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HERBICIDE EXPERIMENTS IN LEAFLESS AND SEMI-LEAFLESS PEAS

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Summary Replicated experiments carried out over three years comparing the performance of pre and post-emergence herbicide treatments in leafless (cv. Filby), semi-leafless (cv. J.I. No. 9) and conventional cultivar Vedette, indicated a lower level of weed control in the leafless cultivar. Slightly inferior weed control also occurred in the semi-leafless cultivar in some experiments but the results were generally comparable to those in the conventional cultivar. Although pre or post-emergence treatments did not always give satisfactory control in the leafless cultivar, a programme of a pre followed by a post-emergence treatment gave good control.

Résumé On à fait des expériences répétées pendant trois ans pour comparer l'efficacité de l'application pré-et post-émergence d'herbicides à deux varieties de mutant avec une formation changée de feuilles, ct à la variété classique de Vedette. Le contrôle des mauvaises herbes a été moins efficace en la variété Filby, et en certaines expériences un niveau de contrôle un peu inférieurs est relevé en la variété J1 n.9 aussi. En ce cas cependant, les résultats ont été comparables en général à ceux en la variété classique. Bien que le contrôle obtenu en la variété Filby par les traitements pré- or post-émergence ne fût pas toujours satisfaisant, une excellente destruction a résulté d'un programme de deux traitements. l'un pré-, l'autre post-émergence.

INTRODUCTION

Peas for processing are an important crop in the U.K.; approximately 58,000 hectares are grown annually for processing at the immature green stage as canned, frozen or dehydrated green peas, together with approximately 30,000 hectares of dried peas harvested at the fully mature dry stage. Dried peas are either reconstituted and canned, or sold as dry produce to be prepared by the housewife. A further 4,500 hectares are grown for "picking", the pods being sold fresh through greengrocers. In spite of intensive breeding, modern varieties still have some undesirable growth characteristics. Due to the weight of the foliage produced and the relative weakness of the stem the plants usually lodge before harvest. In seasons where vigorous growth occurs, lodging may commence before flowering, particularly with the less determinate varieties, but more usually it is when the weight of the developing pods pulls the plant over. Lodging is a serious problem, causing increased disease, lowering harvesting efficiency, while generally reducing the effectiveness of the lower part of the plant. It is a particular problem in dried pea crops where it slows the speed at which the plants and pods dry, causes deterioration of the produce and increases harvesting losses, due to shelling out of pods and the difficulty of lifting the plants into the combine. It can therefore be assumed that under most conditions the pea crop produces more haulm than is desirable, and a reduction would be advantageous.

In recent years the genetic variability within the genus Pisum has been exploited in work carried out at the John Innes Institute (Snoad 1974). Phenotypes without true leaflets or without the characteristic large stipules and even those combining both features, were available in collections and by crossing with conventional cultivars mutant lines were developed which offered commercial potential. Liaison between PGRO and the John Innes Institute concerning the development of the mutant peas has been taking place since 1968, and in 1974 a three year collaborative project between the two bodies was financed by the Agricultural Research Council, the aim being to assess the agricultural potential of the phenotypes. The results indicated that some of the material offered useful advantages compared to conventional cultivars (PGRO Annual Reports 1974-76) and currently several have been registered for Plant Breeders Rights. Once this has been granted and sufficient seed is available these cultivars could be grown commercially, and because of the considerable differences between them and conventional forms, certain aspects of cultivation were studied at PGRO from 1976-1978. One of the most important aspects was considered to be weed control in those phenotypes having reduced leaf area, because of the potential differences in the competitiveness of the plants against weeds. The aims of the work were twofold, firstly to observe any differences in annual broad-leaved weed development due to differences in the competitiveness of the phenotypes, and secondly to assess the performance of herbicides in the different cultivars.

METHOD AND MATERIALS

The experiments were carried out on the Thornhaugh trial grounds, the soils were fine sandy loams with organic matters of 2.5% in 1976 and 1977 and 3.5% in 1978. The experiments were sown on the 24th, 30th and 29th of March, dates of the pre-emergence applications being 1st and 6th April and 30th March respectively, while the post-emergence treatments were applied on 24th, 23rd and 26th May in the three years. The cultivars used were Filby, a leafless type with leaflets replaced by tendrils and reduced "strap-like" stipules, John Innes No. 9, a semi-leafless type where the leaflets were again replaced by tendrils, but with the normal broad stipule retained, and Vedette, a conventional type having normal leaflets and stipules. The pre-emergence herbicide used was the mixture of terbutryne with terbuthylazine (commercial product Opogard 500L) applied at the rate of 1.1 kg a.i./ha, while in 1976 and 1977 the post-emergence treatment was dinoseb-amine (commercial product Supersevtox) used at the rate of 1.87 kg a.i./ha. In 1978 the mixture of cyanazine with MCPB (commercial product Vortix) was used post-emergence at the rate of 1.56 kg a.i./ha. All applications were made with a van der Weij plot sprayer at a volume of 560 l/ha. Plots were 10 m^2 and treatments were replicated four times, except in 1977 when there were three replications. Plant and weed counts were carried out while assessments were made for the effects of the treatments on the crop and weeds. The experiments were harvested at the dried stage and after threshing the weight of produce was measured.

RESULTS

Weed control

Periodic assessments were carried out for the overall level of weed control and control of the major weed species. These results are presented in Tables 1 and 2 respectively, the assessments for overall control are for those carried out nearest to harvest.

Table 1

Weed control and crop vigour assessments

Cultivar	Treatment	1976† Weed 6/7	1976† Crop 27/5	1977† Weed 2/8	1977† Crop 6/7	1978† Weed 25/7	1978† Crop 26/5
Filby	Pre-em. only	6.3	9.8	6.3	10.0	9.0	10.0
"	Post-em. "	8.8	9.0	7.3	10.0	3.7	10.0
"	Pre and Post-em.	9.5	9.8	8.5	10.0	10.0	10.0
J.I. No. 9	Pre-em. only	5.0	7.8	8.0	10.0	9.7	10.0
"	Post-em. "	7.0	8.3	9.0	10.0	6.2	10.0
"	Pre and Post-em.	9.3	8.3	9.3	10.0	10.0	10.0
Vedette	Pre-em. only	8.0	9.8	9.0	9.0	9.7	9.5
"	Post-em. "	8.0	8.8	9.5	10.0	5.7	10.0
"	Pre and Post-em.	9.8	9.3	9.5	9.0	10.0	9.1

Key: † Weed assessment 10 = complete control, 7 = acceptable control
Crop vigour assessment 10 = no damage, 7 = acceptable

In 1976 and 1977 the control from the pre-emergence applications of terbutryne plus terbuthylazine was generally less effective than from the post-emergence applications of dinoseb-amine, but in 1978 under moist conditions the pre-emergence treatments were considerably more effective than the post-emergence treatment of cyanazine plus MCPB. The levels of control achieved from both pre and post-emergence treatments in the leafless cultivar Filby were lower than in the conventional cultivar Vedette in all three experiments, and in two years 1977 and 1978, it was lower than in the semi-leafless cultivar J.I. No. 9. In 1976 this latter cultivar failed to emerge satisfactorily, final population being 69 plants/m^2 compared to 100 & 123 plants/m^2 for Filby and Vedette, and due to the lack of competition, weed control levels were lower than in the other two cultivars. In 1977 the populations of Filby and Vedette were almost exactly the same with 94 plants /m^2, but again the population of J.I. No. 9 was lower at 83 plants/m^2. In 1978 Vedette and Filby had final populations of 108 & 104 plants/m^2 respectively while the population on J.I. No. 9 was 94 plants/m^2. Although this latter cultivar had lower populations in 1977 and 1978, weed control levels were generally as high as those in Vedette. On the other hand Filby had very satisfactory plant stands in all experiments but weed control was generally inferior to that in Vedette. The main problem in Filby occurred when the herbicide treatments were not working effectively. This occurred with the pre-emergence treatments in 1976 and 1977 and under these conditions the degree of weed control was not acceptable in Filby but was just acceptable in Vedette and in J.I. No. 9. In 1978 when the post-emergence treatments did not work effectively, weed control in J.I. No. 9 and Vedette was better than in Filby, but was still not quite acceptable. In all three experiments the 'programme' of a pre followed by a post-emergence treatment gave good weed control, although in 1977 it was less complete in the cultivar Filby.

