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HERBICIDE PROGRAMMES FOR SEASON LONG WEED CONTROL IN SUGAR BEET

W.E. Bray and J.G. Hilton

Norfolk Agricultural Station, Morley, Wymondham, Norfolk, NR18 9DB

Summary An examination has been made of the use of certain herbicide sequences for season long weed control.

All herbicide programmes that used a pre- and post-emergence application gave acceptable control throughout the season.

Some sequences damaged the beet, particularly early in the season. These effects were marked in 1977 and resulted in sugar yield losses.

Résumé Un examen a été fait sur l'utilisation de certaines programmes d'herbicide pour la lutte contre les mauvaises herbes pendant la saison.

Tous les programmes d'herbicides qui utilisaient une application de pré- ou postémergence ont donné un contrôle acceptable tout le long de la saison.

Quelques séquences ont endommagé les betteraves, surtout tôt dans la saison. Ces effets ont été notés en 1977 et ont donné un rendement pouvre en sucre.

INTRODUCTION

Since the introduction of selective herbicides for application in sugar beet in 1961 there has been a continual increase in their use which appeared to reach a plateau in the latter half of the 1970's (Bray, 1980). For example, in 1977 the proportion of the U.K. national crop treated with herbicides pre-drilling, pre-emergence and post-emergence was 34, 68 and 86% respectively with 99% of the area being treated with one or more weedkillers.

With the introduction of phenmedipham in 1968 there was subsequently a rapid increase in post-emergence spraying and herbicide programmes for control of annual broad-leaved weeds became established in the early 1970's. During this period much experimental work was completed to examine the potential of the use of herbicides in sequence (Short, 1972 and 1973; Baldwin and Armsby, 1974; Bray, 1975; Turner, 1976).

The use of herbicide programmes continued to increase commercially, as did the number of available products. Consequently, there was a need to continue work on the sequential use of herbicides.

An experiment was started at the Norfolk Agricultural Station at Morley in 1975 to evaluate the potential for prolonged weed control of various herbicide programmes. Three pre-emergence applied herbicides, namely propham + chlorpropham + fenuron, chloridazon and a tank mixture of ethofumesate + chloridazon, were compared. Throughout the series (1975-78) each of these was followed by post-emergence applications of phenmedipham alone, trifluralin alone, or a sequence of phenmedipham followed by trifluralin. In addition, three other treatments were included, these being the use of phenmedipham twice post-emergence without a previous pre-emergence chemical, an untreated which was kept as weed free as possible by hand and tractor hoeing, and an untreated where weeds were allowed to develop naturally. From 1976 certain post-emergence metamitron treatments were included, used as a single application after each of the pre-emergence sprays, or as two applications in the absence of a pre-emergence herbicide.

At the start of the trial in 1975, chloridazon and phenmedipham were taken as the standard pre-emergence and post-emergence herbicides respectively. For comparison with chloridazon, the propham + chlorpropham + fenuron formulation was chosen as being representative of the many PCF products available commercially which were relatively inexpensive but in wet springs could have low persistence; and ethofumesate + chloridazon as having greater persistence although more expensive. Phenmedipham has contact activity only and to achieve prolonged control more than one application can be necessary. Trifluralin is purely residual in action but unfortunately cannot be applied to beet until they have at least six true leaves and are approximately 10 cm tall when they are able to withstand incorporation of the chemical and movement of soil around the individual plants. The sequence of trifluralin after phenmedipham should ensure acceptable control, but if one could be used without the other, then treatment would be less costly. The introduction of metamitron was attractive because as a post-emergence treatment it exhibits both contact and residual activity (Morris et al, 1976), and might therefore compare favourably with a phenmedipham/trifluralin post-emergence sequence.

METHOD AND MATERIALS

In each year the treatments were accommodated in randomised blocks with four replications. The plot size used for spraying was 3 m (6 rows) x 30 m and for harvesting 1 m (2 rows) x 20 m.

Chemicals were applied overall in a water volume of 230 l/ha by a tractor mounted plot sprayer developed by the British Sugar Corporation (Turner, 1972). The sprayer was fitted with 8003 Teejets and operated at 1.72 bar.

Important site details are shown in Table 1.

Table 1

Site details

Year	Cultivar	Drilled	Seed spacing	Rain after pre-em. spray(mm) 1 week	4 weeks
1975	Nomo	25 April	16 cm	3.5	46.2
1976	Monotri	26 March	16 cm	2.5	14.8
1977	Nomo	10 April	16 cm	0.2	52.5
1978	Nomo	7 April	16 cm	3.8	43.3

The beet was drilled to a stand and the plots untouched between drilling and harvesting with the exception of those treatments receiving trifluralin incorporation, and the weed free controls which were tractor and hand hoed as and when necessary to keep them as clean as reasonably possible. This usually entailed two hand and three tractor hoeings.

In 1976 barban at 0.625 kg/ha was added to all phenmedipham and metamitron treatments because a low population of Avena fatua appeared after crop emergence. In that year an adjuvant oil (Actipron) was not used with metamitron but was in 1977 and 1978. In 1977 barban (0.31 kg) was added to the first application of phenmedipham where no pre-emergence herbicides had been used, to improve the control of Polygonum aviculare.

In all four years the trial was sited on sandy loams at Morley which for herbicide purposes were classified as 'light soils'. All chemical treatments were applied according to the manufacturers' recommendations operative in the year in question as to dose and time of application for both crop and weeds, although occasionally isolated weeds may have been a little more advanced than ideal. The one exception was in 1976 when barban was used as a tank mix with metamitron, there being no recommendation for this combination either then or since.

Detailed weed counts were made in late June or early July. Beet numbers were counted in mid-season and at harvest. Regular visual assessments of weed control and beet vigour were also made. The crop was hand harvested, washed, weighed and then analysed for sugar content.

RESULTS

All herbicide treatments, with the exception of the use of phenmedipham in the absence of a pre-emergence application, gave good weed control until harvest, although PCF followed by trifluralin alone was a little worse than the other sequences. This was a result of poor control of Anagallis arvensis in 1975 and 1978, a weed that is resistant to PCF products. Reliance on phenmedipham alone for weed control was unsuccessful in most years, mainly due to the poor control of P.aviculare in 1975, 1976 and 1978, A.arvensis in 1975 and Viola arvensis in 1976. In 1978 Polygonum convolvulus was an important weed on the trial, but all herbicide treatments controlled it well, even though it is classified as moderately resistant or intermediate to metamitron.

Of the individual herbicide applications, ethofumesate + chloridazon gave better weed control than either PCF or chloridazon, and metamitron was superior to phenmedipham.

Except where phenmedipham alone was used, all herbicide treatments gave better weed control than trying to keep the crop weed free by tractor and hand hoeing only.

The visual vigour of the beet was reduced by all herbicide treatments. The severity varied with season, 1977 being the worst, but was generally aggravated where PCF was used and where phenmedipham had to be sprayed early when a pre-emergence treatment had not been applied. All treatments gave a satisfactory population of beet, at least as good as in the weed free control. No doubt a few plants had been lost from this latter treatment during the various hoeing operations!

Table 2

Mean effects (as percentage of untreated controls) on weeds and crop 1975-78

Treatments pre-em.	post-em.	Weed numbers in late June/ early July	Beet visual vigour in late June	Beet population at harvest	Sugar yield
PCF	phenmedipham	8	70	99	94
"	metamitron±oil*	3	78	101	95
"	trifluralin	11	82	101	92
"	phenmedipham, trifluralin	2	77	101	95
chloridazon	phenmedipham	8	89	103	95
"	metamitron±oil*	6	93	105	101
"	trifluralin	6	96	102	95
"	phenmedipham, trifluralin	1	89	104	97
ethofumesate + chloridazon	phenmedipham	4	81	108	97
"	metamitron±oil*	1	84	102	97
"	trifluralin	2	91	107	99
"	phenmedipham, trifluralin	1	89	105	95
nil	phenmedipham(x2)	32	77	110	94
"	metamitron±oil(x2)*	5	85	101	93
untreated - weedy control		100	78	101	59
untreated - weed free control		13	100	100	100
S.E.		±2.8	±2.8	±2.3	±2.6

*these treatments not examined in 1975

Generally the yields from the herbicide treatments were similar to those from the weed free control, although only chloridazon followed by metamitron (±oil) gave a yield that was as good as this control. This result was particularly interesting as over the three years in which this treatment had been tested, it was the one herbicide sequence that gave a high level of weed control as well as a crop whose appearance resembled most closely that of the untreated weed free plots. All other treatments gave sugar yields that were marginally lower than the hoed plots, a result caused mainly by some treatments reducing sugar yield significantly in 1977.

The climatic conditions experienced in 1977, namely the cool April, May and June with frequent frosts in May, led to high activity from both the pre- and post-emergence herbicides. Vigour of the crop on the worst treatments was affected markedly, persisting to the end of June, and even with the minimum of weeds present on these plots, the restrictions on growth led to subsequent effects on yield.

On average, PCF gave lower yields than chloridazon and ethofumesate + chloridazon, and metamitron gave better yields than the other post-emergence treatments.

DISCUSSION

This trial series has shown that there are several sequences that can achieve satisfactory season long weed control, but some points have arisen which, together with results from other experiments, should be helpful when considering herbicide programmes for beet.

