-	Untouched Control	27.4	80	19.8	100
Mean			26.8		17.4	
s.e. of individual means (27 d.f.)			± 0.53		± 0.32	
Least significant difference P = 5%			1.55		0.93	
s.d. as % of mean			3.9		3.6	

Contd

*Handweeded early June.

Table 3 Contd

The effect on yield of pyrazone/chlorbufam applied just pre and post-flowering to narcissus cv. Fortune and tulip cv. Rose Copland

Year	Rate of Application lb a.i./ac	Time of Application	Narcissus Mean Yield lb/plot	% Weed cover late June	Tulip Mean Yield lb/plot	% Weed cover late June
1970	2.0	Pre-flowering	27.8	5	-	-
	2.0	Post-flowering	27.8	5	17.5	20
	4.0	Pre-flowering	27.0	1	-	-
	4.0	Post-flowering	27.0	5	16.6	10
	-	Cultivated	26.8	1	17.9	1
	-	Untouched Control	26.2	100	17.6	60
Mean			27.2		17.4	
s.e. of individual means (27 d.f.)			± 0.47		± 0.33	
Least significant difference P = 5%			1.37		0.97	
s.d. as % of mean			3.4		3.8	

*Handweeded early June.

Effect on the Crop

In 1968 both 2 and 4 lb a.i./ac caused visual damage to tulip when applied pre-flowering. This showed as reduced flower stem length, green flower petals and yellow foliage. The leaf damage was more severe at the 4 lb a.i./ac rate where it also caused brown leaf tips. The yield of both treatments was reduced significantly compared with the cultivated control. No visible damage was noted from the post-flowering applications but at 4 lb a.i./ac the yield was reduced significantly compared with the cultivated control.

The pre-flowering treatments gave similar results in 1969 and although the post-flowering applications did not cause visible damage the tulip yield was again reduced at 4 lb a.i./ac.

As adverse effects on growth and yield resulted from pre-flowering treatments in 1968 and 1969 only post-flowering treatments were applied in 1970. The 2 lb a.i./ac rate proved safe for the third season. Although the 4 lb a.i./ac rate did not reduce yield some yellowing of the foliage was noted.

In the three seasons that pyrazone/chlorbufam was applied pre and post-flowering to narcissus no visual damage was noted at either rate and no reduction in bulb yield occurred.

Weed Control

In 1968 although a wide range of weed species were present on all plots by the time the pre-flowering treatments were applied, the weed control was good, particularly at the 4 lb a.i./ac rate. Some large weeds of Polygonum aviculare and Veronica spp. had to be removed from the 2 lb a.i./ac treatments at the beginning of June. The cold, wet spring of 1969 did not encourage weed growth, and weed control was excellent with no obvious differences between the two rates of pyrazone/chlorbufam. Similar results were achieved in 1970.

DISCUSSION

The results showed differences in the tolerance of narcissi and tulips to lenacil, linuron and pyrazone/chlorbufam when applied just pre and post-flowering. Seasonal differences were also observed. Previous work (Turquand 1968) had shown that when applied at the same or higher rates pre or just post crop-emergence the three herbicides were safe.

All three herbicides applied pre-flowering to tulip caused crop damage which showed as pale green or yellow foliage, shortened flower stems or flowers which failed to reach full colour. This damage was accompanied by a significant reduction in bulb yield. It was concluded from these results that lenacil, linuron and pyrazone/chlorbufam could not be applied with safety when the tulip is growing rapidly and the flower stem is elongating before flowering.

Post-flowering treatments gave variable results. In 1968, lenacil and linuron did not cause damage or reduce bulb yield, whereas when applied in the wetter conditions of 1969 both caused foliage damage, and bulb yield was reduced significantly. As the grower is likely to associate crop damage with a reduction in bulb yield it was decided that there was too much risk involved in the post-flowering applications of lenacil and linuron even though the treatments appeared to be safe in the first year (Turquand 1968) and work with lenacil and linuron was therefore discontinued. In the three years that pyrazone/chlorbufam was applied post-flowering the 2 lb a.i./ac rate proved safe throughout.

No crop damage or yield reduction occurred in narcissus in the three years that lenacil at 2 lb a.i./ac and pyrazone/chlorbufam at 2 and 4 lb a.i./ac were applied pre and post-flowering. However, linuron caused crop damage and yield reduction when applied pre-flowering in 1968 and post-flowering in 1969.

As the main object was to ascertain the effect of herbicides on growth and yield of narcissus and tulip, the time of treatment was determined by crop and not weed growth. Weed control depended on crop growth and the susceptibility and size of the weed species present at the time of application. As a result weed control was variable. The best results were achieved when the herbicides were applied pre-flowering when there was less crop growth to interfere with the spray application and weeds, if present, were smaller.

When the results in respect of crop safety and weed control are considered jointly, this series of experiments showed that there is a limit to the herbicides that can be used to control weeds after the recommended times of application.

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References

TURQUAND, E.D. (1968). Weed Control in Bulbs: A Summary of Work at Kirton. Proc. 9th Br. Weed Control Conf., 959-964.

Proc. 11th Br. Weed Control Conf. (1972)

EXPERIMENTS WITH PYRAZONE/CHLORBUFAM ON NARCISSUS

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Summary Pyrazone/chlorbufam was evaluated in two experiments for crop tolerance and for weed control efficiency in narcissus cv. Carlton at various dates of application. On plots kept weed-free throughout the growing season, treatment with single or split applications of 4 kg a.i./ha, made from before crop emergence to the time of full flowering resulted in no adverse effects on crop growth in the field. When selected bulbs were forced, no differences due to the dates of application of pyrazone/chlorbufam were noted, but in one experiment all herbicide treatments reduced flower diameter and stem length compared with a weed-free control treatment. *Galeopsis tetrahit* and *Fumaria officinalis* proved resistant to the herbicide, regardless of date of application, and failure to remove them caused yield reductions and changes in bulb size distribution on several treatments. On unweeded control plots, bulb yields were reduced by 5% in one experiment and 17% in the other due to reductions in bulb size. Adverse effects of weed competition on shoot height were evident during the early stages of forcing. In the second experiment this led to significant reductions in stem lengths and flower size.

INTRODUCTION

Investigations into the relationship between weeds and narcissus (Lawson 1971) have shown that the two are most likely to compete during the period of maximum bulb growth. In two experiments at Mylnefield in which the natural spring-germinating weed flora was allowed to develop on plots of narcissus Carlton, the weights of bulbs lifted at the end of the first growing season were 10% and 15% lower respectively than on handweeded control plots. Competition between crop and weeds occurred mainly during June and early July and the weeds also presented an obstacle to efficient harvesting. Control of these weeds at Mylnefield by the restricted range of herbicide treatments hitherto available has not proved to be reliable. Preliminary data from Kirton E.H.S. (Turquand, 1968) indicated that a commercial formulation of pyrazone and chlorbufam* controlled weeds both by contact and by residual activity, with a wide margin of crop safety. This paper reports two experiments in which the formulation was evaluated on soils and weed flora representative of the East of Scotland.