Table 2

Weed assessments 1976-78

(10 = complete control, 7 = acceptable control)

Cultivar	Treatment	1976 C.A.	1976 F.O.	1977 A.C.	1977 P.C.	1977 S.A.	1978 F.O.	1978 P.P.	1978 C.P.B.
		Species †							
Filby	Pre-em. only	6.3	6.5	6.0	6.2	8.5	8.2	10.0	10.0
"	Post-em. only	8.8	9.5	6.0	7.5	10.0	1.7	8.5	10.0
"	Pre & post-em.	9.8	10.0	7.2	10.0	10.0	10.0	10.0	10.0
J.I. No. 9	Pre-em. only	5.3	5.0	7.7	8.2	9.5	9.5	10.0	10.0
"	Post-em. only	8.3	7.8	8.5	10.0	10.0	5.0	8.7	9.7
"	Pre & post-em.	9.8	9.8	9.0	10.0	10.0	10.0	10.0	10.0
Vedette	Pre-em. only	8.0	8.5	8.0	9.5	9.7	9.5	9.0	10.0
"	Post-em. only	9.3	9.5	8.7	10.0	10.0	5.0	7.5	9.2
"	Pre & post-em.	10.0	10.0	9.0	10.0	10.0	10.0	10.0	10.0

Key: †
C.A. *Chenopodium album*
F.O. *Fumaria officinalis*
A.C. *Aethusa cynapium*
P.C. *Polygonum convolvulus*
S.A. *Sinapis arvensis*
P.P. *Polygonum persicaria*
C.B.P. *Capsella bursa-pastoris*

It can be seen from Table 2 that in 1976 there were more problems in controlling the two predominant species *Chenopodium album* and *Fumaria officinalis* in Filby than in Vedette, and in 1977 the same effect appeared with *Aethusa cynapium* and *Polygonum convolvulus*, but it was less noticeable with respect to *Sinapis arvensis*. In 1978 the main problem in Filby was the control of *F. officinalis* while control of *Polygonum persicaria* and *Capsella bursa-pastoris* was good. The results in J.I. No. 9 tended to fall mid-way between those for Filby and Vedette, except for the 1976 experiment where the low populations for this cultivar obviously affected the results.

Crop vigour

The results of assessments for crop vigour appear in Table 1 and it can be seen in 1976 that all the cultivars were affected by the treatments to some extent, but these effects were outgrown by harvest. In the other two years the only cultivar to be affected was Vedette, by the pre-emergence treatment, and this cultivar is known to be rather sensitive to most pre-emergence pea herbicides including the mixture of terbutryne plus terbuthylazine. The effects were outgrown by harvest when there were no visible signs of damage.

Yield

The yields for 1976 and 1977 are shown in Tables 3 and 4.

Table 3

Yield data 1976 - tonnes/ha @ 84% dry matter

Figures in ( ) as % of untreated control

Treatment	Cultivar Filby	J.I. No. 9	Vedette	
Pre-emergence only	0.98 *** (188)	0.61 *** (179)	0.99 ** (118)	
Post-emergence only	1.09 *** (210)	0.49 ** (144)	0.98 ** (117)	±0.04
Pre and post-emergence	1.16 *** (223)	0.56 *** (164)	1.09 ** (130)	
Untreated	0.52 (100)	0.34 (100)	0.84 (100)	
		±0.03		
S.E. as % of general mean			7.5	

** Sig. diff. from untreated at P = 0.01, *** at P = 0.001

Table 4

Yield data 1977 - tonnes/ha @ 84% dry matter

Figures in ( ) as % of untreated control

Treatment	Cultivar Filby	J.I. No. 9	Vedette	
Pre-emergence only	3.05 *** (116)	2.17 *** (126)	2.79 * (106)	
Post-emergence only	2.93 ** (111)	2.46 *** (143)	3.16 ***(120)	± 0.08
Pre and post-emergence	3.31 *** (126)	2.40 *** (140)	3.21 ***(122)	
Untreated	2.63 (100)	1.72 (100)	2.63 (100)	
	±0.07			
S.E. as % of general mean	6.1			

* Sig. diff. from untreated at P = 0.05, ** at P = 0.01, *** at P = 0.001

In general they reflect the level of weed control resulting from the herbicide treatments and in both years all the herbicide treatments significantly outyielded the untreated controls in the three cultivars. In 1976 the increase in yield due to removing weeds from Filby was considerably greater than the increase obtained by controlling them in Vedette, while the increases in J.I. No. 9 were greater than in Vedette but not as great as in Filby. The differences in yield response were not as marked between Filby and Vedette in 1977 and the largest responses obtained were in J.I. No. 9.

DISCUSSION

The results of the experiments carried out with the three cultivars Filby, J.I. No. 9 and Vedette indicate that leaf type and general growth habit of a pea cultivar can affect weed development and herbicide performance. The cultivar Filby not only has little leaf area but remains erect, in many cases until harvest, and thus even where the plants are grown at a relatively high density there is less shading of the soil and weeds than with conventional cultivars. In Vedette early growth is quite rapid, a good crop canopy being developed some eight to ten weeks after emergence under most conditions, and after approximately twelve weeks there is usually almost complete ground cover. In Filby a complete cover is seldom achieved, even late in growth and at harvest light can still readily penetrate to the soil surface, while in the early stages of growth there is little shading effect. The ground cover developed by the semi-leafless cultivar J.I. No. 9 is more similar to Vedette than to Filby and while it remains standing longer than Vedette, it lodges much earlier than Filby. After pea plants have lodged light penetration to the soil appears to be reduced and weed development is slowed down, provided the plant density is adequate and there are no gaps in the crop. Assessments made on the untreated plots in July suggested that the heaviest weed growth in 1977 and 1978 developed in Filby, while in 1976 more weed growth was found on the J.I. No. 9 untreated plots, presumably because of the lower plant population on this cultivar in that season. In 1977, J.I. No. 9 had more weed growth than Vedette, but in 1978 the weed growth was similar on the untreated plots of both these cultivars. These assessments illustrate the effects of the different plant habits and help to explain the results obtained from the herbicide treatments. In Vedette on only one occasion did either the pre or post-emergence treatment fail to give acceptable control whereas on two occasions the pre-emergence treatment was inadequate in Filby and on another two occasions the post-emergence treatment failed to give a satisfactory level of control. Discounting the 1976 results for J.I. No. 9 when the plant density was low, in the other two experiments the only failure was the post-emergence treatment in 1978 and the result was only just below what could be considered to be commercial acceptability. It had been hoped that the post-emergence mixture of cyanazine and MCPB, used in 1978, containing as it does the material cyanazine which has both soil and foliar action, might be more effective in Filby than the contact material dinoseb-amine. The treatment did not perform well under the prevailing conditions and there was no evidence that it was any better than dinoseb-amine in this cultivar. It had been thought that the lack of crop cover in the leafless peas at the time when the post-emergence treatments were applied might help their performance because the weeds would not be shaded by the crop. The results did not substantiate this theory and presumably the poorer control in the leafless cultivar was due to the lack of crop competition on weeds weakened but not immediately killed by the treatment.

The future of the 'leafless' and semi-leafless peas is still uncertain and while experimental work has indicated that they offer several important advantages over conventional types it will probably be only after they have been grown commercially for some time that their true potential will be known. If processors accept that the quality of the produce is suitable, leafless cultivars such as Filby could provide dry produce similar to the imported Alaska or home-grown Vedette peas and such crops are likely to be much easier to harvest than the present cultivars. Semi-leafless types could be grown for processing at the green stage, again providing the cultivars are acceptable in terms of botanical characteristics and produce suitability. Although the U.K. acreage of peas grown for protein or for feed is small at present, this could expand in the future and because of the potential improvement in the harvestability of the leafless cultivars they could well be eminently suitable for use in this way.

The results suggest that weed control problems are not likely to be significantly increased in semi-leafless types of good vigour but in the case of leafless cultivars increased weed problems could occur. On soils where pre-emergence herbicides can be used these would appear to be the essential first step. Under good conditions they may be adequate but if not a post-emergence follow-up will be required and it will be essential to recognise that weeds not fully controlled will probably recover and could cause problems at harvest, thus necessitating the use of desiccants. Although weed control will be more expensive the ease in harvesting these crops should more than compensate for the extra costs.

Work is already in hand at PGRO, evaluating the sensitivity of leafless and semi-leafless peas to currently available herbicides and while the present study was confined to annual broad-leaved weeds it is hoped that similar work on control of wild oats *Avena fatua* will be possible in the future.

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References

SNOAD, B. (1974) A preliminary assessment of 'leafless peas', *Euphytica 23* (*1974*), 257-265.