On mineral soils all weed control programmes should be based on the use of a soil acting herbicide applied pre-drilling or pre-emergence of the crop. This allows greater flexibility in the timing of the post-emergence spray and subsequent effectiveness of this application should be greater. In terms of crop selectivity it would appear to be unwise to rely on the PCF type product as the sole residual component of the pre-emergence application, at least on soils as light as the sandy loam found at Morley. Safety from herbicides is ever more in demand and in this respect metamitron is a most interesting product.

Obviously there are many more sequences that need to be examined and in a follow-up to the trial reported here the pre-emergence treatments being examined include metamitron, chloridazon, PCF + chloridazon and ethofumesate + lenacil; with post-emergence metamitron + oil, phenmedipham and phenmedipham + lenacil.

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References

BALDWIN, J.H. and ARMSBY, W.A. (1974) Experiments to discover the effect of sequential application of different herbicides on the growth of sugar beet, Proceedings 12th British Weed Control Conference (1974), 2, 469-475.

BRAY, W.E. (1975) The use of pre- and post-emergence herbicides for prolonged weed control in sugar beet grown with minimal hand labour in the United Kingdom, Third International Meeting on Selective Weed Control in Beet Crops, Paris (1975), 49-63.

BRAY, W.E. (1980) The present requirements from weed control systems in sugar beet, ADAS Quarterly Review (1980), 36, 40-46.

SHORT, J.L. (1972) The use of sugar beet herbicides on sandy soils, Proceedings 11th British Weed Control Conference (1972), 2, 499-504.

SHORT, J.L. (1973) Herbicides for sugar beet on sandland, 1973 Report Gleadthorpe Experimental Husbandry Farm, 27-33.

TURNER, N.V. (1972) A tractor mounted plot sprayer, Proceedings 11th British Weed Control Conference (1972), 1, 101-103.

URNER, N.V., (1976) Late developing weed. British Sugar Beet Review, 44, 1, 11-12

NOTES

THE SEQUENTIAL USE OF METAMITRON IN SUGAR BEET

J.G. Hilton and W.E. Bray

Norfolk Agricultural Station, Morley, Wymondham, Norfolk, NR18 9DB

Summary Metamitron was examined in sequence with other pre- and post-emergence herbicides at various locations throughout East Anglia. Metamitron proved to be an effective pre- or post-emergence herbicide, whilst several useful sequences were noted.

Résumé On a examiné le metamitron en séquence avec d'autres herbicides de pré- ou de postémergence dans plusieurs endroits de East Anglia. Le metamitron a prouvé son efficacité d'herbicide de pré-ou de postémergence. Plusieurs séquences utiles ont été notés.

INTRODUCTION

Metamitron, when examined by the authors in logarithmic screening trials as Bayer 6676 in 1974 and 1975, looked promising as a sugar beet herbicide,particularly with regard to crop safety. This point was stressed by Morris et al (1976) who tested metamitron at a range of crop growth stages. They also concluded that better weed control was achieved with sequences using 3.5 kg a.i./ha (5 kg product) than with single doses pre- or post-emergence up to 7.0 kg. Hack and Schmidt (1976), came to similar conclusions regarding sequential use.

This led the authors to conduct a series of trials beginning in 1976 to examine the use of metamitron in sequence with other commercially available herbicides.

Three levels of metamitron (2.8, 3.5, 4.9 kg a.i./ha) were compared with other pre-emergence herbicides, namely propham + chlorpropham + fenuron (PCF), chloridazon and ethofumesate + chloridazon (all at commercially recommended rates for the sites concerned), followed by post-emergence applications of metamitron at 3.5 or 4.9 kg, phenmedipham (1.14 kg) or phenmedipham (1.14 kg) + adjuvant oil (Actipron 5 l prod/ha) in fully factorial combinations. The rate of adjuvant oil used was changed from 5.5 l to 5 l prod/ha in 1978 to conform to new metricated recommendations.

METHOD AND MATERIALS

In each year three or four trials were laid down in commercial crops of sugar beet. In all cases the pre-emergence treatments were applied as soon after drilling as possible using a Van der Weij plot sprayer arranged to spray five or six rows to match the drill width. Plot area was 5 or 6 rows x 12.5 m. Applications were made in a volume of 400 l/ha using Birchmeier 1.6-673a-1.3 nozzles at 2.5 bar. The post-emergence spraying was carried out in accordance with commercial recommendations for phenmedipham ± oil regarding growth stages of both beet and weeds and entailed several visits to most sites. During the period of the trial series there were no restrictions on the use of metamitron according to beet growth stage and applications were made, where possible, to very young weeds. The same sprayer was used, applying the treatments in a volume of 200-240 l/ha with Birchmeier 1.6-673a nozzles at 2.2 bar. Site details are shown in Table 1. Timings of the post-emergence applications are shown in Table 2.

Table 1

Site details

Year and location	Soil type	Drilled	Sprayed pre-em.	Rain after pre-em. spraying(mm) 1 week	4 weeks
1976					
1. Morley, Norfolk	sandy loam	25 March	30 March	2.5	14.8
2. Gisleham, Suffolk	sandy loam	27 March	2 April	2.3	7.3
3. Higham, Suffolk	sandy loam	23 March	26 March	0.1	11.9
1977					
4. Morley, Norfolk	sandy loam	10 April	13 April	0.4	43.2
5. East Harling, Norfolk	loamy fine sand	14 April	19 April	4.1	65.5
6. Coltishall, Norfolk	loamy sand	18 March	23 March	12.9	29.2
7. Holt, Norfolk	coarse sandy loam	5 April	6 April	24.4	69.8
1978					
8. Old Buckenham, Norfolk	loamy fine sand	5 April	10 April	22.4	47.0
9. Hoveton, Norfolk	sandy loam	6 April	11 April	19.1	49.5
10. Dersingham, Norfolk	loamy fine sand	31 March	3 April	0.0	42.5

Beet and weed counts were made several weeks after the last post-emergence spray.

Weeds were counted on ten random 10 cm x 50 cm quadrats per plot and the most frequently occurring species recorded separately. Beet were counted on the inner three rows of five row plots or the inner four rows of six row plots, avoiding one metre at either end.

In the autumn, several of the trials were harvested by hand by taking the same area used for the beet counts (3 or 4 rows x 10.5 m) The plots were dug, topped manually and subsequently pressure washed and weighed. Samples of brei were taken and sugar content was determined by means of a polarimeter.

Table 2

Mean times of application of post-emergence sprays after drilling (days) 1976-78

Pre-emergence	metamitron 3.5 kg	metamitron 4.9 kg	Post-emergence phenmedipham	phenmedipham + oil	Mean
untreated	44	44	44	49	45
metamitron 2.8 kg	57	57	58	59	58
" 3.5 kg	64	64	66	69	66
" 4.9 kg	67	67	68	69	68
PCF	49	49	49	54	50
chloridazon	52	52	52	56	53
ethofumesate + chloridazon	53	53	54	58	55
Mean	55	55	56	59	

RESULTS

The timings of the post-emergence herbicides (Table 2) give some indication of the relative usefulness and persistence of the pre-emergence materials. Metamitron proved to be more persistent than the other pre-emergence herbicides. The present standard rate of 3.5 kg gave 11, 13 and 16 days more persistence than ethofumesate + chloridazon, chloridazon and PCF respectively. In the dry spring of 1976 differences between the pre-emergence treatments were marginal. The following year metamitron proved to be the most persistent and it is doubtful if post-emergence spraying on a commercial basis would have been justified on the two higher rates on all of the sites. Even the 2.8 kg rate of metamitron on two sites was sprayed with the post-emergence materials as late as the fourth week of June.

Pre-emergence weed control was less effective in 1978 and no large differences in post-emergence spraying dates occurred, but marked differences in weed control were observed.

Weed counts (Table 3) showed the usefulness of metamitron as a pre-emergence herbicide. Even in the absence of a post-emergence herbicide, 2.8 kg/ha gave a mean weed control of 70 per cent, whilst the recommended rate of 3.5 kg/ha gave 75 per cent. The highest rate of 4.9 kg/ha gave in excess of 80 per cent weed control. Ethofumesate + chloridazon gave the next best control (60 per cent) whilst PCF and chloridazon gave 53 and 43 per cent respectively. These results from metamitron are all the more impressive because in 1976 the two higher rates gave more than 90 per cent control in the very dry spring conditions at Morley. In one trial in 1978, all rates of metamitron pre-emergence gave 75 per cent weed control whereas PCF and chloridazon only gave 17 per cent and 18 per cent respectively and ethofumesate + chloridazon 36 per cent.

When considering the performance of the chemicals applied post-emergence, in the absence of pre-emergence sprays, metamitron was equal to phenmedipham or phenmedipham + oil, although the 4.9 kg rate of metamitron was the marginally superior treatment. These figures include the poor results at one site in 1976,

Table 3

Mean weed population as percentage of untreated plots 1976-78

Pre-emergence	Post-emergence: untreated	metamitron 3.5 kg	metamitron 4.9 kg	phenmedipham	phenmedipham + oil	Mean
untreated	100	37	26	34	33	46
metamitron 2.8 kg	30	14	7	7	7	13
" 3.5 kg	25	14	15	4	5	13
" 4.9 kg	17	11	13	3	3	9
PCF	47	22	18	15	15	23
chloridazon	57	19	17	18	15	25
ethofumesate + chloridazon	40	12	11	14	17	19
			S.E. ± 2.1			S.E. ± 0.9
Mean	45	18	15	14	14	
			S.E. ± 0.8			

when in the extremely dry conditions metamitron failed to control Chenopodium album. Metamitron relies to a large extent on soil uptake by weeds, even when applied post-emergence, and in this particular year C.album germinated late and was not controlled to any reasonable extent. Metamitron applied post-emergence gave limited activity at one other site that year. In contrast, C.album was completely controlled (97% to 100%) by both 3.5 and 4.9 kg of metamitron post-emergence at one site in the following year.