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* as contained in the commercial formulation "Alicep"

METHODS AND MATERIALS

Both experiments were situated at Mylnefield on a medium sandy clay loam soil with an organic matter content (as determined by loss on ignition) of 8%. The crop was grown in ridged rows (70 cm apart), with plots consisting of 2 rows for recording purposes plus shared guard rows. Graded bulbs of narcissus Carlton (12-14 cm circumference) were planted 10 cm apart by hand. Treatments were arranged in a split plot randomised block design with 4 replicates. Individual sub-plots were 2.4 m long by 2.1 m wide and contained 50 bulbs for recording purposes.

Autumn germinating weeds were killed by an overall application of paraquat before crop emergence, in order that the effects of pyrazone/chlorbufam might be assessed solely on the weed flora germinating after crop emergence. Herbicide treatments were applied by Oxford Precision Sprayer in a water volume of 730 l/ha.

Main treatment	Pyrazone/chlorbufam kg a.i./ha	Sub treatment
A Control - no herbicide	-	a) kept weed-free by hand
B Pre-emergence crop	4	b) no supplementary weeding
C Post-emergence crop	4	
D At full flowering	4	
E Pre-emergence crop+	2+	
at full flowering	2	

N.B. The commercial formulation contains 25% pyrazone and 20% chlorbufam wt/wt.

Regular visual assessments of ground cover by weeds and of shading of crop foliage by weeds were made on the weedy sub-plots throughout the growing season. At crop harvest, the fresh weight of weeds removed from the weedy sub-plots was also recorded.

Records were taken of flower and stem size and mean date of flowering of the crop. At harvest, plants were lifted from an area corresponding to 44 planted bulbs per sub-plot and weighed before and after grading.

Thirty bulbs were selected from each of the weed-free sub-plots and from the unweeded control sub-plots (twenty of 10-12 cm size, ten of 12-14 cm size) and forced in the glasshouse during the following winter. Records were taken of flower production and quality. In the second experiment the blooms were graded as follows:-

Grade I - stems >35cm long and flowers >9cm diameter.

Grade II - stems 25-35cm, flowers >9cm <u>or</u> stems >35cm, flowers 7½-9cm.

Grade III - All other blooms.

RESULTS

Expt. I (1968-70)

The crop was planted on 16 September 1968, and paraquat was applied to the autumn weed flora on 12th December. Herbicide treatment was applied on 13th December (pre-emergence), on 2nd April 1969 (crop 2½-10 cm high) and 12th May (full flower). All treatments but the last were applied to bare soil. By 12th May, spring weeds on untreated plots were mainly in the cotyledon - 2 true leaf stage, although

Table I

Expt. I. Crop and weed harvest records (July 1969)

Treatment	Fresh wt. (kg/plot)			No. bulbs /plot	% by number in grades (cm)		
	Foliage	Bulbs	Weeds		0–10	10–16	16–20
A weed-free	2.83	5.72	-	75	10.3	76.6	13.1
weedy	2.73	5.41	4.30	75	15.4	74.6	10.0
B weed-free	2.89	5.76	-	77	9.3	81.1	9.6
weedy	2.65	5.38	3.49	72	12.6	75.1	12.3
C weed-free	2.85	5.64	-	74	12.1	73.6	14.3
weedy	2.55	5.31	2.55	78	19.3	73.2	7.4
D weed-free	2.91	5.75	-	74	11.5	74.3	14.3
weedy	2.69	5.47	2.47	80	14.1	77.4	8.5
E weed-free	3.00	5.67	-	78	13.3	76.6	10.1
weedy	2.82	5.57	3.02	80	17.8	73.1	9.1
S.E. mean ± i)	0.119	0.126	0.441	2.4	2.01	1.84	1.57
S.E. mean ± ii)	0.117	0.117	-	2.0	1.87	1.80	1.68
All weed-free	2.90	5.71	-	76	11.3	76.4	12.3
All weedy	2.69	5.43	-	77	15.9	74.7	9.4
F value for weed status	*	**	NS	NS	**	NS	*

i) for use in comparisons of weed status within main treatments
ii) for use in other comparisons

Table II

Expt. I. Crop forcing records (February 1970)

Treatment	Average shoot height (cm)		Total no. flowers picked	Mean flowering date (days after Feb.18)	Average stem length (cm)	Average corona diam. (cm)	% stems lengths > 35 cm
	Feb.2	Feb.13					
A weed-free	5.5	15.5	36	9.0	36.9	4.0	70
B weed-free	5.0	15.3	37	8.3	35.5	3.9	65
C weed-free	7.3	17.3	37	7.0	36.7	4.9	63
D weed-free	6.0	16.3	34	8.1	37.9	3.9	74
E weed-free	6.0	16.8	36	8.3	36.4	3.7	60
A_b weedy	4.5	12.3	37	9.5	34.4	4.0	62
S.E. mean ±	0.58	1.39	2.1	0.71	1.33	0.35	8.8
Sig. of effects							
A_b v. Rest	*	*	NS	NS	NS	NS	NS
A v. B-E	NS	NS	NS	NS	NS	NS	NS

*, ** significant at the 5 & 1% levels respectively

some seedlings of *Galeopsis tetrahit* - the major weed species - were up to 5 cm high. Other weed species included *Stellaria media*, *Poa annua* and *Capsella bursa-pastoris*. *G. tetrahit* was unaffected by pre-emergence treatment and only slightly scorched by post-emergence treatment. In every instance, regardless of date of application, herbicide treatment gave excellent control of the rest of the weed flora.

Ground cover by weeds reached 15-20% on herbicide-treated plots by 17th June and 40-55% by 18th July. Comparable data for untreated plots were 25% and 70% respectively. Overhead shading of crop foliage was first recorded on 9th June and by 18th July was assessed at 30-50% on treated plots and 70% on untreated plots. Fresh weights of weeds lifted from the weedy sub-plots at crop harvest ranged from 2.47 kg/plot with the single herbicide treatment made in May to 4.30 kg/plot on the unweeded control treatment, but differences between treatments were not statistically significant (Table I).

The pre-flowering treatments caused no malformation or discoloration of foliage or flowers in 1969 and did not affect stem length or date of flowering. Treatment at either rate during flowering had no visible effect on the crop, which was harvested on 22nd July 1969. There were no significant effects of herbicide treatment on any aspect of crop records taken on weed-free sub-plots either at lifting or after grading, compared with the control treatment (Table I). The presence of weeds reduced yields of bulbs and foliage on all weedy sub-plots regardless of main treatment. No significant interactions between herbicide treatment and weed status were found. Overall comparison of weedy and weed-free treatment means shows significant reductions, due to weeds, in foliage and bulb weights lifted at harvest. A significant decrease in the percentage by number of bulbs in the largest size grade (16-20cm), was balanced by an increase in the percentage by number in the smallest size grade (0-10cm), although numbers of bulbs graded per plot were not affected.