THE HERBICIDAL ACTIVITY OF ETHALFLURALIN PLUS ATRAZINE APPLIED POST-EMERGENCE TO MAIZE AND SORGHUM IN FRANCE

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Summary Results from field trials carried out in France in 1978 confirmed the excellent selectivity of the combination ethalfluralin plus atrazine (Maizor (24 + 30) w.p.), when applied post-emergence at 5 or 10 kg formulated product/ha to maize and at 4 or 8 kg formulated product/ha to sorghum. In addition good efficacy, at the lower dosage, has been demonstrated for this combination against summer grasses such as *Digitaria sanguinalis*, *Setaria glauca* and *Echinochloa crus-galli* as well as against broadleaf weeds normally controlled by atrazine alone.

The efficacy was, in general, increased by the addition of oil to the spray tank. A greater flexibility in timing of application with the combination than with atrazine alone was demonstrated for control of the grasses. Post-emergence applications were also shown to control atrazine-resistant biotypes of *Solanum nigrum*.

Résumé Des essais en plein champ menés pendant 1978 en France ont confirmé la sélectivité de l'association ethalfluralin et atrazine (Maizor (24 + 30) P.M.), appliquée en post levée sur mais à des doses de 5 et 10 kg de produit formulé par hectare et sur sorgho à 4 et 8 kg de produit formulé par hectare. En plus, l'association à la dose de 5 kg/ha a fait preuve d'une très bonne efficacité sur des graminées d'été (*Digitaria sanguinalis*, *Setaria glauca* et *Echinochloa crus-galli*) ainsi que sur les dicotylédones normalement controlées par l'atrazine. L'efficacité de l'association a été, en général, ameliorée par l'addition en mélange d'un huile de pétrole. La période d'intervention efficace en post contre graminées est plus longue pour l'association qu'avec l'atrazine seule. L'utilisation du Maisor permet de lutter efficacement contre des biotypes de *Solanum nigrum* resistants à l'atrazine.

INTRODUCTION

Approximately three million hectares of maize are now cultivated in France. This area is distributed throughout the country and, therefore, embraces a wide range of climatic and edaphic conditions. In consequence, the weed flora of the maize crop is very diverse and includes species such as *Amaranthus retroflexus*, *Digitaria sanguinalis* and *Echinochloa crus-galli* from the Mediterranean area as well as those more commonly found in northern Europe, for example, *Polygonum* spp., *Matricaria* spp. and *Stellaria media*. The most important species found in the maize crop, determined in five years of field experimentation, are presented in Table 1.

In contrast to maize, sorghum is grown exclusively in the southern, dryer regions of France and an area of approximately 100,000 ha is now cultivated. The most important weed species in sorghum are, therefore, those mentioned above for the Mediterranean region.

The maize crop is often grown under a simple cereal rotation, for example, maize/winter wheat/maize, and the continued use of atrazine for weed control in the large-grain cereal has caused an increase in the abundance of tolerant weed species. In particular, grass species such as *Digitaria* spp, which germinate late in the season and recently identified biotypes of *Chenopodium album*, *Atriplex patula*, *Polygonum lapathifolium*, *P. persicaria* and *Solanum nigrum* have exhibited significant tolerance to atrazine (Barralis, pers. comm.). In addition, the use of a tight crop rotation, such as that described above, precludes use of higher rates of atrazine to overcome the resistant weed problem.

TABLE 1

Annual weed species found in maize crops in France in descending order of importance (Information from 5 years of trials)

GRASSES	BROADLEAVES	
Digitaria sanguinalis	Chenopodium album	Atriplex patula
Echinochloa crus-galli	Amaranthus hybridus	Stellaria media
Setaria viridis	A. retroflexus	Anagallis arvensis
S. glauca	Polygonum aviculare	Tripleurospermum maritimum
D. ischaemum	P. persicaria	Matricaria recutita
S. verticillata	P. lapathifolium	Mercurialis annua
Lolium multiflorum	Solanum nigrum	Raphanus raphanistrum
	P. convolvulus	Sinapis arvensis

In order to alleviate the atrazine persistance problem from these high doses and to control resistant weed species, ethalfluralin was mixed with the normal application rate of atrazine and then tested in maize. The herbicidal activity of ethalfluralin in cotton was first described by Skylakakis *et al*., (1974). Experimentation with ethalfluralin was initiated in maize in 1973 and in 1974 the combination with atrazine was first tested. The excellent performance of this combined formulation, containing 240 g/kg ethalfluralin plus 300 g/kg atrazine, applied pre-emergence, was first described by Beraud *et al*., (1977) who also described preliminary data on the activity of post-emergence applications to maize (Beraud *et al*., 1978).

Data are presented from field trials carried out in France in 1978 which illustrate the post-emergence activity of ethalfluralin plus atrazine in maize and sorghum.

METHOD AND MATERIALS

Field trials were carried out in France employing the methods described by the Commission des Essais Biologique (1961 & 1973). The experimental programme on maize included a number of cultivars the most important of which was LG11. The most important of the sorghum cultivars tested was NK121. The trial plots varied in size from 16 to 24 m^2 and were arranged in either 2 or 4 randomized blocks with semi-paired controls. The herbicide combination containing 240 g/kg ethalfluralin plus 300 g/kg atrazine was applied with a knapsack sprayer at a volume rate of 300-400 l/ha. Atrazine, as 50 w.p. and propachlor 65 w.p. were similarly applied.

Oil Orchan, 263 (manufactured by Standard Oil of New Jersey) a wetting and penetrating agent, was included as a tank mixture with some of the post-emergence treatments at an application rate of 5 l/ha.

Herbicidal efficacy was visually assessed as a direct control rating on whole plots, utilizing the Barratt and Horsfall (1945) rating system.

Selectivity on both maize and sorghum was evaluated by stand counts and vigour ratings.

RESULTS

Selectivity It is apparent that the selectivity of ethalfluralin plus atrazine in maize was similar when application was made either pre- or early post-emergence (Table 2). A slight reduction in crop stand was observed which was more evident at the higher application rate.

A comparison with the recommended pre-emergence treatment for sorghum, propachlor plus atrazine, indicated excellent selectivity of post-emergence applications of ethalfluralin plus atrazine at 0.96 and 1.2 kg ai/ha, respectively, and also at double that dosage. (Table 2).

TABLE 2

Selectivity of ethalfluralin plus atrazine when applied pre- and post-emergence to maize (7 trials) and sorghum (4 trials)

Crop	Treatment	Dosage kg a.i./ha	Crop stage at application	Crop stand*	Crop vigour*
Maize	Ethalfluralin + atrazine	1.2 + 1.5	pre-emergence	98	100
		2.4 + 3.0		97	99
		1.2 + 1.5	post-em 3 leaves	98	100
		2.4 + 3.0		97	99
Sorghum	Propachlor + atrazine	2.6 + 1.0	pre-emergence	100	97
		5.2 + 2.0		98	87
	Ethalfluralin + atrazine	0.96 + 1.2	post-em. 2-5 leaves	102	99
		1.92 + 2.4		103	98
	Untreated			100	100

* Values expressed as % of untreated
Crop stand assessed 12 to 15 days after post-em. application.
Crop vigour assessed at 5 to 7 leaf stage of crop.

Herbicidal efficacy The poor control of summer-germinating grasses with atrazine alone, applied post-emergence is illustrated in Table 3. This is particularly noticeable in the control of *D. sanguinalis* where the addition of ethalfluralin significantly improved efficacy. In order to achieve acceptable control, however, oil must be included with the combination. The addition of oil to atrazine alone did improve control of *D. sanguinalis* but not to an acceptable level.

TABLE 3

Control of summer-germinating grasses with early post-emergence applications of atrazine alone and ethalfluralin plus atrazine, with and without the addition of oil in maize (4 trials)

Treatment	Dosage kg a.i./ha	% control 20 to 90 days after applic.		
		Digitaria sanquinalis	Echinochloa crus-galli	Setaria glauca
Atrazine	1.5	31	65	81 (11)
Ethalfluralin + atrazine	1.2 + 1.5	80	79	87 (42)
	1.56 + 1.95	80	86	92 (67)
Atrazine + oil	1.5	46	85	91 (83)
Ethalfluralin + atrazine + oil	1.2 + 1.5	91	88	94 (81)
	1.56 + 1.95	97	96	98 (83)

Data in parentheses are from assessments 7 days after application.

In the absence of oil, ethalfluralin plus atrazine provided better control of E. crus-galli than atrazine. Where oil was added, however, there was no difference between these treatments. Control of S. glauca was good with all treatments, 20 days after application, particularly when oil was included. At an early assessment time, however, there was significantly better control with the combination than with atrazine alone. Where oil was added there were no differences between treatments.

Figure 1 illustrates the effect of time of application on the efficacy of atrazine, and ethalfluralin plus atrazine for control of the grass species presented in Table 3. All post-emergence applications included oil. Post-emergence applications of the combination as late as the 3-leaf stage of the crop, provided acceptable control. At this stage the weeds had 2-3 leaves. Where application was made at a later stage there was a large decrease in control.