Most pre- plus post-emergence herbicide sequences gave in excess of 80 per cent weed control. The best combinations appeared to be metamitron pre-emergence followed by phenmedipham or phenmedipham + oil, which at the higher rates of metamitron (3.5 and 4.9 kg) gave 95 per cent weed control or above. An essential part of a good herbicide sequence is effective pre-emergence weed control and this was clearly demonstrated at one site in 1978, where both chloridazon and PCF were ineffective and herbicide sequences including these materials gave unacceptable results.

Metamitron + adjuvant oil post-emergence was not used in this trial series and from a weed control point of view this treatment would be expected to give better results than metamitron alone.

Data relating to seedling establishment are given in Table 4. PCF significantly reduced beet seedling population and vigour at several sites and ethofumesate + chloridazon caused a vigour reduction on one site in 1977. At this last site all pre-emergence treatments, with the exception of the 2.8 kg rate of metamitron, reduced beet seedling population. This included the two higher rates of metamitron, suggesting that this product may not be completely safe under all conditions.

The post-emergence treatments of phenmedipham and particularly phenmedipham + oil reduced beet seedling vigour on occasions, but did not affect beet seedling population. Metamitron at 4.9 kg at one site also reduced beet seedling vigour slightly.

Table 4

Mean beet seedling population as percentage of untreated plots 1976-78

Pre-emergence	Post-emergence untreated	metamitron 3.5 kg	metamitron 4.9 kg	phenmedipham	phenmedipham + oil	Mean
untreated	100	107	103	103	108	104
metamitron 2.8 kg	108	106	104	110	104	106
" 3.5 kg	101	103	103	102	105	103
" 4.9 kg	104	103	107	106	106	105
PCF	99	105	101	101	102	102
chloridazon	108	107	107	110	103	107
ethofumesate + chloridazon	100	107	103	107	103	104
			S.E. ± 2.0			S.E. ± 0.9
Mean	103	105	104	106	104	
			S.E. ± 0.7			

Table 5

Mean yield of sugar as percentage of untreated plots 1976-78

Pre-emergence	Post-emergence untreated	metamitron 3.5 kg	metamitron 4.9 kg	phenmedipham	phenmedipham + oil	Mean
untreated	100	126	133	134	135	126
metamitron 2.8 kg	134	145	140	143	141	141
" 3.5 kg	135	138	139	139	140	138
" 4.9 kg	137	134	139	141	137	138
PCF	116	129	132	133	126	127
chloridazon	131	137	140	135	131	135
ethofumesate + chloridazon	130	138	138	138	137	136
			S.E. ± 2.4			S.E. ± 1.1
Mean	126	135	137	138	135	
			S.E. ± 0.9			

The summary of sugar yield data (Table 5) shows the safety of metamitron whether used in sequences with itself or the other herbicides tested with the exception of PCF, where yields were generally lower when this herbicide preceded metamitron and the other post-emergence herbicides. The lower yields from untreated crop or ones treated with PCF alone are due in part to weed competition, even though the trial areas were hoed after weed assessments had been made.

DISCUSSION

This series of experiments over three years clearly demonstrates the useful pre- and post-emergence herbicidal activity of metamitron. The effect on the weeds and the degree of persistence of this new material has proved to be equal to, and in some cases superior to the other pre-emergence herbicides examined. Its post-emergence activity only proved to be limited in the extremely dry conditions of 1976. There is evidence to suggest, even though this was not examined in this trial, that under such circumstances the use of an adjuvant oil will improve the contact activity of metamitron to a level similar to that of phenmedipham. In most cases the residual activity associated with its use, not only pre- but also post-emergence, has been an added bonus over the purely contact post-emergence herbicides, which rely on relatively uniform emergence of weeds for really effective activity from a single application. Metamitron obviously fits in well as part of a programme of herbicide use (Hack & Schmidt, 1976) and its place in the sequence will depend upon the particular conditions of the farm concerned and should take into account soil type and weed flora. The PCF herbicide was the only one which gave yield reductions when compared with the other treatments, and its use should perhaps be restricted to heavier or peaty soils.

Metamitron appears to be safe for the crop (Morris et al, 1976) and under these three years of experimentation its use gave yields as good as or better than given by the other herbicides examined. This was even evident on the one occasion that a slight loss in population was observed with metamitron used pre-emergence. This surprising result has since occurred in commercial practice in isolated instances, but nevertheless it can still be said that metamitron is one of the safest products available for pre- or post-emergence use in sugar beet. The addition of an adjuvant oil to metamitron to enhance the contact activity can reduce selectivity somewhat and certain pre-emergence products might in this situation pre-dispose the beet to phytotoxicity more than others. The manufacturers of metamitron have severely restricted its use in sequence with other herbicides, but it is hoped that data obtained from these trials will go some way to indicate possible useful sequences and eliminate those which may have a damaging effect.

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References

HACK, H. and SCHMIDT, R.R. (1976) Use of metamitron in weed control systems in sugar beet, Proceedings 13th British Weed Control Conference, 1, 197-204

MORRIS, D.B, BIRCH, P.A. and ROSE, P.W. (1976) The development of metamitron, a highly selective and versatile herbicide for use on sugar beet in the U.K. Proceedings 13th British Weed Control Conference, 1, 189-196.

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THE CONTROL OF ANNUAL WEEDS PRE-EMERGENCE IN SUGAR BEET, WITH A MIXTURE OF PROPHAM, CHLORPROPHAM FENURON AND METAMITRON, 1977-1980

R.A. Elliott and K.U. Jung
Cropsafe Limited, Salisbury Road, Downton, Wilts.

Summary 16 trials carried out on sugar beet grown on a range of mineral soils, between 1977 and 1980, showed that a mixture of propham, chlorpropham and fenuron (PCF) @ 0.58 - 1.18 kg ai/ha, tank-mixed with metamitron @ 1.4 - 1.75 kg ai/ha, gave excellent weed control and crop tolerance, when applied pre-emergence.

Crop emergence and subsequent vigour from the PCF/metamitron mixture at 'normal' dosage, was very similar to that from both the untreated area and metamitron @ 3.5 kg ai/ha. PCF/metamitron at 'twice normal' dosage gave excellent emergence and reduced vigour by only 7 % compared to the single dosage.

Weed control was improved by the PCF/metamitron mixture through better control of Polygonum convolulus, Polygonum persicaria, Veronica persica and Viola arvensis than was given by metamitron @ 3.5 kg ai/ha.

Résumé 16 experiences executées entre 1977 et 1980 sur la betterave qui a poussé dans une variété de sols, donnaient des résultats suivants: un mélange de propham, chlorpropham et fenuron a 0.58 - 1.18 kg ai/ha, mélange avec metamitron a 1.4 - 1.75 kg ai/ha donnait un traitement herbicide excellent et n'affectait pas la récolte.

La récolte et la vitesse suivante du mélange de PCF/metamitron applique d'un dosage normal rassemblaient beaucoup celles de la zone sans traitement et celle ou le metamitron était a 3.5 kg ai/ha. PCF/metamitron a double dosage normal donnait une émergence excellente, et ne reduisait la force que par 7 % par comparaison avec le dosage simple.

Le traitement herbicide à été ameliore avec le mélange du PCF/metamitron par un meilleur contrôlé du Polygonum convolulus, Polygonum persicaria, Veronica persica et Viola arvensis une amelioration sur les résultats donnes par metamitron a 3.5 kg ai/ha.

INTRODUCTION

Formulated mixtures of propham, chlorpropham and fenuron (PCF) have been widely used in the U K for pre-emergence weed control in sugar beet for nearly twenty years. During the late 1960's and early 1970's a four-way mixture was developed consisting of a tank mixture of PCF and chloridazon, each at half the rate of active ingredient recommended for use alone. The mixture was approved under the Agricultural Chemicals Approval Scheme. Later this four-way mixture became available as a ready-mixed product .

The advantages of this mixture were threefold;

a) The weed spectrum of the four-way mixture was wider than that of the products when used separately.

b) The safety to the crop was increased.

c) The cost of the treatment was reduced below that of the non-PCF component used alone.

The appearance of metamitron for pre-emergence weed control in sugar beet in the mid 1970's (Morris et al 1976), suggested a possible four-way mixture of PCF/metamitron. The published data referring to metamitron mixtures (Morris et al 1978), referred only to the full rate of each component being applied. However previous mixtures of other herbicides with PCF had been found to be successful at reduced rates of all constituents, and it was only with these dosages that the advantages of b) and c) listed above could be expected.

METHOD AND MATERIALS

All 16 trials were of a randomised block design, each with four replicates, and all were carried out in commercial crops of sugar beet located in Eastern England. Soil types varied from loamy sand to clay loam.

Plot size was 2.8 metres by either 8.4 or 10.0 metres. All applications were made with a Van der Weij "Azo" Sprayer at a pressure of 3.0 bar using fan jets, delivering 330 l/ha.

PCF was formulated as a 21 % e.c. for trials in 1977-79; in 1980 a 42 % s.c. was used. A full series of replicated trials carried out in 1980 (Elliott 1980) showed that there was no difference in activity between equivalent rates of the e.c. and s.c. formulations.

Metamitron was formulated as a 70 % w.p. All treatments were applied within a few days of drilling, before crops or weeds had germinated.