Forcing records (Table II) show no differences between weed-free herbicide treatments and the weed-free control treatment in any aspect of crop growth. Bulbs from weedy control plots came through later than the rest and average shoot height was for some time less on these plots. However, by the time flower picking commenced these effects had largely disappeared and no significant effects of treatment were recorded.

Expt. II (1969-71)

The crop was planted on 16th September 1969, and paraquat applied to the autumn-germinating weed flora on 5th February 1970. Herbicide treatment was applied on 12th December (pre-emergence) on 25th March (crop 2½-10cm high) and 12th May (full flower). All treatments except the last were applied to bare soil. The last treatment was made when the weed flora on hitherto untreated plots was in the cotyledon - 2 true leaf stage. The flora on these plots consisted mainly of *Fumaria officinalis*, *Matricaria* spp, *Papaver rhoeas* and *Polygonum aviculare*.

Both crop and weeds emerged much later than is normal at Mylnefield but thereafter grew rapidly. Treatments with pyrazone/chlorbufam had very little effect on *F. officinalis* regardless of date or rate of application. Other weed species were well controlled with the exception of *P. rhoeas* on plots treated in December. *F. officinalis* spread to fill gaps in the crop and weed cover on herbicide-treated plots, resulting in increases in weed scores of from 7-14% ground cover on 8th June to 53-76% by 21st July. Comparable figures for untreated plots were 18% and 80% respectively. By the latter date, scores for crop foliage shaded by weeds were 18-43% on herbicide-treated plots and 45% on untreated plots. Fresh weight of weeds removed at crop harvest ranged from 6.31 kg on plots treated in March to 8.45 kg on untreated plots but differences between treatments were not statistically significant (Table III).

Table III

Expt. II. Crop and weed harvest records (August 1970)

Treatment	Fresh wt (kg/plot) Foliage	Bulbs	Weeds	No. bulbs /plot	% by number in grades (cm) 0–10	10–16	16–20
A weed-free	0.76	5.36	–	90	21.8	61.7	16.5
weedy	0.40	4.46	8.49	80	35.5	53.3	11.2
B weed-free	0.70	5.38	–	92	26.6	57.2	16.2
weedy	0.37	4.61	7.85	86	32.7	55.7	11.6
C weed-free	0.61	5.04	–	84	21.8	61.4	16.8
weedy	0.54	5.09	6.31	93	28.6	61.6	9.8
D weed-free	0.70	5.29	–	96	30.0	57.8	12.3
weedy	0.49	4.69	7.01	87	31.5	57.4	11.2
E weed-free	0.63	4.82	–	84	21.9	62.1	16.0
weedy	0.57	4.99	6.44	86	28.2	56.0	15.8
S.E. mean ± i)	0.060	0.236	0.754	3.5	2.55	2.77	2.19
S.E. mean ± ii)	0.058	0.207	–	3.1	2.52	2.80	2.37
All weed-free	0.68	5.18	–	89	24.4	60.0	15.6
All weedy	0.48	4.76	–	86	31.3	56.8	11.9
F value for weed status	***	*	NS	NS	***	NS	**

i) for use in comparisons of weed status within main treatments
ii) for use in other comparisons

Table IV

Expt. II. Crop forcing records (February 1971)

Treatment	Total no. flowers picked	Mean flowering date (days after Feb.4)	Average stem lengths (cm)	% stem lengths > 35 cm	Average flower diam. (cm)	% flowers diam. > 9 cm	% blooms Grades I	II	III
A weed-free	29	10.5	39.3	91	9.2	65	62	30	8
B weed-free	32	12.2	38.9	78	8.9	49	44	40	16
C weed-free	32	12.4	37.8	75	8.7	44	39	41	20
D weed-free	32	10.5	37.1	75	9.0	56	42	43	15
E weed-free	31	11.3	38.2	74	8.9	53	47	34	19
A_b weedy	29	13.1	36.2	62	8.6	34	26	39	35
S.E. mean ±	3.4	0.62	0.83	5.7	0.09	4.6	4.9	3.8	5.9
Sig. of effects									
A_b v. Rest	NS	*	*	*	**	**	**	NS	**
A^b v. B–E	NS	NS	NS	*	**	*	**	*	NS

*, **, *** significant at the 5, 1 & 0.1% levels respectively

None of the treatments had any effect on early crop growth or flower production in 1970. Crop and weeds were harvested on August 6th, 1970. There were no significant effects of herbicide treatment on any aspect of crop records taken on weed-free sub-plots either at lifting or after grading, compared with the weed-free control treatment (Table III). The presence of weeds reduced yields of foliage on all weedy sub-plots regardless of main treatment although this may have been a result of the earlier senescence on these plots as well as of any effect on leaf size. Significant reductions in bulb yield were found on weedy control sub-plots and those treated on 12th December, compared with equivalent weed-free treatments. No significant interactions between herbicide treatment and weed status were found. Overall comparison of weedy and weed-free treatment means shows significant reductions in foliage and bulb weights lifted, in percentage bulbs by number in the largest size grade and a corresponding increase in the percentage by number in the smallest size grade (Table III). Numbers of graded bulbs per plot were unaffected by treatment.

Forcing records showed no significant differences between the individual weed-free herbicide treatments, but as a group, they produced significantly smaller flowers, and fewer stems >35 cm long than did the weed-free control treatment (Table IV). When the picked blooms were graded to examine the overall result of these effects, it was found that significantly fewer flowers classed as Grade I were obtained from herbicide-treated weed-free plots than from untreated weed-free plots, regardless of date of treatment. Herbicide treatment did not significantly affect mean flowering date or mean stem length. Bulb foliage on weedy control plots was shorter than those on weed-free plots, at all stages up to and during flowering, giving a significant reduction in stem length at picking. Other significant effects of weediness were delayed flowering date and smaller mean flower diameters which contributed to a marked reduction in Grade I blooms. Flower numbers were not affected by any experimental treatment.

DISCUSSION

Crop tolerance

The lack of adverse effect of herbicide treatment on crop growth and development in the field agrees with later reports of trials on silt soils at Kirton (MAFF, 1970; MAFF, 1972) where approximately equivalent rates were applied ($2\frac{1}{4}$ & $4\frac{1}{2}$ kg a.i./ha) over a range of stages of growth of cvs. Golden Harvest & Fortune. In particular, the safety of the treatment applied during flowering offers considerable promise for "top-up" weed control, provided resistant weed species are not present. Although the quality standards used in these experiments to assess forced blooms may have been more exacting than those normally used in commercial practice, the adverse effects of herbicide treatment on forcing bulbs in the second experiment merit further investigation.

Weed control

Neither G. tetrahit nor F. officinalis were effectively controlled by any herbicide treatment, regardless of date of application. Since both these species are major weeds of arable soils in Eastern Scotland, their resistance to pyrazone/chlorbufam severely limits the potential value of the formulation, by itself, for season-long weed control. December application failed to control P. rhoeas, but otherwise there was little to choose between pre- and post-emergence treatments or the single and split applications. All other weed species were effectively controlled throughout the experiments. Since higher dosages have been reported to cause occasional crop injury in the field (MAFF, 1970) the best methods of utilizing the contact/residual activity of pyrazone/chlorbufam and the wide range of safe stages of crop growth at which it may be used may be in herbicide mixtures or as a supplementary treatment following the use of a pre-emergence residual herbicide. Mixtures and programmes involving lenacil, linuron and propachlor have shown promise in investigations at Kirton (MAFF, 1972). It is possible, however, that other combinations may be necessary to suit the weed flora of the bulb growing areas of Scotland, since lenacil has not proved effective against G. tetrahit and the other two herbicides do not control F. officinalis.