It is apparent from Fig. 1 that control by atrazine alone was lower than that by the combination for all application times. In addition, when application of atrazine was made after the 1-2 leaf stage of the crop (emergence to one leaf stage of weeds) there was subsequent unacceptable control.

Two trials were initiated on sites where atrazine-resistant biotypes of S. nigrum had been identified. The results from these trials, in comparison with those from a trial on an atrazine-susceptible biotype, are presented in Table 4. The data illustrate the advantage of the combination of ethalfluralin plus atrazine over atrazine alone where resistant biotypes occur. It was also observed that S. nigrum plants which survived the combination treatment were severely stunted.

FIGURE 1.

Effect of application time on control of summer-germinating grasses with atrazine and ethalfluralin plus atrazine (5 trials)

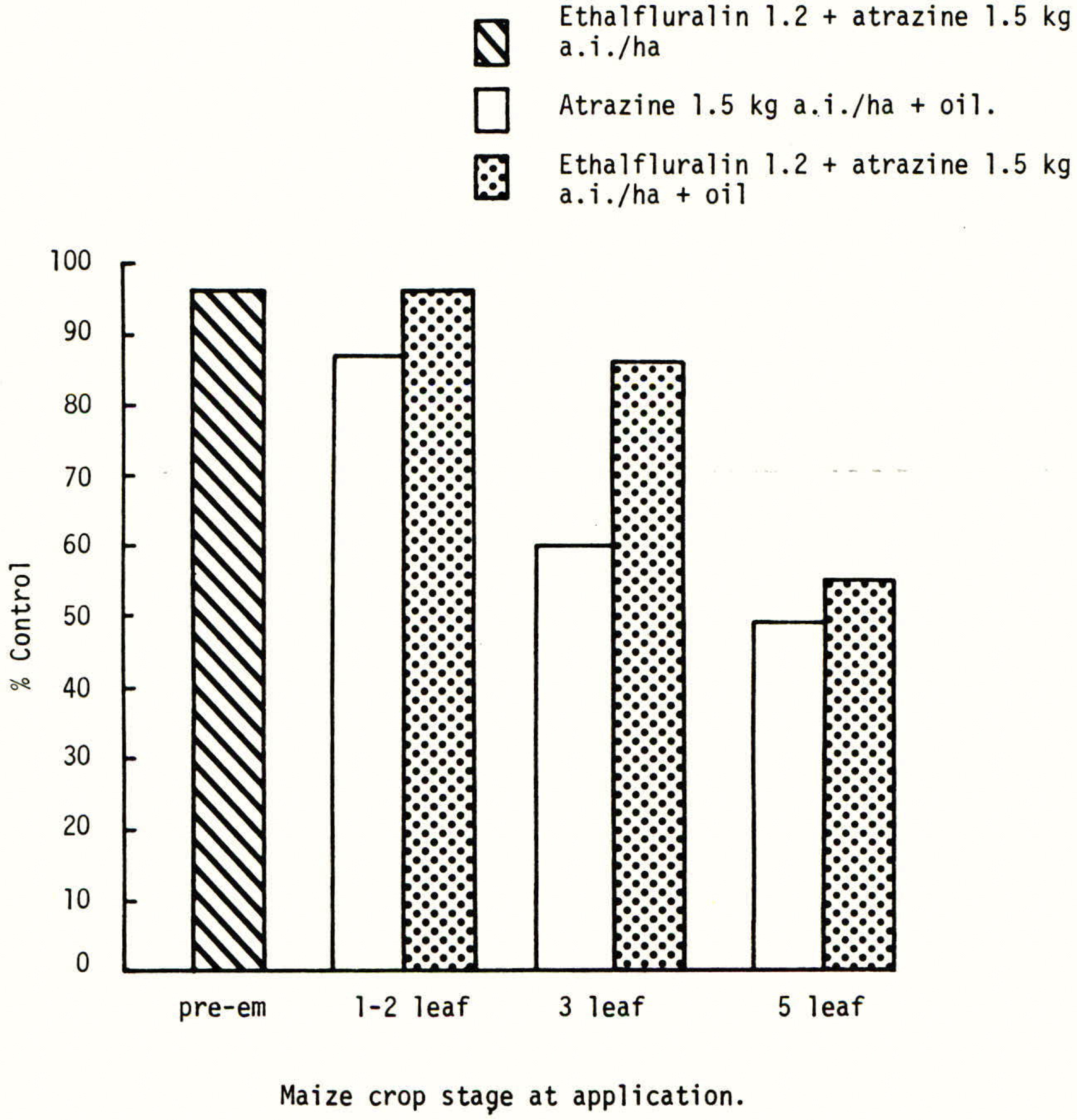

TABLE 4

Response of atrazine-susceptible and resistant biotypes of Solanum nigrum to early post-emergence (1-2 leaves of crop) applications of ethalfluralin plus atrazine

Treatment	Dosage kg a.i./ha	% Control 40 days after application*	
		Susceptible biotype	Resistant biotype
Atrazine	1.5	100	38
Atrazine + oil	1.5	100	65
Ethalfluralin + atrazine	1.2 + 1.5	100	89
	1.56 + 1.95	100	90

* Susceptible biotype data from one trial.
Resistant biotype data from two trials.

DISCUSSION

The combination of 240 g/kg ethalfluralin plus 300 g/kg atrazine is marketed in France as a pre-emergence herbicide in maize. The excellent selectivity was confirmed in 1978 trials where there was heavy rainfall and relatively low temperature during the Spring. At the same time early post-emergence applications using up to 10 kg formulated product per hectare were adequately selective, with only slight reductions in crop stand. The tolerance of maize to ethalfluralin is known to be due to a depth protection or physical separation mechanism and where the seedbeds are uneven and the crop is drilled shallowly a reduction in emergence can occur, particularly at double the recommended application rate.

The sorghum crop is generally very sensitive to herbicide applications and for this reason there is only a limited number of products available for use in this crop. Ethalfluralin plus atrazine was shown to be very selective in sorghum when applied post-emergence at up to 8 kg formulated product per hectare (1.92 + 2.4 kg ai/ha, respectively).

The 1978 experimental programme confirmed that early post-emergence applications of ethalfluralin plus atrazine at 5 kg formulated product per hectare provide similar control to that obtained with pre-emergence applications. In addition, a greater flexibility in timing of application with the combination than with atrazine alone was demonstrated, where control of emerged grass species after the 2-3 leaf stage can be poor with the latter compound.

Ethalfluralin, therefore, increases the spectrum of control of atrazine, in post-emergence applications, and in addition controls those biotypes of S. nigrum which have exhibited atrazine-resistance.

References

BARRATT, R.W. and HORSFALL, T.G. (1945). An improved grading system for measuring plant disease. Abstr. Phytopath., 35 655.

BERAUD, J.M., DELERUE, A., and TUSSAC, M. (1977). Ethalfluralin + atrazine, une nouvelle association pour le desherbage du mais. 9° Conference du Columa 2 343-358.

BERAUD, J.M., LECA, J.L. and VINCENT, B. (1978). Qu'est-ce que Maizor? La Defense des Vegetaux 190 87-100.

Methode d'essai d'efficacite pratique des herbicides destines au desherbage selectif des cereales. Methodes C.E.B. No. 13 (1961).

Methode d'essai d'efficacite pratique des herbicides destines au desherbage du mais et du sorgho. Methode C.E.B. No. 46 (1973).

SKYLAKAKIS, G., ANASTASIADIS, B., BUENDIA, J., BAYO, R.M., ORAN, Y. and WALDREP, W.T. (1974). EL-161, a new pre-plant incorporated herbicide for control of grass and dicotyledonous weeds in cotton. Proceedings of the 12th British Weed Control Conference 2 795-800.

NOTES

CHEMICAL WEED CONTROL IN WINTER OIL SEED RAPE

1977 AND 1978 HARVEST YEARS

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Summary Nine herbicides were compared at various dose rates, combinations and spray timings in 21 experiments in 1976/77 and 1977/78. Crop and weed assessments from all sites and yields from 6 sites are presented.

TCA used pre emergence showed promise, and a light incorporation improved weed control slightly, trifop methyl gave very rapid control of grass weeds, particularly when applied early (1-2 leaves).

INTRODUCTION

The vital need for early grass weed control, to ensure crop establishment and satisfactory yields, have been clearly shown in previous years trials (Proctor & Finch 1976). The introduction of pre emergence treatments to better achieve this, necessitated the present work.