Crop tolerance was measured initially by crop emergence counts of 10 x 1m lengths of row per plot; the data is presented as thousands of plants per hectare. Crop vigour assessments were made by visual comparison with the untreated control and results are expressed as percentage crop vigour (Dead = 0 %).

Herbicidal activity was measured by making weed counts in 10 quadrats of $0.1m^2$, in each untreated plot, the treated plots being scored visually on a percentage control basis relative to each untreated control plot. Both control of individual species and overall weed control were assessed in this manner.

The PCF/metamitron mixture applied at the proposed 'normal' (n) rate varied with soil type as follows:

Table 1

The variation in dosage of PCF & metamitron to give a 'normal' rate for each soil type

	Soil Type (ADAS classification)				
	Sand	Very light	Light	Medium	Heavy
PCF kg ai/ha	0.58	0.74	0.86	1.05	1.18
Metamitron kg ai/ha	1.40	1.40	1.40	1.75	1.75

Metamitron @ 3.5 kg ai/ha was included as the commercial comparison in each trial, together with a double dose (2n) of the PCF/metamitron mixture for crop safety evaluations.

Table 2

Individual site details

	Site No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Year of trial	1977						1978		1979				1980			
Location (1)	S	S	S	S	S	S	S	S	S	N	N	S	N	L	S	S
Soil type (ADAS classification)	CSL	CSL	SL	CL	CL	SL	FSL	LS	LS	CSL	CSL	VFSL	SL	ZyL	ZyL	ZL
Previous Crop	B	W	B	W	P	W	B	B	B	B	B	B	B	W	B	W
Variety	Bush	Nomo	Bush	Sharp's	Nomo	Vytomc	Nomo	Nomo	Bush	Bush	Bush	Sharp's	Bush	Sharp's	Monotri	Sharp's
Drilling Date	2/4	2/4	9/4	9/4	15/4	14/4	8/4	14/4	17/4	19/4	11/4	8/5	26/3	8/4	10/4	14/4
Spraying Date	8/4	9/4	10/4	15/4	17/4	18/4	9/4	15/4	19/4	19/4	19/4	14/5	26/3	10/4	15/4	18/4

(1) S = Suffolk
N = Norfolk
L = Lincs

(2) B = Barley
W = Wheat
P = Potatoes

RESULTS

Weather conditions

The two years for which crop emergence data was recorded were representative of very different Spring weather conditions. In 1979 warm, wet weather gave very good crop emergence generally and optimum herbicide action. Conversely in 1980 hot, dry conditions, without rainfall from the end of March to the end of May, caused generally poor emergence and poor action from many residual herbicides.

Crop emergence (Table 3)

The variation in emergence between sites was much greater in 1980 due to the adverse weather conditions, than in 1979. Trial No. 12 was not drilled to a stand, and emergence counts were taken before chopping out.

Table 3

Summary of crop emergence results in 1979 & 1980

Crop emergence 000's/ha		Untreated	PCF/metamitron 'n'	PCF/metamitron '2n'	metamitron 3.5 kg ai/ha	LSD
1979						
Trial No.	9	100.0	86.1	89.7	92.8	
	10	80.7	72.7	72.1	80.7	
	11	91.8	91.2	85.5	99.7	
	12	136.3	133.8	132.8	128.7	
1979 mean		102.2	96.0	95.0	100.5	
1980						
Trial No.	13	50.9	55.3	51.7	62.2	
	14	89.2	96.9	108.0	106.1	
	15	74.6	76.6	77.5	72.7	
	16	35.5	34.2	28.7	25.7	
1980 mean		62.6	65.8	66.5	66.7	
1979/80 mean		82.4	80.9	80.8	83.6	S.E $\pm$ 2.8

No significant difference in crop emergence were found between any of the treatments, including the PCF/metamitron treatment at both single and double dosage, both being within 2 % of the untreated, showing the wide margin of safety to the germinating crop.

Crop vigour (Table 4)

The vigour of the crops assessed between 1977-80 was generally very high except Trial No. 14 (1980), which was suffering from drought and slight mineral deficiency when scored. The mean vigour scores of all trials showed very little difference between untreated, metamitron and PCF/metamitron, which were 99, 98 and 97% respectively overall, and 98, 96 and 94 % if the 1979 and 1980 trials are considered alone. Doubling the dosage of PCF/metamitron reduced vigour by 11 % compared to the untreated crop which was considered a reasonable safety margin.

Table 4

Summary of % crop vigour results 6-7 weeks post spraying 1977-1980

Trial No.	Year	Untreated	PCF/metamitron 'n'	PCF/metamitron '2n'	metamitron 3.5 kg ai/ha
1	1977	100	100	-	100
2		100	100	-	100
3		100	100	-	100
4		100	100	-	100
5		100	98	-	100
6		100	98	-	100
7	1978	100	100	-	100
8		100	100	-	100
9	1979	100	85	73	95
10		100	94	89	98
11		100	98	86	96
12		100	90	93	98
13	1980	100	93	68	98
14		85	88	85	83
15		100	100	100	100
16		100	100	100	100
Mean		99	97		98 S.E. $\pm$ 1.1
Mean of trials 9-16		98	94	87	96 S.E. $\pm$ 3.2

In the wet year 1979, there were greater crop vigour reductions by PCF/metamitron, than in the dry year 1980. This was opposite to the effect of metamitron alone.

Overall weed control (Table 6)

The overall herbicidal effect achieved by metamitron or PCF/metamitron was very similar over the four years trials, with both products averaging 90 - 92 % weed control. Doubling the dose of PCF/metamitron increased this already excellent control to 94 %.

Table 5

Summary of % overall weed control 6-7 weeks post spraying 1977 - 1980

Trial No.	Untreated	PCF/metamitron 'n'	PCF/metamitron '2n'	metamitron 3.5 kg ai/ha
1	-	90	-	98
2	-	98	-	98
3	-	98	-	95
4	-	65	-	85
5	-	98	-	85
6	-	95	-	98
7	-	85	-	89
8	-	77	-	94
9	-	98	100	100
10	-	100	100	100
11	-	96	99	99
12	-	99	100	99
13	-	70	82	65
14	-	88	85	83
15	Trials affected by drought			
16				
Mean	0	90	-	92 S.E $\pm$ 1.8
Mean of trials 8-14	0	92	94	91 S.E. $\pm$ 1.0

Control of individual species (Table 6)

Results are presented in alphabetical order of the individual weed species. The trial reference number is followed by the individual weed population found on that trial and then the percentage weed control obtained by each treatment. If a species occurred on more than one trial site a mean percentage weed control is given. In the case of Chenopodium album, Matricaria maritimum, Polygonum aviculare and Stellaria media the range of results is given in place of the individual figures as the data for each of thess species was so similar.

Table 6

The % control of individual weed species 6-7 weeks post spraying 1977-80

	Trial No.	Pop'n in untreated per m^2	PCF/metamitron 'n'	PCF/metamitron '2n'	metamitron 3.5 kg ai/ha
Aethusa cynapium	7	64	83	-	100
Avena fatua	4	36	70	-	80
Chenopodium album	1-4,7-11 13,14	4-278	90-100	100	89-100
	Mean		98		98
Matricaria maritimum	1-3,11	11-56	99-100	100	97-100
	Mean		100		99
Polygonum aviculare	2,3,5, 8,9,11-13	6-97	73-100	90-100	80-100
	Mean		95		94
Polygonum convolulus	2	9	98	-	85
	5	76	95	-	80
	7	24	67	-	67
	Mean		87		77
Polygonum persicaria	3	24	100	-	85
	6	850	95	-	85
	10	226	100	100	95
	Mean		98		92
Silene alba	7	11	75	-	96
Sinapsis arvensis	7	35	92	-	100
Stellaria media	1,4,8, 10-12	15-84	98-100	100	95-100
	Mean		99		98
Urtica urens	11	237	99	100	98
Veronica persica	1	11	95	-	95
	4	10	95	-	95
	7	19	57	-	57
	9	38	98	100	76
	10	34	100	100	96
	11	149	95	100	94
	Mean		90	-	86
Viola arvensis	8	216	65	-	95
	9	39	98	100	61
	11	28	84	100	59
	Mean		82		72

The majority of weeds encountered were controlled toover 90 % by both metamitron and PCF/metamitron. These included C. album, M. maritimum, P.aviculare P. persicaria, S. arvensis, S. media, and U. urens.

Three weeds, A. cynapium, A. fatua and S. arvensis appeared to be controlled better by metamitron alone, although all three weeds each occurred on only one site. (A. fatua is listed as resistant and S. arvensis as only moderately susceptible to metamitron.)

Five weeds appeared to be controlled better by the PCF/metamitron mixture than by metamitron alone. S. alba occurred on only one site and there only in modest numbers. However, P. convolvulus, P. persicaria, V. persica and V. arvensis all occurred on at least three sites and often in very large numbers. Metamitron alone achieved 77, 92 86 and 72 % control of these four species respectively, whereas PCF/metamitron gave 87, 98, 90 and 82 % control, which indicates that at least the first three species can be considered fully susceptible to the PCF/ metamitron mixture.

DISCUSSION

The results show that when PCF at half the dosage normally recommended for a particular soil type is tank mixed with 1.4 kg ai metamitron, crop safety is excellent, both as regards emergence and subsequent vigour, and under both wet and very dry conditions.