Weed competition

These results confirm previous reports that untreated spring weeds can adversely affect the growth and yield of bulbs during the first growing season after planting (Lawson, 1971). The 5% reduction in weight of bulbs lifted in Expt. I was less than might have been expected from the size and vigour of the weed population, but the reduction of 17% in Expt. II was more typical of previous results. Yield differences were due to smaller bulbs on weedy plots, as shown by differences in the percentages of bulbs in the large and small size grades.

Most of the herbicide treatments reduced the weed population considerably compared with that on the untreated plots, but both major resistant weed species were able to exploit the space available and to shade the crop foliage. As a result, some aspect of crop growth in the field was affected by weeds on almost every plot. Yield reductions due to one or two resistant weed species on herbicide-treated plots were also reported by Wood & Howick (1958). In addition, resistant weeds can make efficient harvesting difficult. Possibly more important, however, than either of these were the effects on the forcing characteristics of graded bulbs at Mylnefield. This was only temporary in Expt. I but permanent and of severe injury to bloom quality in Expt. II. Turquand (1966) has also reported adverse effects of weediness on forcing quality of narcissus following a small reduction in bulb yield. This aspect is worth further investigation, to find out to what extent the removal of weeds resistant to herbicide treatments is justified from the point of view of the subsequent treatment of the harvested crop. It may be that a much higher level of weed control is required in crops due to be lifted for forcing than would be acceptable purely from the point of view of bulb yield and ease of harvesting.

References

LAWSON, H.M. (1971). Weed competition in narcissus crops. Proc. 1st International Symposium on flowerbulbs. Noordwijk/Lisse 1970, 300-304.

MINISTRY OF AGRICULTURE, FISHERIES & FOOD (1970). Rep. Kirton Expl. Hort. Stn. for 1968, 6-29.

MINISTRY OF AGRICULTURE, FISHERIES & FOOD (1972). Rep. Kirton Expl. Hort. Stn. for 1970, 7-26.

TURQUAND, E.D. (1966). Linuron as a herbicide on narcissus and tulip. Proc. 8th Br. Weed Control Conf. (1966) 110-116.

TURQUAND, E.D. (1968). Personal communication.

WOOD, J. and HOWICK, S.J. (1958). Experiments with herbicides on beds of narcissus and tulips 1955-58. Proc. 4th Br. Weed Control Conf. 1958, 112-115.

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EXPERIMENTS ON THE USE OF TERBACIL ON NURSERY STOCKS

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Summary In trials carried out in 1970 and 1971 terbacil was applied at doses of 0.75 to 2.0 lb/ac to a range of ornamental trees and shrubs growing on a medium to heavy loam soil. Many of the species tested showed a high degree of tolerance to terbacil, which proved very successful against *Agropyron repens* (couchgrass) and many commonly occurring annual weeds. However, some damage did occur, especially to *Berberis* and *Cistus* and golden and yellow conifers showed browning within three months of treatment.

INTRODUCTION

Terbacil has been used with success for the control of *Agropyron repens* in established orchards (1), established asparagus plantations (2) and in strawberries (3). It also gives good control of annual weeds, *Rumex* spp. (docks) and checks other broad-leaved weeds. Its use is especially valuable in view of the danger of buildup of weed populations resistant to simazine which has now been used as a routine measure on ornamental crops for a number of years. However, the failure of simazine to control *A. repens* and many broad-leaved perennials has resulted in these weeds becoming a more acute problem.

METHODS AND MATERIALS

Trials were carried out in 1970 and 1971 at Kinsealy and St. Annes, Co. Dublin on medium to heavy clay loams containing 25-30% clay and 4-7% organic matter. Treatments were applied as an overall spray using a knapsack sprayer at 30 lb/in^2 pressure. Where cuttings were tested each treatment was replicated four times and each plot contained 15 species. The deciduous cuttings were planted 3-6 in. deep according to the size of the cutting, and the evergreen subjects 3 in. deep. Established plants were planted 1-2 ft apart in permanent positions and one year old cuttings were lined out for growing on (Tables 1, 2, 3). Established plants were 15-18 in. in height and had been planted for at least two years.

Two assessments of plant damage were made, the first three weeks after spraying and the second six months later. A score system of 0-10 was employed for each assessment and the scores relate to 'susceptibility' in the tables as follows:-

0 (R) - no visible damage or affect on growth
1-4 (MR) - slight to moderate chlorosis in older leaves, new growth unaffected
5-9 (MS) - overall moderate to severe chlorosis and stunted growth
10 (S) - total kill

Only results referring to crop susceptibility are presented in this paper.

RESULTS

Tables 1 to 4 summarise the results of these preliminary trials on the tolerance of ornamental trees and shrubs to terbacil. The majority of established plants were unaffected by the herbicide (Table 1). Younger plants (Tables 2 and 3) showed less tolerance but in most cases the check to growth and leaf chlorosis was only temporary. Berberis and Cistus species were, however, very susceptible and many plants on these plots were killed. Deeply planted cuttings were tolerant of terbacil at 1.5 lb/ac except for Populus alba which was damaged at this dose. The degree of damage was similar in all replications except in the case of the shrub Atriplex halimus where damage caused by a dose of 0.75 lb/ac was variable though never severe.

Because of the large number of species tested the results are presented in tabular form.

Table 1

Susceptibility of established plants to terbacil

Species	Treatment lb/ac	Susceptibility
Amelenchier canadensis	1.5	R
Aucuba japonica	1.5	MR
Berberis darwinii	1.5	S
Berberis thungbergii x ottawensis superba	1.5	S
Caryopteris clandonensis	1.5	R
Ceratostigma willmottianum	1.5	R
Chamaecyparis lawsoniana 'Allumii'	1.5	R
" " 'Aurea'	1.5	S
" " 'Brilliantissima'	1.0	R
" " 'Drummondii'	1.0	R
" " 'Ellwoodii'	1.0	R
" " 'Glauca'	1.5	R
" " 'Lutea Smithii'	1.5	MS
" " 'Milfordiensis'	1.0	MS
" " 'Patula'	1.5	R
" " 'Pottenii'	1.0	R
" " 'Stewartii'	1.5	R
" obtusa 'Crippsii'	1.0	MS
Cotoneaster dammeri var. radicans	1.0	MS
" " 'Skogsholm'	1.0	S
" horizontalis 'Variegatus'	1.0	MR
Cytisus x kewensis	1.0	R
Diervilla florida 'Variegata'	1.0	S
Elaeagnus pungens 'Maculata'	1.5	R
Genista hispanica	1.0	R
Ilex aquifolium 'Argenteo marginata'	1.5	R
" " 'Madame Briot'	1.0	R
Juniperus chinensis pfitzeriana 'Aurea'	1.0	R
" " 'Blaauw'	1.0	R
" " 'Stricta'	1.0	R
" " plumosa 'Aurea'	1.0	R
" virginiana 'Burkii'	1.0	R
Magnolia stellata	1.0	MR
Malus sargentii	1.0	R

Table 1 cont.