METHOD AND MATERIALS

Randomised blocks with four replications and two untreated plots per block. Plot size 3 m x 7.5 m. Sprays applied with a modified van de Weij sprayer at 281 l/ha @ 3.3 bar. Yields were determined by hand sampling of four 0.56 m^2 quadrats per plot. Oil contents were determined by nuclear magnetic resonance (NMR) to the standard of the soxhlet extraction method. Treatments are given in Table 1, site details in Table 2.

DISCUSSION

Two poor growing seasons and severe pigeon damage in the Spring of 1978 reduced the apparent effectiveness of some treatments. In 1976/77 5 sites (D, E, F, H, I) and 1977/78 only one site (M), were harvested for yield.

The value of pre-emergence herbicides to control the early flush of grass weeds to enable good crop establishment, is confirmed at sites G, H, M, and the desirability of keeping up the level of control for good yields by sequential treatment is demonstrated by several sites.

Late applications of dalapon delayed flowering, an effect which was also observed when slow acting treatments were applied (Sites D & E). As the percentage oil did not vary significantly between treatments these have been omitted, but are reported in Eastern Region Experiments (Proctor & Finch 1978 and 1979).

At several sites in 1977/78, notably O and P *Stellaria media* (chickweed) recovered

Table 1

Treatments 1976/77

Treatment	Timing	Herbicide	Rate ai kg/ha
0	-	Untreated	-
1	V.Early	dalapon	0.71
2	Early	dalapon	1.43
3	Early	dalapon	2.87
4	Early	dalapon	1.43
	Late	dalapon	1.43
5	V.Early	dalapon	0.71
	Late	propyzamide	0.70
6	Early	dalapon	0.96
	Late	propyzamide	0.56
7	Early	dalapon	1.96
	Late	propyzamide	0.70
8	V.Early	dalapon	0.71
	Late	(carbetamide	2.10
		(dimefuron	0.70
9	Early	dalapon	0.96
	Late	(carbetamide	1.40
		(dimefuron	0.45
10	Late	propyzamide	0.70
11	Late	(carbetamide	2.10
		(dimefuron	0.70
12	Late	propyzamide	0.42
		(benazolin	
		(Dowco 290	0.35
13	Early	clofopisobutyl	0.54
		dalapon	1.91
14	Early	clofopisobutyl	0.54
	Late	propyzamide	0.56
15	Early	clofopisobutyl	0.54
		(carbetamide	1.40
	Late	(dimefuron	0.45
16-18	Herbicides used According to site - see Results table		

Pre emergence		Rate ai kg/ha heavy soils	Rate ai kg/ha medium/light soils
19	carbetamide	2.0)	1.6)
	dimefuron	0.5)	0.4)
		All soils	
20	propham	3.36	
21	TCA	7.45	
22	TCA + paraquat	7.45 + 0.84	
23	dalapon + paraquat	0.71 + 0.84	

benz = benazolin

Treatments 1977/78

Treatment	Timing	Herbicide	Rate ai kg/ha
0		Untreated	
1	Pre em	TCA harrowed in	8.0
2	Pre em	TCA	8.0
3	Pre em	Rydex	0.5
4	Pre em	TCA	8.0
	Late	benz + Dowco 290	0.35
5	Pre em	TCA	8.0
	Late	(carbetamide	2.1
		(dimefuron	0.7
6	Pre em	TCA	8.0
	Late	propyzamide	0.7
7	Pre em	TCA	8.0
	Early	dalapon	1.27
	Late	benz + Dowco 290	0.35
8	Pre em	TCA	8.0
	Early	dalapon	1.27
	Late	(carbetamide	2.1
		(dimefuron	0.7
9	Pre em	(carbetamide	* 1.6
		(dimefuron	0.4
10	V.Early	trifopmethyl	0.36
11	V.Early	trifopmethyl	0.36
	Late	benz + Dowco 290	0.35
12	Early	dalapon	1.27
13	Early	dalapon	1.27
	Late	propyzamide	0.7
14	Early	dalapon	1.27
	Late	(carbetamide	2.1
		(dimefuron	0.7
15	Late	propyzamide	0.5
		benz + Dowco 290	0.35
16	Late	(carbetamide	2.1
		(dimefuron	0.7
17	V.Early	clofopisobutyl	0.36
18	V.Early	clofopisobutyl	0.54
19	Pre em	TCA	16.0
20	Pre em	TCA	16.0
	Early	dalapon	2.54
21	Early	dalapon	2.54
22	V.Early	diclofop methyl	1.08
23	Early	diclofop methyl	1.08
24	Late	propyzamide	0.7
25	Late	propyzamide	0.5
26	Late	trifopmethyl	0.36
27	Early	TCA	8.0

* = Site U ai kg/ha 1.2
0.3

Table 2

Site Details

Site	Sown	Spray Dates 1st	Spray Dates 2nd	Spray Dates 3rd	Number of True Leaves on crop at spraying 1st	2nd	3rd	Dominant Weed	General Crop Vigour	
A	8/9/76	23/9	13/10	17/11	Cotyledon to 1	2 to 3	2 to 6	A. mysuroides	poor	Bourn
	9/9/76	21/9	19/10	8/11	Cotyledon	4 to 5	5 to 6	Barley & A. mysuroides	high	Cumberlow Gn
C	10/9/76	20/9	8/10	9/11	Cotlyedon to ½ leaf	4½	4 to 7	A. mysuroides, V. persica	poor	Duxford
D	3/9/76	21/9 and 27/9	8/10	8/11	Cotyledon to ¼ leaf	3 to 4	3½ to 6	A. mysuroides & Barley	moderate	Newton
E	6/9/76	27/9	13/10	17/11	Cotyledon to 1 leaf	3½	4 to 6	A. mysuroides & Barley	good	Renhold
F	8/9/76	14/9			Pre Em			A. mysuroides	poor	Bourn Pre em
G	9/9/76	14/9			Pre Em			Barley	good	Cumberlow Pre em
H	18/9/76	8/9			Pre drill			A. mysuroides & Barley	good	Elsworth
I	8/9/76	14/9			Pre Em			Barley	good	Fen Drayton
J	3/9/76	7/9			Pre Em				poor	Newton Pre em
K	6/9/76	8/9			Pre Em				good	Renhold Pre em
L	8/9/77	8/9	19/10	28/11	Pre Em	Cotyledon to 4	8"-10"	Barley	moderate	Stukeley
M	12/9/77	14/9	17/10	28/11	Pre Em	2 to 4	8"	A. mysuroides	good	Warboys
N	13/9/77	14/9	18/10	28/11	Pre Em	Cotyledon to 2½	4"-10"	Oats and S. media	v. Poor	Cumberlow
O	14/9/77	14/9	26/10	13/12	Pre Em	2 to 4	Cotyledon to 6	S. media	poor	Boxworth/I
P	14/9/77	15/9	26/10	9/12	Pre Em	2 to 4	Cotyledon to 6	S. media	poor	Boxworth/II
Q	15/9/77	16/9	26/10	19/12	Pre Em	Cotyledon to 5	1 to 7		moderate	Elsworth
R	18/9/77	19/9	26/10	30/11	Pre Em	1 to 4	2 to 10"	A. mysuroides & Wheat	good	Lolworth
S	18/9/77	19/9	19/10	13/12	Pre Em	Cotyledon to 2½	Cotyledon to 7	A. mysuroides & Wheat	moderate	Brampton
T	21/9/77	22/9	17/10	30/11	Pre Em	Cotyledon to 1½	6"-10"	Barley	good	Longstanton
U	24/9/77	26/9	27/10	29/11	Pre Em	1 to 4	8"	S. media, Matricaria spp	good	Stradbrooke

TABLE 3 RESULTS OF EXPERIMENTS 1976/77

Site			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SITE 'A'	Crop		No crop differences																		
BOURN	Blackgrass	Nov	10	8	4	5	7	8	8	5	9	7	8	9	9	4	3	6	9	4	
Cambs		Dec	7	7	2	2	2	7	4	2	7	4	7	7	9	1	1	1	7	2	
cv: Expander		Jan	7	7	2	1	3	5	3	2	5	3	5	6	7	1	2	2	7	4	
		Feb	7	8	0	0	0	2	1	0	4	1	2	5	5	0	0	0	4	4	
		Mar	7	7	0	0	0	0	0	0	1	1	0	2	1	0	0	0	0	3	

Yields were not taken due to high degree of irregularity of crop and weed population

Tr. 16 dalapon ai kg/ha 0.71 v. early Tr. 17 clofopisobutyl) ai kg/ha 0.37 v. early
dalapon 0.96 late dalapon) 0.48