Overall weed control by metamitron alone and the PCF/metamitron mixture was excellent. However on an individual weed species basis the PCF/metamitron mixture gave increased control of a wider range, especially P. convolulus, P. persicaria, V. persica and V. arvensis which are serious weeds in sugar beet. If not almost completely controlled they have the ability to recover from an initial check and thus to compete with the crop and impede harvesting, P. convolulus being especially important in this respect.

The results indicate that the PCF/metamitron mixture gives similar advantages over metamitron alone, to those given by the PCF/chloridazon mixture over chloridazon alone.

It is of particular interest that a four-way herbicide mixture at reduced rates of each ingredient can simultaneously increase both weed control and crop safety, over that given by the components used separately, at full rate. It may well be that by reducing the dosage of individual active ingredients, and combining low dosage of other pesticides showing some selectivity between crops and weeds, a wide range of safe but effective pesticide mixtures can be formulated. This is of increasing importance in the search for better pesticides, in the face of a decline in the discovery of new active ingredients.

References

ELLIOTT, R.A. (1980) Cropsafe Technical Report No 8

MORRIS, D.B. BIRCH, P.A. and ROSE, P.W. (1976) The development of metamitron, a highly selective and versatile herbicide, for use on sugar beet in the U K. Proceedings 12th British Weed Control Conference 189 - 196

MORRIS, D. B. BIRCH, P.A. and ROWLEY, K.W. (1978) Sugar beet weed control programmes based upon metamitron. Proceedings 14th British Weed Control Conference 277 - 284

THE CONTROL OF GRASS AND BROAD LEAVED WEEDS IN SUGAR BEET WITH CHLORIDAZON AND DIALLATE

S G Draper and D A Stormonth

BASF (United Kingdom) Limited, Lady Lane, Hadleigh, Ipswich IP7 6BQ, Suffolk

Summary Good control of broad leaved and grass weeds was obtained with a formulated mixture of chloridazon and diallate as a suspension colloid. The weed control over a range of soil types was better with the formulation than with a tank mix at the recommended rates of chloridazon and triallate. However, the formulated mixture of chloridazon and triallate gave markedly better weed control than the tank mix of the two ingredients, the level of weed control obtained being equivalent to that given by the formulated mixture of chloridazon and diallate.

Résumé On a obtenu un bon contrôle des mauvaises herbes (à feuilles larges, et graminées) en employant un mélange formulé de chloridazon et diallate en colloide en suspension. Le contrôle de mauvaises herbes sur des espèces variées de terre fut plus efficace avec la formulation qu' avec le mélange en réservoir aux proportions recommandées de chloridazon et de triallate. Le mélange formulé de chloridazon et triallate a effectué un controle remarquablement plus efficace qu'un mélange en réservoir des deux produits, et le niveau de contrôle de mauvaises herbes que l'on a achevé équivalait à celui qui a été obtenu en employant le mélange formulé de chloridazon et diallate.

INTRODUCTION

The herbicidal activity of chloridazon on broad leaved weeds in sugar beet (Fischer 1962) and the activity of diallate on the grass weeds (Hannah 1959) have been reported in earlier papers. The activity of both products applied either sequentially or as a tank mix has also been reported (Bray and Hilton 1970). The mixture applied as a pre-emergence incorporated treatment gave good broad-leaved and grass weed control with reduced rates of both products, indicating the good additive properties of the two components. In 1977 trials were initiated to see if a formulated mixture of the two compounds could obtain the same degree of activity as the tank mix on both broad leaved and grass weeds in sugar beet on a range of soil types without adversely affecting the crop safety.

METHOD AND MATERIALS

Site Details - small plot four times replicated, sprayed with a Van der Weij knapsack sprayer at 2.5 bar and 250 l/ha of water. Plot size was 2.8 to 4 m x 10 m.

Assessments -

a) weed control: individual weed species were counted by using 9 x 0.33m^2 quadrats taken at random per plot at crop cotyledon to 1 true leaf stage. A visual assessment of % overall weed control was made at crop 2-4 true leaf stage.

RESULTS

Table 2

Per cent weed control given in six trials by a formulation and tank mix of chloridazon + diallate - 1978 (over a range of soil types)

Weed Species	chloridazon + diallate formulated W.P. (BAS 41801H)	chloridazon + diallate (tankmix)
Avena fatua	80.0	77.5
Poa annua	84.0	77.0
Polygonum aviculare	84.0	71.4
Polygonum convolvulus	75.6	81.8
Stellaria media	63.7	62.5
Overall weed control	71.0	63.0

Weed control was assessed at cotyledon to 1st true leaf stage of the crop.

Table 3

Weed control spectrum from treatment with chloridazon + diallate or triallate on light soil types from four trials carried out in 1979 (as per cent weed control)

Weed Species	Untreated (Plants/m^2)	BAS41805H	BAS41801H	BAS41905H	BAS 11906H + BAS 12602H (tankmix).
Avena fatua	14.5	95	90	97	91
Chenopodium album	59.5	90	89	90	80
Lamium amplexicaule	58.0	91	79	65	45
Myosotis asvensis	23.5	65	84	71	34
Poa annua	96.6	97	98	96	92
Polygonum aviculare	38.1	75	59	63	61
Polygonum convolvulus	18.3	84	41	84	66
Polygonum persicaria	48.5	89	95	93	94
Stellaria media	42.4	79	66	65	44
Veronica persica	39.2	88	83	82	85
Overall weed control	24.1	86	83	84	73
S.E (12 DF)	15.8				

Table 4

Weed Control spectrum from treatment with chloridazon and diallate on medium soil types from eight trials carried out in 1979 (as per cent weed control)

Weed Species	Untreated (plants/m^2)	BAS41805H	BAS41801H	BAS41905H	BAS 11916H + BAS 12602H (tank mix)
Avena fatua	5.0	96	92	94	90
Atriplex patula	24.5	79	78	72	71
Chenopodium album	24.4	83	84	77	75
Lamium amplexicaule	23.8	66	85	84	71
Matricaria matricarioides	13.3	98	99	100	99
Myosotis arvensis	12.3	78	63	37	69
Polygonum aviculare	19.0	77	84	87	78
Polygonum convolvulus	6.3	94	88	81	85
Polygonum persicaria	25.0	92	89	93	97
Stellaria media	23.1	81	82	81	74
Overall weed control	21	76	77	73	67
SE (12 DF)	12.8				

Table 5

Weed control spectrum from treatment with chloridazon + diallate or triallate on heavy soil types from four trials carried out in 1979 (as per cent weed control)

Weed Species	Untreated (plants/m^2)	BAS41805H	BAS41801H	BAS41905H	BAS 11916H + BAS 12602H (tank mix)
Avena fatua	11.0	90	96	92	86
Atriplex patula	32.75	81	81	91	65
Chenopodium album	6.85	85	63	63	74
Mysotis arvensis	8.35	97	97	94	97
Polygonum aviculare	13.5	76	74	91	91
Polygonum convolvulus	8.1	80	77	75	66
Polygonum persicaria	23.8	94	92	96	90
Stellaria media	27.6	83	82	86	83
Veronica persica	17.3	97	91	96	97
Overall weed control	18	66	77	75	69
SE (12 DF)	5.9				

b) Crop safety was assessed using three scales:

i) crop vigour was assessed using a 0-200 linear scale where the untreated always equals 100

ii) crop damage: a two part scale was used. The percentage area of the plot affected was assessed and the severity of damage was graded on a 0-10 scale.

iii) germination density: the number of seedlings germinated in 10 x 1 m lengths of row per plot taken at random were counted

Table 1

Rates of use and % active ingredients of the chloridazon + triallate or diallate mixtures

	BAS 41805H			BAS 41801H			BAS 11916H+ BAS 12602H			BAS 41905H		
		gms ai/ha			gms ai/ha			gms ai/ha			gms ai/ha	
SOIL* TYPES	Rate of use 1/ha	chlori-dazon	dial-late	Rate of use 1/ha	chlori-dazon	dial-late	Rate of use 1/ha	chlori-dazon	trial-late	Rate of use 1/ha	chlori-dazon	trial-late
light	6.0	1960	1200	6.0	1960	1200	3.0 + 3.0	1300	1200	6.0	1960	1200
Medium	6.0	1960	1200	6.0	1960	1200	4.5 + 3.0	1900	1200	6.0	1960	1200
Heavy	8.0	2640	1600	8.0	2640	1600	6.0 + 3.0	2580	1200	8.0	2640	1600

* In accordance with the ADAS Soil Textural Classification

MATERIALS

BAS 41805H a suspension colloid containing 33% chloridazon and 20% diallate
BAS 41801H a wettable powder containing 33% w/v chloridazon and 20% diallate
BAS 41905H a suspension colloid containing 33% chloridazon and 20% diallate
BAS 11916H a suspension colloid containing 43.3% w/v chloridazon
BAS 12602H an emulsifiable concentrate containing 40% w/v triallate
BAS 11401H an emulsifiable concentrate containing 40% w/v diallate

Table 6

Crop safety on all soil types with chloridazon + diallate or triallate from twelve trials carried out in 1979. (trials were assessed at crop emergence)

Soil Texture Category	BAS41805H	BAS41801H	BAS41905H	BAS 11916H + BAS 12602H (tank mix)
		crop vigour		
Light	95.3	94.5	93.5	96.5
Medium	96.0	98.3	95.8	97.0
Heavy	98.8	99.0	97.0	97.5
	plants germinated - relative to untreated = 100			
Light	93.5	91.0	86.5	93.5
Medium	97.0	101.5	104.8	91.5
Heavy	95.3	96.8	96.8	96.8

Table 7

The persistance of chloridazon + diallate or triallate as shown by overall weed control and crop vigour assessed at the crop 2-4 leaf stage from sixteen trials in 1979

Soil Texture Category	BAS41805H	BAS41801H	BAS41905H	BAS 11916H + BAS 12602H (tank mix)
		weed control		
Light	85	83	78	73
Medium	83	83	79	78
Heavy	82	80	83	81
		crop vigour		
Light	92	92	90	94
Medium	95	99	98	100
Heavy	98	94	100	98

DISCUSSION

In 1977 BASF produced a formulated mixture of chloridazon and diallate as a wettable powder. This was compared in trials with chloridazon and diallate as a tank mixture on heavy, medium and light soils in 1978. (Table 2). On all soil types the activity of the wettable powder in terms of weed control was generally superior to the tank mix. This may have been due to the amount of chloridazon and/or diallate in the formulation, which was higher than in the tank mix on the light and heavy soil types. However, this variation had no effect on the level of the crop safety compared to the tank mix recommendation (Table 6).