Species	Treatment lb/ac	Susceptibility
Olearia traversii	1.5	R
Phormium tenax	1.0	R
Sorbus xanthocarpa	1.5	R
Syringa 'Etna'	1.0	MR
" 'General Pershing'	1.0	MR
" 'Hugo de Vries'	1.0	MR
" 'Mar. Foch'	1.0	MR
" 'Mme. F. Stepman'	1.0	MR
" 'Miss E. Willmott'	1.0	MR
" 'Michel Buchner'	1.0	MR
" 'Mrs. E. Harding'	1.0	MR
" 'Night'	1.0	MR
" 'Oliver de Serres'	1.0	MR
" 'Paul Deschanel'	1.0	MR
Viburnum bodnantense	1.0	R
" burkwoodii	1.0	R
" x carlcephalum	1.0	MR
" carlesii	1.0	MR
" fragrans	1.0	S
" x hillieri	1.0	MR
" x juddii	1.0	MR
" opulus	1.0	R
" 'Park Farm Hybrid'	1.0	MR
" tinus	1.0	MR

Table 2

Susceptibility of 'liners' to terbacil

Species	Treatment lb/ac	Susceptibility
Abelia grandiflora	1.0	MS
" schumanii	1.0	S
Berberis 'Barbarrossa'	1.0	S
" 'Buchaneer'	1.0	S
" darwinii	1.0	S
" 'Pirate King'	1.0	S
" verruculosa	1.0	S
Ceanothus 'Gloire de Versailles'	1.0	MS
" 'Henri Defosse'	1.0	MR
" 'Indigo'	1.0	MR
Cistus 'Silver Pink'	1.0	S
" 'Sunset'	1.0	S
Itea illicifolia	1.0	R
Kolkwitzia amabilis	1.0	S
Olearia forsteri	1.0	R
" macrodanta	1.0	R
" traversii	1.0	R
Potentilla arbuscula	1.0	R
" fruticosa 'Beesii'	1.0	R
" " 'Klondyke'	1.0	R

Table 2 cont.

Species	Treatment lb/ac	Susceptibility
Potentilla fruticosa 'Snowflake'	1.0	R
" " 'Tangerine'	1.0	R
Prunus laurocerasus 'Otto Luyken'	1.0	R
Pyracantha coccinea 'Kasan'	1.0	R
Santolina chamaecyparissus	1.0	R
Senecio compactus	1.0	R
" elaeagnifolius 'Buchanani'	1.0	S
" greyii	1.0	R
Skimmia japonica	1.0	MR
" " 'Foremanii'	1.0	MR
Tamarix pentandra	1.0	MS
Viburnum davidii	1.0	MR
" tomentosum 'Lanarth'	1.0	S

Table 3

Species	Treatment lb/ac	Susceptibility
Aucuba japonica	1.0	MS
Berberis irwinii 'Corallina Compacta'	1.0	MR
" stenophylla 'Gracilis Nana'	1.0	R
Caryopteris clandonensis	1.0	MR
Ceanothus 'Gloire de Versailles'	1.5	MR
Cotoneaster congestus	1.0	MS
" 'Little Gem'	1.0	MS
Deutzia scabra	1.0	MR
" " 'Pride of Rochester'	1.0	MS
Euonymus japonicus 'Microphyllus Variegatus'	1.0	MS
" radicans	1.0	MS
Gingko biloba	1.0	MS
Gleditsia triacanthos	1.0	MS
Philadelphus 'Bouquet Blanc'	1.0	MR
" 'Burkwoodii'	1.0	MS
" 'Favourite'	1.0	MR
Prunus cerasifera 'Vesuvius'	1.0	MR
" illicifolia var. integrifolia	1.0	MR
Thuja occidentalis 'Boothii'	1.0	R
" " 'Fastigiata'	1.0	R
" " 'Globosa'	1.0	R
" " 'Lutea'	1.0	MS
" " 'Robusta'	1.0	R
" " 'Rosenthalii'	1.0	R
" " 'Spiralis'	1.0	R
" " 'Vervaeneana'	1.0	R
" " 'Woodwardii'	1.0	R
" plicata 'Zebrina'	1.0	MS
Ulmus hollandica	1.0	R

Table 4

Susceptibility of unrooted cuttings to terbacil

Species	Treatment lb/ac	Susceptibility
Atriplex halimus	0.75	MR
" "	1.5	MS
Cornus stolonifera	0.75	R
" "	1.5	R
" 'Flaviramea'	0.75	MR
" stolonifera 'Flaviramea'	1.5	MR
Griselinia littoralis	0.75	R
" "	1.5	R
Hebe elliptica	0.75	R
" "	1.5	R
Lycium halimifolium	0.75	R
" "	1.5	R
Platanus acerifolia	0.75	R
" "	1.5	R
Populus alba	0.75	S
" "	1.5	S
Populus nigra 'Italica'	0.75	MR
" " "	1.5	MR
Populus robusta	0.75	R
" "	1.5	R
Prunus cerasifera 'Pissardii'	0.75	MS
" " "	1.5	MS
" laurocerasus	0.75	R
" "	1.5	R
Rosa caniana	0.5	R
" "	1.0	R
" "	1.5	R
" "	2.0	R
Rosa rugosa	0.5	R
" "	1.0	R
" "	1.5	R
" "	2.0	R
Salix alba 'Tristis'	0.75	MR
" " "	1.5	MR
" daphnoides	0.75	MR
" "	1.5	MR
" matsudana 'Tortuosa'	0.75	R
" " "	1.5	MR
Symphoricarpus chenaultii	0.75	R
" "	1.5	MR

DISCUSSION

These results indicate that many species of woody ornamentals have a useful degree of tolerance to terbacil when grown on a medium to heavy loam soil. Deeply planted cuttings of many species are similarly tolerant but smaller cuttings and newly rooted plants are sometimes damage.

Terbacil proved very successful against A. repens and may commonly occurring annual weeds e.g. Senecio vulgaris (groundsel), Stellaria media (chickweed), Sonchus asper (annual sowthistle) and Polygonum persicaria (redshank). Its main defects are that the margin of safety appears to be small and its long persistence in the soil will handicap its integration into nursery practice. Nevertheless, in view of its outstanding herbicidal properties and the difficulties of controlling A. repens by other chemical or cultural means, it seems likely that terbacil in low doses will find a place in nurseries where experience has already been obtained in the accurate application of herbicides.

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References

O'KENNEDY, N.D. and MCDONNELL, P. F. (1969) Chemical Weed Control in Orchards. Hort. Res. Rep. Agric. Institute.