Site			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SITE 'B'	Crop		No crop differences																		
CUMBERLOW GREEN	Barley	Nov	10	9	7	5	6	8	6	6	8	5	9	9	8	6	9	9	6		
Herts		Dec	10	10	4	2	6	8	4	5	6	4	8	6	7	4	8	9	5		
cv: Expander		Jan	10	10	3	2	5	6	3	3	5	3	7	7	7	3	8	7	3		
		Feb	8	10	1	0	2	1	0	0	1	0	2	2	2	0	1	2	0		
		Mar	8	10	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0		

Yields were not taken as nitrogen applied so late that area was very weak in growth and very seriously grazed by birds

Tr. 16 dalapon ai kg/ha 1.96 early

Site			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SITE 'C'																					
DUXFORD	Crop	Jan		5	5	5	5	4	5	4	4	5	5	5	5	4	5	5	5		
Cambs	Grass weeds	Nov		8	1	0	1	7	3	0	6	6	5	6	4	0	6	6	2		
cv: Rapora		Jan		4	1	0	0	3	2	0	2	2	1	2	1	0	0	1	0		
		Apr	6	4	1	0	1	0	0	0	1	1	0	1	0	1	0	1	1		
	Veronica persica	Mar		7	8	7	6	4	4	4	2	4	4	2	5	5	3	3	7		

Yields were not taken as crop growth too variable

Tr. 16 dalapon ai kg/ha 1.96 early

Site			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SITE 'D' NEWTON	Yield at 92% DM t/ha SE ± 0.514			0.9	2.2	3.0	2.6	2.5	3.2	2.4	1.7	2.3	2.1	1.6	1.9	2.7	2.3	2.6	2.3	1.7	2.1
Cambs	Crop	Jan	8	7	8	7	7	7	7	7	7	7	7	7	8	6	7	7	7	6	8
cv: Primor		May	5	2	8	8	7	5	8	7	6	7	5	5	5	7	7	7	5	4	7
	Blackgrass	Nov	10	9	6	5	7	9	7	6	10	6	10	10	10	5	3	3	9	9	2
		Dec	10	9	4	3	4	9	6	4	9	6	10	9	10	3	0	0	8	9	2
		Jan	10	10	4	1	2	8	5	2	9	3	10	10	10	1	0	0	7	8	4
		Feb	10	10	1	0	1	3	1	0	4	1	3	5	4	0	0	0	2	3	2
		Mar	10	10	2	0	0	2	1	0	3	1	4	4	3	0	0	0	2	2	3
		Mar	10	10	3	0	0	0	0	0	2	1	0	4	0	0	0	0	0	0	4
	Flowering of crop	May	6	8	8	8	8	6	8	7	7	7	5	7	5	8	7	8	6	4	8

Tr. 16 dalapon ai kg/ha 0.71 v. early; clofopisobutyl 0.54) dalapon 0.96) late

Tr. 17 dalapon ai kg/ha 0.71 v. early; clofopisobutyl 0.54) dalapon 1.96) late

Tr. 18 clofopisobutyl ai kg/ha 0.54) dalapon 0.48) v. early

SITE 'E' RENHOLD, Beds, cv: Expander

		Treatments:-	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Yield at 92% DM t/ha SE ± 0.444				3.6	2.8	3.4	3.2	3.0	3.9	3.1	3.6	3.5	3.2	3.4	3.4	3.2	3.7	3.5	3.4	3.1	3.6
	Crop	Nov	9	8	9	8	9	8	8	8	8	8	8	8	8	8	9	9	8	8	9
		Feb	7	7	7	7	7	5	6	6	5	6	5	5	6	7	7	8	6	6	8
		Apr	8	9	9	9	7	7	8	8	7	9	6	7	7	9	9	9	9	5	10
	Blackgrass	Nov	10	10	8	8	9	10	10	8	10	9	9	10	10	6	5	6	10	10	3
		Dec	10	10	7	8	8	9	8	6	9	8	10	10	10	4	1	2	10	10	2
		Jan	10	10	4	2	4	9	8	3	8	6	9	10	10	1	1	1	9	10	1
		Feb	10	10	1	0	0	8	1	0	7	2	10	10	10	0	0	0	8	10	1
		Mar	5	5	0	0	0	2	0	0	2	0	3	3	3	0	0	0	2	2	0
		Mar	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Flowering of crop	Apr	5	5	6	6	4	4	6	4	4	6	3	4	4	6	6	7	5	2	7

NOTE blackgrass virtually died out through natural causes

Tr. 16: dalapon, ai kg/ha 0.71, v. early; clofopisobutyl 0.54, late.
Tr. 17: dalapon, ai kg/ha 0.71, v. early; dalapon 1.96, late.
Tr. 18: clofopisobutyl, ai kg/ha 0.37; dalapon 0.48, v. early.

PRE-EMERGENCE SITES

SITE 'F' BOURN, Cambs, cv: Expander

		Treatments:-	0	19	20	22	23
Yield at 92% DM t/ha SE ± 0.235				2.3	2.4	2.6	2.3
	Crop	Nov	10	5	8	9	9
		Mar	7	5	6	7	6
	Blackgrass	Nov	7	2	2	1	6
		Mar	5	1	1	1	5

The crop was weak and weed populations very low and non aggressive

SITE 'G' CUMBERLOW GREEN, Herts, cv: Expander

Yields not taken as nitrogen applied so late that area was very weak in growth and very seriously grazed by birds

	Treatments:-	0	20	21	23
Crop	Nov	10	8	9	5
	Jan	10	6	7	3
	May	9	7	9	6
Barley	Oct	10	6	1	2
	Mar	10	5	0	1
Flowering of crop	May	9	8	10	5

SITE 'H' ELSWORTH, Cambs, cv: Primor

		Treatments:-	0	19	20	21	22
Yield at 92% DM t/ha SE ± 0.613				3.4	3.4	3.9	4.4
	Grass Weeds	Nov	10	6	6	5	3
		Dec	6	2	3	2	1
		Apr	5	2	1	1	0
	Flowering of crop	May	5	4	5	5	5

Weed population was very low and it is difficult to conceive that the apparent marginal superiority of treatment 22 over the other treatments could have affected yield while treatments 19 & 20 may have had a toxic effect on the crop, this can hardly apply to 21.

SITE 'I' FEN DRAYTON, Cambs, cv: Rapora

		Treatments:-	0	19	20	22	23
Yield at 92% DM t/ha SE ± 0.506				3.0	2.5	2.7	2.7
	Crop	Nov	10	7	5	9	9
		Feb	9	6	6	9	8
		Apr	10	9	8	10	10
	Barley	Nov	6	1	2	0	4
		Jan	3	1	2	0	2
		Apr	0	0	1	0	0
	Flowering of crop	Apr	8	8	8	8	9

The crop was very vigorous and weed population very low

SITE 'J'
NEWTON
Cambs
cv: Primor

		Treatments:- 0	19	20
Crop	Nov	10	8	9
	Mar	5	5	6
Blackgrass	Nov	10	1	2
	Mar	10	1	2
	Mar	9	3	3

Yields not taken due to smallness of treatment differences in growth of crop and lack of apparent differences between treatments in degree of weed kill

SITE 'K'
RENHOLD
Beds
cv: Expander

		Treatments:- 0	19	20	21	22	23
Crop	Nov	10	10	10	10	10	10
	Dec	9	7	8	8	8	9
	Feb	7	6	7	7	7	7
	Apr	9	8	8	9	8	8
Blackgrass	Oct	/m^2	111	226	184	289	811
	Nov	10	3	4	3	3	9
	Dec	6	2	2	1	2	5
	Feb	4	1	2	1	1	3
	Mar	1	0	0	0	0	0
Flowering of crop	Apr	7	6	6	7	6	6

Yields were not taken due to damage to crop from herbicide residues from previous season

RESULTS OF EXPERIMENTS 1977/78

SITE 'L'
STUKELEY
Cambs
cv: Rapora

		Treatments:- 0	1	2	3	5	6	9	10	12	13	14	16	21	24	25
Crop	Mar	6	7	7	6	7	7	7	7	6	6	7	6	7	6	6
Barley	Nov	9	6	6	10	6	3	8	1	5	6	5	9	4	8	9
	Dec	7	3	3	7	3	1	5	0	4	3	3	6	2	6	7
	Jan	6	1	1	7	0	0	5	0	1	0	0	2	0	4	4
	Mar	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0