In 1979 a flowable formulation of chloridazon + diallate (BAS 41805H) was produced which in trials was compared with the wettable powder formulation (Tables 4 and 5). Although there was no difference in the amount of active ingredients applied the flowable formulation gave a more consistant commercially acceptable level of weed control. This was especially noticeable with *Polygonum aviculare*, *Polygonum convolvulus* and *Stellaria media* on light soil types and may possibly be explained by the slightly greater persistance of the flowable formulation on these soil types.

In 1979 trials, chloridazon and triallate as a formulated flowable mixture (BAS 41905H) and a tank mixture were also included. The chloridazon and triallate formulated mixture was directly comparable to the chloridazon and diallate mixtures in terms of active ingredients applied. The chloridazon and triallate as a tank mix was included at the manufacturers' recommended rate and thus the amount of active material varied from flowable formulation. Thus on light soil types, more chloridazon was present than with the tank mix and on heavy soil types, while the amount of chloridazon was virtually the same, the rate of diallate was increased by 25% over the tank mix recommendation.

There was generally little difference in the weed control obtained with either chloridazon + triallate or chloridazon + diallate when applied as flowable formulations, except that the diallate mixture appeared to give slightly less variable results and was also slightly more persistent (Table 7). However, when the weed control given by these treatments was compared to the tank mix the formulated mixtures were generally superior. This superiority may be explained partly by the increase of chloridazon content on the light soil.

Past experience has shown that increasing the rate of chloridazon on the light soils has increased the crop damage proportionally. Although the amount of chloridazon applied in formulation on light soil was greater than that in the tank mix, it did not exceed the amount recommended when chloridazon is used alone. Thus the differential amount of chloridazon did not result in any significant reduction in crop population or plant vigour (Table 6). This together with results on other soil types indicated that the formulated products had a high degree of crop safety on a range of soil types.

Formulated mixtures of chloridazon and diallate showed acceptable levels of weed control and crop safety when applied pre-drilling and incorporated on a range of soil types and thus are a useful addition to the range of sugar beet herbicides.

References

FISCHER, A. (1962) 1-phenyl-4-amino-5-chlor-pyradazon-6 a new herbicide. Weed Res 2, 177-184

HANNAH, L. H. Avadex- a selective wild oat herbicide. Proc. of Joint Meeting of 16th Western Canada Weed Control Conference

EVANS, D.N. (1970) The performance of triallate in granulat form for control of *Avena* species and *Alopecurus myosuroides*. Proc. 1970 British Weed Control Conference, 842-848

BERRY, W.E. and MILTON, S.G. (1970) Weed control in sugar beet using diallate followed by pyrazone. Proc. 1970 British Weed Control Conference, 586-592

BAS 483 .. H, READY MIXES OF CHLORIDAZON AND ETHOFUMESATE FOR THE CONTROL OF A BROAD SPECTRUM OF WEEDS IN SUGAR BEETS

B.-H. Menck, U. Lüning, W. Nuyken, D. Klingenschmitt

Agricultural Research Station of BASF Aktiengesellschaft, Limburgerhof, Federal Republic of Germany

Summary The results from three years of trials in sugar beet with three different ready mixes of the active ingredients chloridazon + ethofumesate are reported. BAS 483 00 H has been registered in France in 1980 for preemergence application in beet at 7 l/ha. BAS 483 01 H has been registered in England since 1979. BAS 483 02 H is undergoing pre-registration testing in 1980 in the Federal Republic of Germany. The active ingredients chloridazon and ethofumesate are complementary in their activity against mono- and dicotyledonous weeds. Compared to chloridazon alone, in combination their activity is improved against *Alopecurus myosuroides*, *Amaranthus retroflexus*, *Anagallis arvensis*, *Chenopodium album*, *Echinochloa crus-galli*, *Galium aparine*, *Mercurialis annua*, *Polygonum spp.*, *Solanum nigrum* and *Stellaria media*, while selectivity remains constant. Conversely, the gaps in the activity of ethofumesate against Cruciferae and Compositae are narrowed by chloridazon.

Résumé Les résultats d'essais de trois ans obtenus sur betteraves à sucre avec trois formulations différentes prêtes à l'emploi de chloridazone et d'éthofumesate (matières actives) sont rapportés. Le BAS 483 00 H a été homologué en France en 1980 avec 7 l/ha sur betteraves à sucre en pré-levée. Le BAS 483 01 H est homologué depuis 1979 en Grande-Bretagne (7 l/ha); en R.F.A., le BAS 483 02 H se trouve depuis 1980 au stade essais officiels avant homologation. Les matières actives chloridazone et éthofumesate se complètent au point de vue efficacité dans la destruction des adventices mono- et dicotylédones. L'addition de l'éthofumesate au chloridazone permet d'obtenir une meilleure efficacité contre *Alopecurus myosuroides*, *Amaranthus retroflexus*, *Anagallis arvensis*, *Chenopodium album*, *Echinochloa crus-galli*, *Galium aparine*, *Mercurialis annua*, *Polygonum spp.*, *Solanum nigrum* et *Stellaria media*, la sélectivité demeurant la même. Par ailleurs, les défauts d'efficacité de l'éthofumesate sur Crucifères et Composées sont éliminées par l'action du chloridazone.

RESULTS

Statistics show that over recent years the weed spectrum in sugar beet has shifted to species which are more difficult to control weeds. For example, in England, France and West Germany today the following weeds are among the ten most important ones: Stellaria media, Chenopodium album, Polygonum aviculare, Polygonum convolvulus, Alopecurus myosuroides, Avena fatua, Matricaria spp., Galium aparine and Mercurialis annua. G. aparine and M. annua, in particular, have spread severely over the last years. Consequently we made it our goal to develop a sugar beet herbicide that could control these weeds effectively.

METHOD AND MATERIALS

The results of the trials presented here are collected from a three-year field study from 1978 to 1980. A total of 120 trials with three different formulations was performed in England, France and West Germany. The treatments were made preemergence, i.e. immediately to five days after drilling the beet. The three different ready-mix formulations were suspension concentrates (table 1). The proportions of the active ingredients chloridazon and ethofumesate in the respective ready mix were adjusted to the herbicidal performance demanded of a beet herbicide in the countries of England, France and West Germany, determined by previous tank mix trials. The trials were carried out on small plots of 10-50 m^2 with 3-4 randomized replicates, using the knapsack sprayers standard for field trials (Pressure: 2,5-3 bar, nozzle type: SS8002-8003 and 6673 A, Volume of application: 300-500 l/ha).

Evaluation of plant injury and thinning was according to the EWRC system scaled from 1-9; evaluation of herbicidal activity was by percentage, respectively in the 1-9 scale. The first assessment was made 3-5 weeks after treatment at Growth Stage 5-6 of the sugar beets, while the second assessment was made 2-3 weeks later at sugar beet Growth Stage 7-8.

The χ^2-Test was used to reinforce the differentiation of herbicidal activity between two products.

Table 1

Composition of three different ready mixes of chloridazon and ethofumesate

Products	active ingredient g/l chloridazon	ethofumesate	trade name (country)
BAS 483 00 H	280	115	Magnum F (France)
BAS 483 01 H	275	170	Magnum (United Kingdom)
BAS 483 02 H	290	145	- (West Germany)

RESULTS

Crop tolerance

All three ready mixes of chloridazon + ethofumesate were tested at 7 l/ha, corresponding to 1.96-2.03 kg/ha chloridazon + 0.81-1.02 kg/ha ethofumesate, in comparison to 2.6 kg/ha chloridazon as the average standard application rate.

As is shown in table 2, the selectivity of BAS 483 .. H is slightly lower than that of chloridazon, which is also apparent in the somewhat greater standard deviation. Under moist/cool conditions, the well-known "lettuce-head" shape appeared on some beet plants in 1980, caused by ethofumesate. Thinning occured only to a very limited extent, thus on the whole, all three ready mixes can be termed beet herbicides with good selectivity.