FRYER, J. D. and MAKEPEACE, R. J. (Eds.) (1970) Weed Control Handbook 6th Ed. Blackwell Scientific Publications, Oxford

RATH, N. Control of couch grass in strawberries. Tech. Bull. Hort. Series, Agric. Institute, Index 3, 2-71.

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LENACIL AS A HERBICIDE IN AMENITY HORTICULTURE

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Summary Trials and commercial usage over a four year period have shown lenacil to be safe to established herbaceous and woody ornamentals. Trials have also shown lenacil to be safe to a wide range of newly planted herbaceous subjects. Some newly planted herbaceous subjects however, have shown symptoms of phytotoxicity following applications of lenacil particularly when heavy rain fell soon after application.

INTRODUCTION

As a result of rising costs of labour, local authorities, nurserymen and others concerned with the upkeep of amenity plantings have recently tended to rely more heavily on herbicides for weed control. The main problem facing such potential users has been the lack of information regarding the safety of herbicides to a large range of ornamental subjects.

Simazine which has been widely used in amenity horticulture can be damaging to a range of subjects. In trials carried out by Messrs Blooms of Bressingham (Bateman 1971) 50% of newly planted subjects treated with simazine were damaged, the comparative figure for lenacil was 5%.

The herbicidal properties of lenacil are well documented (Marks 1966) and initial Pan Britannica Industries trials in 1968 indicated that lenacil could be safely used on a range of newly planted subjects.

Subsequently trials with lenacil have been undertaken by Pan Britannica Industries, nurserymen, local authorities, colleges and the National Agricultural Advisory Service and Agricultural Development and Advisory Service. This paper summarises results obtained in trials conducted by some of the above organisations and individuals, regarding the safety of lenacil to ornamental subjects of a wide range of genera.

METHOD AND MATERIALS

Lenacil was applied as an 80% wettable powder at between 1.6 lb a.i. and 4 lb a.i. per acre as an overall spray to newly planted subjects within 2 weeks of planting.

Subjects were inspected for possible damage at between six and ten weeks following the application of lenacil.

In commercial usage in established amenity plantings lenacil has been applied in conjunction with paraquat/diquat at 7-14 ozs per acre to control established weeds.

Table 1

Location	Rate a.i. per acre lenacil	Soil Type	Time Elapsing between planting and application
Various	1.6-2.4 lb	Various	up to 2 weeks
Guildford	2.4 lb	Sandy loam	2 days
Basildon	2.0 lb	Clay loam	established plants

RESULTS

Location - various

Application of lenacil to newly planted herbaceous subjects

Herbaceous subjects of the following genera appear tolerant to lenacil applied within two weeks of planting, which in most cases was in spring/early summer.

Table 2

Acanthus	Cimicifuga	Hosta	Platycodon
Achillea	Coreopsis	Iris	Polygonum
Aconitum	Convollaria	Kniphofia	Polemonium
Adenophora	Crambe	Lactuca	Potentilla
Alchemilla	Crinum	Lamium	Prunella
Allium	Cynara	Lavandula	Pulmonaria
Alstroemeria	Cynoglossom	Liatris	Pyrethrum
Alyssum	Dahlia	Ligularia	Ranunculus
Anaphalis	Delphinium	Limonium	Romneya
Anemone	Dianthus	Linum	Rudbeckia
Anthemis	Doronicum	Lithospermum	Salvia
Aquilegia	Echinops	Lobelia	Saponaria
Armeria	Epimedium	Lychnis	Saxifraga
Asphodelus	Erigeron	Lysimachia	Scabiosa
Aster	Eryngium	Lythrum	Sedum
Astrantia	Euphorbia	Macleaya	Sempervivum
Avena	Festuca	Malva	Sidalcea
Baptisia	Galega	Molinia	Sisyrinchium
Bergenia	Geranium	Monarda	Solidago
Betonia	Geum	Nepeta	Solidaster
Bocconia	Gypsophila	Oenothera	Stokesia
Buphthalmum	Helenium	Paeonia	Symphytum
Callirhoe	Helianthus	Papaver	Tradescantia
Catananche	Heliopsis	Pennistetum	Trollius
Campanula	Helleborus	Penstemon	Verbascum
Chrysanthemum	Hemerocallis	Physalis	Veronica

The following subjects have shown signs of phytotoxicity at some sites, but the effects were not normally severe, and plants recovered.

Achillea 'moonshine'	Centaurea dealbata	Oenothera sp.
Agapanthus africanus	Dicentra eximia	Primula polyanthus
Anchusa 'Opal'	Dictamnus sp.	Pyrethrum 'Brenda'
Artemisia 'Silver Queen'	Digitalis sp.	Stachys macrantha
Astilbe sp.	Dimorphotheca sp.	Thalictrum rocquebrunianum
Aubrietia sp.	Heuchera sp.	Thalictrum diplerocarpum
Brunnera sp.	Holcus mollis	Tiarella sp.

Location - Guildford

Effects of lenacil on newly planted ground cover subjects

At this site heavy rain fell within 1 week of planting. None of the following showed symptoms of phytotoxicity.

Table 3

Ajuga reptens 'atropurpurea'	Juniperus chinensis 'Pfitzeriana'
Alchemilla mollis	Juniperus communis
Bergenia cordifolia	Juniperus conferta
Calluna vulgaris 'Barnett Anley'	Lamium maculatum
Carex morrowii 'variegata'	Lonicera acuminate
Cotoneaster praecox	Lonicera japonica
Cynoglossum grande	Luzula sylvatica 'marginata'
Epimedium pinnatum	Mahonia aquifolium
Erica darleyensis 'Darley Dale'	Pachysandra terminalis
Euonymus fortunei 'Hogs Back Clone'	Pinus mughus
Festuca crassifolia	Polygonum bistorta 'superbum'
Galtheria shala	Potentilla alba
Genista saggitalis	Potentilla fruticosa 'Elizabeth'
Geranium endresii 'A. T. Johnson'	Potentilla russeliana 'Gibsons Scarlet'
Geranium rectum 'album'	Prunus laurocerasus 'Otto Luyken'
Hebe subalpina	Sarcococca humilis
Hedera canariensis 'Gloire de Marengo'	Spiraea nipponica
Hedera colchica	Stachys olympica 'Silver Carpet'
Hedera helix 'minima'	Symphytum rubrum
Heuchera sanguinea	Tellima grandiflora 'purpurea'
Hypericum calycinum	Vinca minor
	Waldsteinia fragrarioides

The following subjects showed signs of phytotoxicity

Ceratostigma plumbaginoides	MR
Erica carnea 'December Red'	MR
Filipendula ulmeria 'aurea'	S
Geranium macrorhizum 'album'	S
Libertia formosa	MS
Phalaris arundinacea 'variegata	S
Polygonum affine 'Donald Lowndes	MS
Rubus calycynoides	MR
Senecio laxifolius	MS
Sorbaria assurgens	MR
Vinca major	MR

S = Susceptible
MS = Moderately susceptible (marked check)
MR = Moderately resistant (slight check or slight veinal chlorosis)

Location - Basildon

Usage of lenacil under commercial conditions on established subjects

This site consists of a number of plantings in and around a New Town maintained by contractors. The borders are dug over in early April to remove resistant weeds, and for aesthetic reasons. Lenacil and paraquat/diquat are then applied towards the end of April by knapsack sprayer. A second application is made in late July/early August.