SITE 'M'
WARBOYS
Cambs
cv: Rapora

		Treatments:- 0	1	2	3	5	6	*7	8	9	10	12	13	14	16	17	25	26
Yield at 92% DM t/ha		-	2.6	2.9	2.4	3.7	3.3	3.0	3.1	2.4	3.0	2.8	2.8	3.1	3.3	3.0	3.4	2.8
Crop	Jan	5	5	6	5	6	7	6	6	5	7	5	5	5	7	6	5	5
	Apr	4	7	8	5	8	9	8	7	6	8	7	7	7	7	7	7	7
	May	6	8	8	6	9	9	9	9	7	9	8	8	8	8	8	8	8
Blackgrass	Nov	9	6	5	9	5	7	6	4	10	3	5	8	6	9	4	9	9
	Dec	8	5	3	9	3	2	3	3	10	1	3	6	5	9	3	8	9
	Jan	6	1	2	6	1	1	0	0	8	1	2	2	1	6	1	5	6
	May	5	1	1	5	0	0	0	0	5	0	1	0	0	0	2	0	0
Barley	Nov	10	8	6	10	6	7	2	1	7	0	4	6	6	10	8	10	10
	Dec	9	5	5	7	4	4	1	1	5	0	5	6	5	6	6	8	7
	Jan	7	3	3	5	1	1	0	0	3	0	3	1	1	3	4	4	4
	Feb	5	1	1	4	0	0	0	0	2	0	1	0	0	0	2	0	0

*Treatment 7 TCA and dalapon only

SITE 'N'
CUMBERLOW GREEN
Herts
cv: Expander

		Treatments:- 0	1	2	*3	4	5	6	7	8	9	10	11	12	13	14	15	16	22	23
Oats	Nov	10	7	8	10	8	7	8	6	7	7	2	2	9	10	10	10	10	10	10
	Dec	9	6	6	8	7	6	4	1	1	4	0	0	6	5	7	9	8	0	9
	Feb	8	4	4	9	4	1	2	0	0	3	0	0	6	3	2	9	7	0	7
	Mar	4	1	1	3	1	0	0	0	0	1	0	0	1	0	0	3	0	0	1
	Apr	4	1	1	0	2	0	0	0	0	1	0	0	1	0	0	4	0	0	0
Chickweed	Dec	0	2	1	1	1	1	1	1	2	1	3	2	1	0	1	1	1	2	0

SITE 'N' (cont)	Treatments:-		0	1	2	*3	4	5	6	7	8	9	10	11	12	13	14	15	16	22	23
(cont)	Chickweed	Feb	3	5	5	1	1	2	1	0	1	2	4	2	3	1	1	1	1	5	4
Crop severely grazed		Apr	5	5	4	1	0	0	0	0	0	2	4	0	4	0	0	0	0	3	5
by pigeons		May	2	8	6	1	0	0	0	0	0	3	6	0	6	0	0	0	1	5	6

*Treatment 3 was oversprayed 6 March with NP.48 alloxydim sodium 0.56 ai kg/ha

SITE 'O'	Treatments:-		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	*18	27
SITE 'O'	Crop	May	7	8	6	5	6	6	8	7	7	4	6	8	7	6	7	7	7	7	6
BOXWORTH	Barley	Nov	8	6	7	6	6	5	5	3	4	7	3	2	5	6	5	7	6	7	6
Cambs		Jan	3	1	1	2	1	1	1	0	0	2	0	0	0	1	0	1	1	1	1
cv: Rapora		Mar	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
	Chickweed	Nov	8	6	7	6	5	5	7	4	5	5	6	7	5	3	7	10	6	6	4
		Jan	8	6	8	7	3	5	6	2	1	5	6	6	3	2	4	8	6	6	3
		Mar	9	8	9	7	0	1	0	0	0	8	7	0	4	0	0	0	1	0	2
		May	8	9	10	8	0	8	1	0	1	9	10	0	8	0	2	0	4	1	8

SITE 'P'	Treatments:-		0	1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	*18	21
SITE 'P'	Crop	May	6	6	8	7	8	8	7	5	7	8	8	7	6	8	7	6	7	7
BOXWORTH	Barley	Nov	7	4	4	5	6	6	5	3	6	3	4	6	5	7	6	7	6	7
Cambs		Jan	2	1	1	1	1	1	1	0	2	0	0	1	1	1	2	3	2	1
cv: Primor	Grasses	Mar	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	1	1	0
	Chickweed	Nov	8	6	5	6	6	5	6	4	3	5	5	2	3	5	7	8	7	2
		Jan	8	6	4	7	5	3	5	1	3	6	4	3	1	1	3	7	5	1
		Mar	9	8	6	7	0	1	0	0	5	7	0	3	0	0	1	3	1	1
		May	9	10	4	9	2	5	4	2	8	9	4	7	3	2	1	9	3	8

*Treatment 18 trifopmethyl 0.36 ai kg/ha benazolin) Dowco 290) 0.35 ai kg/ha Tank mix

SITE 'Q'	Treatments:-		0	1	2	3	5	6	9	10	12	13	14	16	21	25	26
SITE 'Q'	Wheat	Nov	9	7	5	9	5	5	9	3	5	3	3	9	3	9	8
ELSWORTH		Jan	6	2	1	5	1	1	4	0	1	0	0	4	0	4	4
Cambs	Grasses	Mar	4	1	2	4	0	0	4	0	0	0	0	1	0	1	1
cv: Primor																	

SITE 'R'	Treatments:-		0	1	2	5	6	9	10	12	13	14	16	17	18	19	25
SITE 'R'	Crop	Feb	3	7	7	7	7	6	7	6	5	6	6	7	6	7	7
LOLWORTH	Wheat	Nov	8	7	5	7	5	7	6	5	7	6	9	5	9	4	9
Cambs	Blackgrass	Nov	8	6	4	4	3	4	4	5	5	6	9	4	8	2	8
cv: Primor		Dec	8	3	3	2	1	8	0	1	1	1	7	3	7	0	7
		Feb	7	1	1	0	0	6	0	0	0	0	2	2	4	0	4

SITE 'S'	Treatments:-		0	1	2	3	4	5	6	9	10	*11	12	13	14	15	16	17	18
SITE 'S'	Crop	Mar	5	6	5	6	6	6	5	5	5	6	5	6	5	6	5	6	6
BRAMPTON		Apr	7	7	8	8	7	8	7	8	8	7	7	7	8	7	7	7	7
Cambs	Blackgrass	Nov	10	4	3	9	3	4	3	8	2	10	10	8	7	9	9	5	10
cv: Rapora		Dec	4	1	1	4	1	1	1	3	1	6	5	1	1	5	4	1	5
		Apr	3	1	0	1	0	0	0	2	0	0	0	0	0	0	0	1	1

*Treatment 11 Tank mix

		Treatments:-	0	1	2	3	5	6	7	8	9	10	12	13	14	16	20	21	25
SITE 'T'	Crop	Mar	6	7	7	7	7	8	7	7	6	7	8	7	6	7	6	8	7
LONGSTANTON	Barley	Nov	10	9	7	9	9	7	5	3	9	1	5	5	4	9	8	2	10
Cambs		Dec	7	6	5	4	5	4	3	1	7	0	2	1	2	6	6	0	6
cv: Rapora		Mar	4	3	2	3	0	0	1	0	3	0	1	0	0	0	0	0	0

		Treatments:-	0	1	2	3	4	5	6	9	10	11	12	13	14	15	16	17	19
SITE 'U'	Grass Weeds	Nov	6	2	2	5	2	2	2	5	1	1	4	4	2	4	4	5	1
STRADBROOKE		Feb	4	2	1	4	1	0	0	4	0	0	0	0	0	1	0	4	1
Suffolk	Chickweed	Nov	4	3	3	4	2	3	1	2	3	4	3	2	3	6	5	4	2
cv: Primor		Feb	7	7	6	6	0	0	0	5	6	1	4	0	0	0	0	6	3

DISCUSSION (cont)

after an early check from carbetamide plus dimefuron.

One other trial (not reported due to lack of space) was conducted on a site with *Matricaria* sp (mayweed) as the dominant weed, treatments which satisfactorily controlled *Matricaria* were, dimefuron, benazalox + Dowco 290 and Dowco 290 alone, the higher earlier rates were more effective (Proctor & Finch 1978).

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References

PROCTOR J.M. and FINCH, R.J. Chemical weed control in Winter Oil Seed Rape, Proceedings 1976 British Crop Protection Conference - Weeds 1976, 509-516.

PROCTOR J.M. and FINCH, R.J. Weed Control in Oil Seed Rape, Experiments and Development in the Eastern Region, MAFF, 1978, 102-116; 1979

INTERPRETATION OF SOIL ANALYSES FOR HERBICIDE RESIDUES

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Summary Valid conclusions can be drawn from analyses for residues of soil acting herbicides, only if soil samples for analysis are precisely taken to a uniform depth. Interpretation of analyses must take into account the soil type, cultivations and the effect of the weather on degradation of residues between time of sampling and crop response. In experiments on three soil types ploughing before sowing reduced damage to cereal crops caused by residues of eleven soil acting herbicides.