Table 2

Crop tolerance of BAS 483 .. H in comparison to chloridazon in sugar beet (pre-emergence treatment)

	rate l/ha	Assessment	Number of trials	Evaluation 1-9 (EWRC) BAS 483 .. H	Chloridazon 2,6 kg/ha a.i.
BAS 483 00 H	7	1.	31	1.3 (1.0)	1.2 (0.8)
		2.	29	1.3 (0.8)	1.2 (0.7)
	9	1.	23	1.3 (0.5)	1.2 (0.4)
		2.	22	1.2 (0.4)	1.1 (0.2)
BAS 483 01 H	7	1.	14	1.1 (0.3)	1.1 (0.3)
		2.	13	1.1 (0.3)	1.1 (0.3)
BAS 483 02 H	7	1.	47	1.5 (1.2)	1.3 (0.9)
		2.	41	1.5 (0.8)	1.2 (0.5)

Weed spectrum

The data on the individual herbicidal activities of the three different formulations are presented in figure 1. The degrees of control of the three herbicides are not directly comparable, since for the most part they come from different trials. The data for BAS 483 00 H, for example, are primarily from France; those for BAS 483 01 H are mostly from England; and the majority of those for BAS 483 02 H are from the Federal Republic of Germany. Listed are those weeds controlled more than 75% by the combinations. Control averaging greater than 95% is achieved for the following weeds: Anacyclus tomentosum, Capsella bursa-pastoris, Digitaria sanguinalis, Matricaria chamomilla, Myosotis arvensis, Papaver rhoeas, Poa annua (only BAS 483 02 H), Polygonum aviculare and Polygonum persica, Polygonum convolvulus (except BAS 483 00 H), Portulaca oleracea, Raphanus raphanistrum, Setaria verticillata, Silene sp., Solanum nigrum, Spergula arvensis, Stellaria media, Thlaspi arvense and Veronica spp.

More than 90% control is obtained for Alopecurus myosuroides, Avena fatua, Chenopodium album, Galium aparine, Lamium purpureum, Mercurialis annua (except BAS 483 00 H), Sinapis arvensis and Viola tricolor. Thus, the ten most important weeds referred to earlier for sugar beet crops in France, England, and the Federal Republic of Germany are controlled well to very well.

As with all soil herbicides without vapor pressure, the extent to which activity fluctuates is dependent on soil moisture and the time the weeds and grasses emerge. Control ranges from 70% to 100% for Alopecurus myosuroides and Avena fatua.

Incorporation of the products before drilling the beet may increase activity under dry conditions. The level of control of Amaranthus retroflexus, Avena fatua, Chenopodium album, Echinochloa crus-galli and Polygonum aviculare, for instance, is increased considerably by shallow incorporation (3 cm) of BAS 483 01 H (Table 3).

Table 3

Influence of incorporation on the effect of BAS 483 01 H in comparison to a preemergence treatment. Weed control in %.

Weeds	7 l/ha BAS 483 01 H pre-planting incorporated	7 l/ha BAS 483 01 H preemergence
Amaranthus retroflexus	82	53
Avena fatua	96	88
Chenopodium album	90	75
Echinochloa crus-galli	71	50
Polygonum aviculare	99	91

BAS 483 02 H was also more active than chloridazon alone, giving improved control of grass weeds (Alopecurus, Avena, Digitaria, Echinochloa and Setaria) and at a rate of 7 l/ha (2.03 kg/ha a.i. chloridazon + 1.02 kg/ha a.i. ethofumesate) improved control of Chenopodium album (fig. 2), Galium aparine (fig. 3), Mercurialis annua (fig. 4), Polygonum aviculare (fig. 5) and Stellaria media (fig. 6).

The increased activity in the cases of Galium aparine and the Polygonum species is very pronounced. It is noticeable that the activity against Galium aparine can begin even relatively late (sugar beet Growth Stage 7). This happens when growing conditions are dry at first. The plants remain small, become deformed and finally die when moister soil conditions allow greater uptake of herbicide.

Similar complementary activity of the two active ingredients was obtained with the other two ready-mix formulations BAS 483 00 H and BAS 483 01 H.

DISCUSSION

In order to broaden the weed spectrum of chloridazon, three different ready mixes with ethofumesate were developed for preemergence application. Various active ingredient combinations were chosen depending on the weed spectrum in the countries France, England and the Federal Republic of Germany. BAS 483 00 H (280 g/l chloridazon + 115 g/l ethofumesate) was developed for France; BAS 483 01 H (275 g/l chloridazon + 170 g/l ethofumesate) was developed for England and BAS 483 02 H (290 g/l chloridazon + 145 g/l ethofumesate) for the Federal Republic of Germany.

Especially notable is the good activity of the formulated mixtures against *Chenopodium album*, *Galium aparine*, *Matricaria spp.*, *Mercurialis annua*, *Polygonum spp.* and *Stellaria media*. Besides this, grasses such as *Alopecurus myosuroides*, *Digitaria sanguinalis*, *Poa annua* and *Setaria spp.* are also controlled; but control of *Avena fatua* and *Echinochloa crus-galli* is much more variable.

In addition to the practice of preemergence application, the first positive experiences have been made with postemergence application of BAS 483 .. H as well as with system treatments consisting of a preemergence and a postemergence application. It is most important to keep sugar beet weed free. A single herbicide application can only achieve this when conditions for its use are optimum. Thus in practice herbicide systems including mixtures and/or sequences are required.

Acknowledgements

The authors would like to express their gratitude especially to the French, English and German BASF field technicians for carrying out the trials and providing the trial data.

Fig. 1

Weed spectrum of BAS 483 .. H (preemergence)

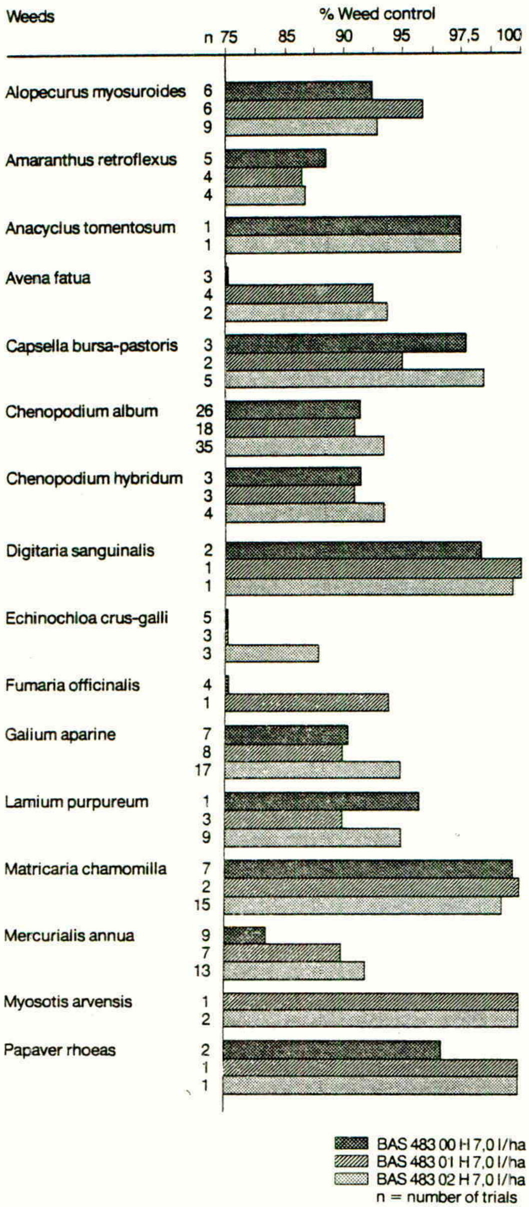


Fig. 1 (Continue)

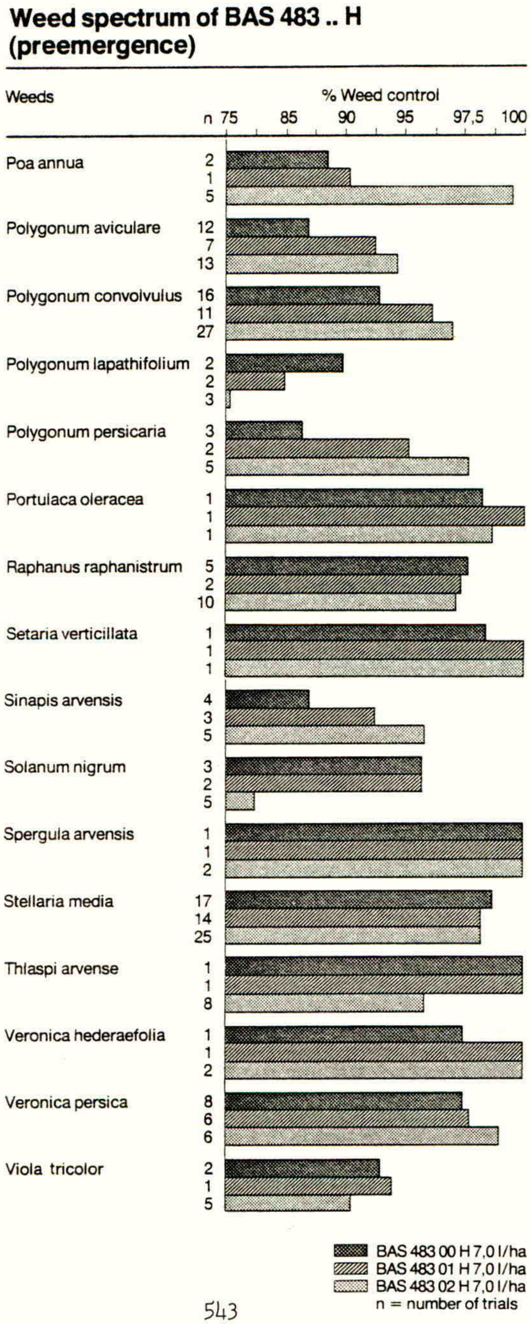
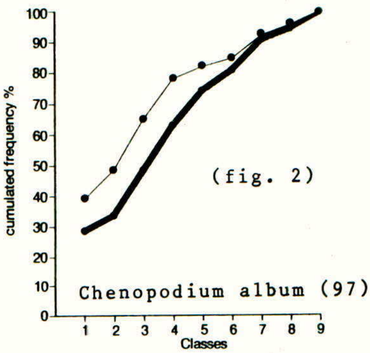
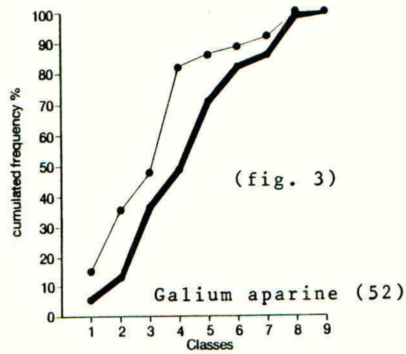
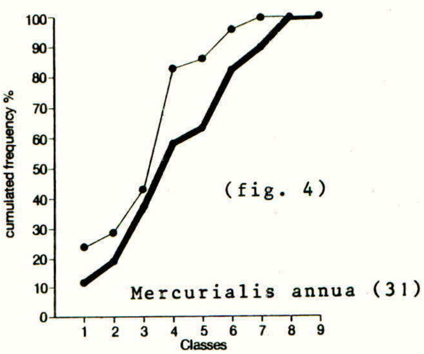
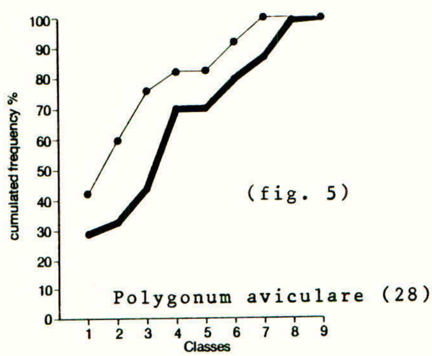