The following established ornamentals have been so treated since 1970 and no signs of phytotoxicity have been noticed.

Table 4

Amalanchier canadensis	Corylus avellana	Potentilla fruticosa
Berberis sp.	Elaeagnus sp.	Rhus cotinus
Buxus sempervirens	Forsythia sp.	Rosa sp.
Caryoptera sp.	Ilex sp.	Rosmarinus officinalis
Chaenomeles sp.	Lonicera sp.	Salix sp.
Cornus sp.	Nepeta sp.	Sambucus sp.
Cotoneaster sp.	Osmeria burkwoodii	Symphoricarpus sp.
		Spiraea sp.

DISCUSSION

In practice it is not economical to carry out a series of replicated trials on a wide range of soil types with a wide range of ornamental subjects at differing rates of application. Such trials must therefore of necessity, be mainly of an observational nature, and only by collecting information from many sources can one eventually build up a list of plants tolerant to a herbicide under a range of conditions of weather, methods of application, and soil type. Table 2 is a result of such collection and represents the outcome of a large number of such observation trials.

Table 3 is a specific trial and is of interest because of the small number of subjects that were damaged under extreme conditions. The application rate of 2.4 lb was excessive for the sandy loam at this site, and the fact that heavy rain fell within one week following application would have pre-disposed susceptible plants to damage.

The large scale usage of lenacil under commercial conditions at the Basildon site has not damaged any established plants in the three years that it has been used. It is under such conditions that the safety of lenacil to plants will be of importance, as those who apply the material are unlikely to have horticultural training and will be unable to distinguish between the wide range of subjects likely to be grown.

Acknowledgements

Thanks are due to a number of nurserymen who have provided sites for trials and who have provided information on results obtained with lenacil, included in these are Messrs Hilliers, Notcutts and Jackmans. Thanks are also due to Mr G. Dendy of Merrist Wood Agricultural College and Mr. W. Mayne of the Basildon Development Corporation for the provision of sites.

References

MARKS, T. G. (1966) Lenacil a new residual herbicide for the control of annual weeds in sugar beet. Proc. 8th Br. Weed Control Conf. 470-477

BATEMAN, G. (1971) Herbicides on herbaceous plants. Gardeners Chronicle, 169 (2), 17-21

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TREES AND SHRUBS - WEED CONTROL IN TRANSPLANTS

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Summary Nine herbicides were applied shortly after planting and again in mid-summer to young transplants of 14 cultivars of trees and shrubs. Mixtures of herbicides, although giving reasonable weed control, caused unacceptable crop damage. Simazine used as a standard treatment gave good weed control but caused a little more damage on some plants than is usual. Chloroxuron used alone showed promise and merits further investigation. Propachlor caused least damage.

INTRODUCTION

Simazine is a well established and valuable residual herbicide for annual weed control in lined out hardy ornamental trees and shrubs. It will not, however, control all common annual weeds and is ineffective against emerged weed seedlings. Simazine is not comprehensively proven for use on young transplants and can damage established lined out shrubs of a few sensitive genera and species. This report describes an attempt to resolve some of these shortcomings.

METHODS AND MATERIALS

An experiment to evaluate 9 chemical weed control treatments against hand-weeded control over a range of tree and shrub transplants was undertaken during 1971 on a fertile loam overlying river gravel at Shardlow Hall, Shardlow, Derbyshire. During the winter preceding planting, farmyard manure was ploughed into the land at the rate of 30 tons per acre. Planting was at a spacing of 1 ft 4 in. x 1 ft 0 in. in beds 122 ft 0 in. long x 4 ft 0 in. wide. A 2 ft 0 in. wide path separated each bed. Date of planting was 30th March.

The cultivars age and types of plants were as follows:-

1 year seedling; Berberis thungergii

2 year seedling; Cotoneaster wardii and Picea excelsa

7 month cutting; Buxus sempervirens cv. suffruticosa, Chamaecyparis lawsoniana cv. fraseri, Deutzia scabra cv. candidissima, Forsythia x intermedia cv. lynwood, Hypericum patulum cv. hidcote, Ligustrum ovalifolium cv. aureomarginatum, Senecio greyi, Spiraea x bumalda cv. Anthony Waterer, Symphoricarpus albus cv. erect, Viburum bodnantense cv. dawn and Weigela florida cv. variegata.

Herbicide treatments	Rate of application lb/acre
Chloroxuron	4.0
Chlorthiamid	5.25
Lenacil	2.0
Lenacil + chloroxuron	2.0 + 4.0
Linuron	0.75
Propachlor	3.9
Simazine	1.5
Simazine + chloroxuron	1.5 + 4.0
Simazine + lenacil	0.75 + 1.0
Untreated control	

Plots were hand hoed free of weeds as necessary one to two days before treatment. With the exception of chlorthiamid, all herbicides were applied in 100 gal water per acre as overall sprays on 19 April and 30 July. Chlorthiamid was applied as a granule on 19 April only. No attempt was made to avoid contact of the herbicides with crop foliage. There were two replications of each treatment.

Control plots were hand-weeded on 4 occasions viz. 3rd/4th June, 8th/9th July, 12th/13th August and 8th/9th September.

Assessments were made as follows:-

A. Phytotoxicity: Expressed as a percentage of the total foliage showing chlorosis, necrosis or other damage attributed to the treatment.

B. Survival: Number of plants surviving at end of season.

C. Growth: Height of plant measured vertically from shoot tip to soil level at end of season.

D. Weed control: Weed counts and percentage soil cover were assessed approximately 6 weeks after the April treatments.

RESULTS

Table 1

Percentage foliar damage on 25 May (5 weeks approximately after the first treatment

Crop	Chloroxuron	Chlorthiamid	Lenacil	Lenacil/ chloroxuron	Linuron	Propachlor	Simazine	Simazine/ chloroxuron	Simazine/ lenacil	Control
	Treatments									
Berberis	0	0	0	0	0	0	0	0	0	0
Buxus	0	2	0	Tr	0	3	2	3	10	0
Chamaecyparis	0	0	0	0	0	0	0	Tr	0	0
Cotoneaster	0	0	0	0	10	0	0	0	Tr	0
Deutzia	15	5	40	50	100	5	30	100	55	0
Forsythia	15	25	0	30	15	2	Tr	35	25	0
Hypericum	5	0	0	0	0	0	0	0	0	0
Ligustrum	15	Tr	40	65	60	0	40	55	60	0
Picea	2	0	0	Tr	0	3	0	0	5	0
Senecio	Tr	5	0	2	Tr	10	10	10	5	0
Spiraea	Tr	0	0	0	15	5	15	50	30	0
Symphoricarpos	35	10	10	45	35	10	25	40	35	0
Viburnum	2	0	0	0	Tr	0	Tr	Tr	0	0
Weigela	100	0	Tr	100	10	5	0	100	5	0