Résumé C'est possible de prendre les décisions valides de l'analyse des résidus des herbicides effectives aux sols, mais seul si les échantillons de ces sols soient toujours pris exactement d'un fond uniforme. Il faut pour une vraie interprétation des résultats, qu'on tient compte du type du sol des méthodes de la cultivation et de l'effet du temps sur la dégradation des résidus, du temps de l'échantillonage au début de la recolte. À titre d'essai sur trois types du sol labourer devant semer est un remède éprouvé pour reduire les dégâts aux céréales occasionnés par les résidus d'onze herbicides effectives dans le sol.

INTRODUCTION

Interpretation of soil residue analysis presents different problems depending on whether the analysis is either to determine the reason for damage to a crop or to decide whether a following crop is likely to be damaged by residues. The first case presents fewer difficulties because any irregularity in application of the herbicide causing damage will be apparent from variations in severity of damage to the crop and it is relatively simple to obtain samples from areas of affected and healthy crop. Also the weather pattern since the herbicide was applied will be known so a reasonable estimate can be made of the extent of degradation of residues that will have occurred between the occurrence of crop damage and sampling the soil.

Prediction of damage that may occur from residues is much more difficult because both the rate of breakdown and crop response will depend on the future weather pattern which is unknown as are dates of sowing and emergence. Also the extent of any unevenness of application leading to overdosing in overlap areas will not be known.

SAMPLING THE SOIL

Whether sampling in a damaged crop or for prediction samples must be carefully taken with a core sampler to precisely the same depth for all cores; unless this is done completely misleading results can be obtained. Most persistent soil acting herbicides are strongly adsorbed by the soil. Unless the soil has been ploughed or cultivated, the residues are normally concentrated near the surface and the top centimetre or so must be adequately represented in the sample. The following typical results were obtained in August 1976 on a clay soil in Cambridgeshire following application of simazine in March for weed control in beans.

Sampling depth cm	simazine mg/kg
0-2.5	0.54
2.5-5	0.27
5-7.5	0.07

Samples taken to the following different depths would have given widely different figures:-

Sampling depth cm	simazine mg/kg
0-2.5	0.54
0-5	0.41
0-7.5	0.29
0-10	0.22
0-15	0.15

Hence samples consisting of cores from a range of unspecified depths can give completely misleading results.

An analysis of a sample taken to a precise depth can be used together with the bulk density of the soil to calculate the dose remaining. For example if the bulk density of the soil is 1.3 the factor is 2.0 to convert mg/kg ai, in a sample taken to 15 cm depth, to kg/ha.

If the field has been cultivated or ploughed before sampling the sample must be taken to at least the depth of ploughing or cultivation or preferably split into two depths, eg 0-10 and 10-20 cm.

FACTORS AFFECTING DAMAGE FROM HERBICIDE RESIDUES

Amount of Residue

The amount of residue in the soil is obviously the most important factor determining whether crop damage will occur. However, the effect of a given amount of herbicide can vary greatly depending on weather conditions which determine the growth of the crop.

Winter wheat is a crop which is often at risk from residues but damage from photosynthesis inhibitors such as atrazine, simazine, metribuzin and terbacil is usually not seen until the spring when the crop starts to transpire rapidly. In the autumn, when growth is normally slow, the crop can tolerate quite a high level of residues which will have partially broken down by the spring. However, if growth is unusually rapid in a very warm autumn or the residues are unusually large damage can be seen at that time.

Damage from inhibitors of cell or nuclear division such as dichlobenil, propyzamide or trifluralin is usually first seen in the autumn and affects the germinating seed so the crop is at risk from the amount of residue in the soil at the time the seed germinates, not when rapid growth commences in the spring.

Cultivations

Cultivations which disperse the residues in a larger volume of soil can greatly reduce crop damage. Crops sown by direct drilling or after very shallow cultivations are most at risk. Mouldboard ploughing is usually particularly effective in reducing the damage from herbicide residues. Its effect on the damage caused by residues to wheat and barley crops was investigated in five experiments on sandy loam, very fine sandy loam and clay loam soils. Eleven soil acting herbicides were applied at an average rate of 1.6 kg/ha ai using a logarithmic sprayer. Separate blocks were ploughed and cultivated, or just cultivated, and then drilled to wheat or barley some weeks later. The results in Table 1 show that the amounts of damage caused by every herbicide were reduced by ploughing.

Table 1

Effect of Ploughing Down Herbicide Residues on Damage to Cereal Crops

Herbicide	No of sites	Not ploughed: Mean % reduction in plant emergence	Not ploughed: Mean % of emerged crop damaged	Ploughed: Mean % reduction in plant emergence	Ploughed: Mean % of emerged crop damaged
propyzamide	5	95	-	42	-
trifluralin	5	52	-	15	-
ethofumesate	3	38	-	0	-
terbacil	5	-	95	-	59
atrazine	5	-	71	-	37
metribuzin	5	-	59	-	25
simazine	5	-	50	-	18
lenacil	5	-	39	-	1
dimefuron	5	-	36	-	3
trietazine	5	-	14	-	0
linuron	5	-	6	-	0

Soil Type

The minimum level of herbicide residue that will cause damage to a susceptible crop varies with soil type for some herbicides. In Britain there is more experience with residues of atrazine and simazine than with any other herbicides and it is well established that damage on light sandy soils can occur with a much lower level of triazine than on heavier soils. With propyzamide there appears to be no significant effect of soil type. The critical level for damage by metribuzin appears to be approximately the same on all mineral soils but may be higher on organic soils. Levels at which damage is likely to occur in winter wheat based on soil samples taken to 15 cm depth are given in Table 2 for several herbicides The textures described follow the ADAS soil texture classification (Eagle, 1976)

Table 2

Approximate Minimum Herbicide Residue Levels which can Damage Winter Wheat

Herbicide	Soil Type	Minimum Damaging residue mg/kg
atrazine or simazine	sands and very light soils	0.05
	light soils	0.1
	medium soils	0.15
	heavy soils	0.2
metribuzin	mineral soils	0.08
propyzamide	" "	0.1
terbacil	" "	0.1
dichlobenil	" "	0.1
linuron	" "	0.2
lenacil	" "	0.15
trifluralin	" "	0.2

PREDICTION OF DAMAGE FROM HERBICIDE RESIDUES

Following the 1975 summer drought herbicide residue damage occurred in a number of winter wheat crops. The herbicides were propyzamide applied to oilseed rape and metribuzin applied to potatoes. Serious damage occurred only in crops sown without ploughing, contrary to the manufacturers recommendations, but was accentuated by slow breakdown of residues during the drought. The occurrence of the even longer drought in 1976 resulted in many requests for analyses of residues of these and other herbicides in fields to be sown with winter wheat. Often the level of residue in a sample taken during the drought was enough to cause damage. Whether damage actually occurred would obviously depend on when the drought ended and the length of time for residues to degrade while the soil was still warm. As the weather could not be predicted farmers were warned of a risk of damage if sufficient residues persisted to cause injury, assuming little or no breakdown by sowing time, and were advised to minimise the risks by ploughing.

The risk of damage to a succeeding crop can be high when heavier than normal doses of herbicide are applied to a crop with marked tolerance to it. Examples are atrazine on maize and propyzamide on lettuce; commonly two or more crops are grown consecutively and each one treated with the herbicide. If a soil sample is taken for analysis during the winter when breakdown is very slow and likely to remain slow until crop growth commences interpretation is relatively straightforward. For example interpretation of atrazine levels in heavy soils would be as follows for crops other than maize or sweet corn:-

atrazine mg/kg in 0-15 cm sample	Interpretation
less than 0.1	safe
0.1 - 0.2	serious damage unlikely; possibility of damage in overlaps; can be minimised by ploughing.
0.2 - 0.3	risk of damage, severe in overlaps; can be minimised by ploughing.
0.3 - 0.4	risk of severe damage, can be reduced by ploughing
greater than 0.4	risk of failure
greater than 0.5	probable failure

For propyzamide the interpretation for susceptible crops is as follows:-

propyzamide mg/kg in 0-15 cm sample	Interpretation
less than 0.05	safe
0.05 - 0.1	possibility of damage in overlaps if not ploughed.
0.1 - 0.2	failure likely if not ploughed, damage likely if ploughed
0.2 - 0.3	risk of failure even if ploughed
greater than 0.3	probable failure

When samples are taken before the winter an estimate of the amount of breakdown which will occur has to be made on the basis of published data on the persistence of the herbicide concerned.

References

EAGLE, D J. (1976) Soil texture classification for the adjustment of herbicide dose. Proc. 13 British Weed Control Conference 1976 Vol 3, 981-988.