Tr = trace

Table 2

Percentage foliage damage on 21 August (4 weeks approximately after the second treatment

Crop	Chloroxuron	Lenacil	Lenacil/ chloroxuron	Linuron	Propachlor	Simazine	Simazine/ chloroxuron	Simazine/ lenacil	Control
	Treatments								
Berberis	0	0	2	5	0	0	3	0	0
Buxus	Tr	Tr	5	Tr	0	5	10	Tr	0
Chamaecyparis	0	0	0	0	0	0	0	0	0
Cotoneaster	0	0	0	0	0	0	0	0	0
Deutzia	Tr	Tr	10	-	0	0	-	Tr	0
Forsythia	Tr	Tr	5	15	0	0	5	Tr	0
Hypericum	0	0	0	0	0	0	0	0	0
Ligustrum	0	0	-	-	0	Tr	-	-	0
Picea	0	0	0	0	0	0	0	0	0
Senecio	0	0	Tr	5	0	Tr	2	0	0
Spiraea	0	0	0	Tr	0	0	0	Tr	0
Symphoricarpos	0	0	Tr	2	0	0	Tr	0	0
Viburnum	0	0	0	Tr	0	0	0	0	0
Weigela	-	0	-	2	0	0	-	Tr	0

- = no plants survived on these areas. Tr = trace

Table 3

Percentage plant survival at harvest time

Crop	Chloroxuron	Chlorthiamid	Lenacil	Lenacil/ chloroxuron	Linuron	Propachlor	Simazine	Simazine/ chloroxuron	Simazine/ lenacil	Control
	Treatments									
Berberis	100	100	100	100	100	100	100	100	100	100
Buxus	98	98	95	98	98	95	100	95	98	100
Chamaecyparis	100	95	100	100	100	100	100	98	98	91
Cotoneaster	100	98	98	98	100	100	100	100	98	100
Deutzia	43*	69	41*	17*	5*	98	31*	7*	43*	91
Forsythia	95	93	100	83*	95	100	100	81*	93	100
Hypericum	100	62	100	100	100	100	100	100	100	100
Ligustrum	52	67	5*	0*	14*	64	21*	5*	5*	71
Picea	95	86	100	98	95	86	98	98	93	95
Senecio	98	69*	98	100	100	98	100	95	100	100
Spiraea	71	93	93	76	69	79	64	14*	67*	83
Symphoricarpos	88	76*	81*	64*	57*	86	55*	41*	62*	95
Viburnum	98	52*	98	95	86	93	93	98	93	95
Weigela	5*	71	86	5*	24*	93	48*	5*	64*	86

This data were transformed to angles for statistical analysis. Treatments significantly different from control at P = 0.05 are indicated by *.

Table 4

Mean plant height (inches) at the end of the season

Crop	Chloroxuron	Chlorthiamid	Lenacil	Lenacil/ chloroxuron	Linuron	Propachlor	Simazine	Simazine/ chloroxuron	Simazine/ lenacil	Control
Berberis	20	13	21	21	18	20	21	20	19	21
Buxus	3	3	3	2	3	4	2	2	3	4
Chamaecyparis	12	8	10	10	11	11	10	10	10	11
Cotoneaster	34	31	31	30	30	34	30	31	30	32
Deutzia	23	22	17	12	0	25	20	0	18	25
Forsythia	33	22	33	28	29	36	35	28	34	38
Hypericum	28	18	26	24	25	28	29	24	28	27
Ligustrum	7	5	0	0	0	9	3	0	0	9
Picea	9	8	10	9	9	9	9	10	5	8
Senecio	19	17	18	18	18	19	19	17	19	19
Spiraea	9	6	9	8	7	9	7	3	9	10
Symphoricarpos	37	29	38	36	28	37	30	25	33	41
Viburnum	33	13	30	33	31	33	37	31	35	34
Weigela	0	17	14	0	11	15	15	0	16	16
Mean	21	16	19	18	17	21	20	17	19	

S.E. (9 d.f.) ± 0.6

Table 5

Weed counts per square yard and soil cover assessment on 3rd June

Crop	Chloroxuron	Chlorthiamid	Lenacil	Lenacil/ chloroxuron	Linuron	Propachlor	Simazine	Simazine/ chloroxuron	Simazine/ lenacil	Control
Capsella bursa-pastoria	0	0	1	0	3	3	0	0	0	8
Chenopodium album	2	0	1	0	1	2	0	0	1	2
Chenopodium polysperum	1	0	0	0	3	1	0	0	0	5
Matricaria spp.	3	0	0	0	0	0	0	0	0	3
Poa annua	14	0	1	0	18	20	1	1	2	21
Polygonum aviculare	0	1	0	0	1	2	1	0	1	0
Senecio vulgaris	0	0	0	0	1	0	0	0	0	4
Solanum nigrum	0	0	0	0	0	0	1	0	0	1
Stellaria media	3	1	2	0	1	3	0	0	2	5
Urtica urens	2	0	4	1	8	9	1	0	0	14
Veronica spp.	3	0	2	0	5	0	1	0	0	0
Miscellaneous	1	1	2	1	4	2	0	1	3	13
Total	29	3	13	2	45	42	5	2	9	76
Percentage weed cover	7	Tr	4	2	9	11	Tr	Tr	2	33
Mean height of weeds (ins)	5	1	4	2	3.5	4	2	1.5	2.5	7

DISCUSSION

Best weed control was obtained by the use of lenacil/chloroxuron, simazine/chloroxuron, simazine/lenacil and chlorthiamid but all of these treatments caused a high level of crop damage. None of the herbicides used in mixtures were so phytotoxic when used alone. Chlorthiamid was noticeable in that it generally restricted growth, sometimes severely without necessarily killing the crop. Hypericum was particularly sensitive to this herbicides.

Linuron combined unacceptable levels of damage with indifferent weed control. Propachlor and lenacil were the least phytotoxic to the crop but weed control was comparatively poor on this occasion. The reported ability of propachlor and lenacil to control Galium aparine and Polygonum spp. respectively however indicates that these 2 materials could be useful to complement simazine. Many of the weeds resistant to these 2 herbicides are susceptible to simazine.

Simazine susceptible shrubs e.g. Deutzia scabra cv. candidissima, Ligustrum ovalifolium cv. aureomarginatum, Symphoricarpos albus cv. erect and Weigela florida cv. variegata were also susceptible to damage from many other herbicides, whereas Berberis thunbergii, Chamaecyparis lawsoniana cv. fraseri, Cotoneaster wardii, Hypericum patulum cv. hidcote and Picea abies were generally tolerant. Forsythia readily showed pronounced chlorosis on a few leaves but growth was not otherwise affected.

Plants were more sensitive to damage in April approximately 3 weeks after planting than in July when the plants were well established and growing vigorously.

Chloroxuron used either alone or at lower rates in combination with other herbicides is worthy of further investigation, particularly for established transplants.