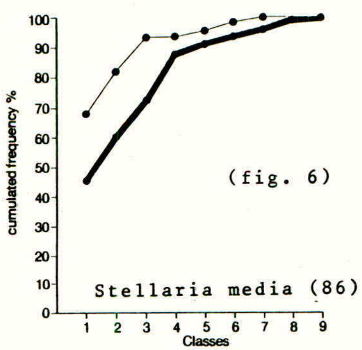
Fig. 2-6 **Activity of BAS 483 02 H in comparison to Chloridazon (preemergence treatment)**











Classes	% Efficacy
1	100
2	99,9 – 97,5
3	97,4 – 95,0
4	94,9 – 90,0
5	89,9 – 85,0
6	84,9 – 75,0
7	74,9 – 65,0
8	64,9 – 32,5
9	32,4 – 0

— BAS 483 02 H 7,0 l/ha
▬ Chloridazon 2,6 kg/ha a.i.
( ) = number of dates
2. Evaluation

THE USE OF HIGH VOLTAGE ELECTRICITY FOR WEED BEET CONTROL

M.F. Diprose and
F.A. Benson

Department of Electronic & Electrical Engineering, The University of Sheffield, Mappin Street, Sheffield S1 3JD, U.K.

N.V. Turner

British Sugar Corporation, Holmewood Hall, Holme, Nr. Peterborough PE7 3PG, U.K.

Summary A machine is being developed which uses electricity to kill annual beet. Experiments began with a static generating set and hand held electrodes and have now developed to the use of tractor driven units. In 1979 a 6 row machine moving at 1.6 km/h was used with an output voltage of 8.6 kV rms, 24 kW and it killed 75% of the annual beet in the trial plots - without damaging the crop. The 1980 machine spans 12 rows and can move at 5 km/h and develops 17 kV, 54 kW using a maximum of 81 hp from the tractor pto.

The electric current passes through the plants heating them up and destroying the cellular structure. A high voltage is necessary to make the process rapid, to use short electrodes and attain a high tractor speed. The method kills all weeds which appear above the crop and it can be used in light winds and leaves no residues in the soils.

Résumé Nous sommes en train de développer une machine qui emploie l'électricité pour tuer la betterave annuelle. Nous avons commencé par expérimenter avec un groupe générateur fixe et des électrodes tenues à la main. Ensuite, nous nous servions des machines actionnées par des moto-tracteurs. Pendant 1979, nous employions un mécanisme à six rangs qui marchait à 1,6 kilomètres à l'heure. Cet appareil avait une alimentation électrique de 8,6 k Vrms, 24 kW et il a tue 75% de la betterave annuelle dans les lots de terrain d'essai - sans dégâts aux récoltes. La machine de 1980 embrasse douze rangs, elle est capable d'atteindre une vitesse de 5 kilomètres à l'here et elle développe 17 kV, 54 kW, exigeant un maximum de 81 hp du tracteur pto.

Le courant électrique passe à travers les plantes, tout en les échauffant et en détruisant la structure cellulaire. Il faut de la haute tension pour rendre le processus rapide - afin de pouvoir employer des électrodes étroites et d'atteindre une plus grande vitesse de tracteur. La méthode tuera chaque mauvaise herbe qui apparaît au-dessus de la récolte, elle peut être employée pendant le temps venteux et elle ne laisse aucun résidu dans le sol.

INTRODUCTION

A survey commissioned by the British Sugar Corporation has shown an increase in weed beet populations during the last three years. Nationally, the area on which misplaced seedlings were seen has increased from 15% in 1977 to 24% in 1979 with some factory areas having 50% of the acreage infested (Maughan, 1980).

Hand roguing is a good way of reducing weed beet when populations up to 4,000 plants/hectare are present (Turner 1980). Two types of pasture cutter have been adapted for topping weed beet and now two specially designed bolter cutters are available. Herbicides can be applied selectively on the basis of crop/weed height difference to annual beet and there are two designs of roller applicator on the market. In addition rope wick applicators are becoming available.

These methods are not entirely satisfactory and the authors have been investigating and developing an electrical method of weed beet control. Laboratory experiments have been described in which plants were killed by passing electric currents through them. (Diprose et al, 1978). Voltages between 1 kV rms and 5 kV rms were applied to three weed types, Chrysanthemum segetum, Sinapsis arvensis, and beet bolters. The electrical power dissipated in the plants heated the tissue and destroyed the cellular structure. The higher the initial voltage the faster the process occurred.

This paper describes the experiments and equipment developed for the control of weed beet by electricity during three years of field trials, from the hand held electrodes as used in the laboratory to the tractor-driven machinery.

METHOD AND MATERIALS

The first field trials (1978) were carried out with a lorry-mounted 16 kW, 240V rms diesel alternator set and a transformer which stepped up the voltage to a maximum of 8.4 kV rms. A long length of cable went to the electrode applying the current to the weed beet. This electrode was a metal rod 1cm diameter and 1m long clamped at the end of a long insulating handle. The plants were treated singly and voltages between 3 kV rms and 8 kV rms were applied for times varying between 5s and 60s.

In 1979 a tractor-driven system was developed. The final model used a 65 hp tractor providing p.t.o. drive for 24 kW, 240V rms generator. The high voltage output was variable in steps up to 8.4 kV rms. The generator, transformer and associated switchgear were all mounted on a platform carried on three point linkage. Two 50cm diameter steel wheels each 12cm wide were bolted underneath the platform and carried the weight of the equipment when operating to ensure good contact with the ground for earthing purposes. The electrode consisted of a rectangular array of 6 metal rods. It was 3m wide to span 6 crop rows and 1m in length to provide sufficient contact time with the plants. It was suspended about 15cm above the crop height. The output voltage could be turned on and off and varied from the cab, and various safety features were incorporated.

The latest development has a 415V, 3 phase, 56 kW generator requiring 81 hp from the tractor. The transformer provides outputs at 7.5 kV rms, 10 kV rms and 12.5 kV rms which after full wave bridge rectification gives electrode voltages of 10kV at 5A, 13.5 kV at 4A and 17 kV at 3A. Once again the generating equipment is mounted at the rear with similar earthing arrangements. The front mounted electrode spans 12 rows and is suspended from the frame by electrical insulators. A central 6 row width has a retractable 3 row wing attached at each end. The fully extended width is 6m and the length is 0.35m; the electrode is surrounded by a safety enclosure preventing access from the top, sides and rear. Communication between the driver and a fieldman is provided with a 2 way radio system and the fieldman has another small radio transmitter with which he can turn off the high voltage. Other safety features developed in conjunction with representatives of the Health and Safety Executive include on/off buttons, a main isolating switch in the cab and a seat switch.

RESULTS

The results of the work done during 1978 and 1979 are fully described elsewhere (Diprose and Benson 1980, Diprose et al 1980) and so only brief descriptions are included here.

The first trials showed that weed beet was killed by electric currents. Only those plants treated with 3 kV rms for 5s survived. Longer times at 3 kV rms killed the plants as did the higher voltage levels. It was necessary to produce loss of turgor for the plant to die. The whole plants were killed and no regrowth occurred from any of the treated ones.

The 1979 trials demonstrated that it was possible to kill weed beet with a mobile unit. With an output of 8.4 kV rms and the 1m electrode length a maximum speed of 1.6 m/h could be reached. The generator power was only just adequate, however, especially towards the end of the season when the weeds were very tall and thick. The equipment was suitable for killing any of the weed types which were present above the crop, e.g. Avena fatua and Chenopodium album. No damage was done to the sugar beet. If only one or two leaves of a plant touched the electrode, then those leaves died, but the rest of the plant was unaffected.

In the trial plot there were 186 bolting and weed beet and 51 of these had not grown a stem at the time of treatment. Of the 135 that had been electrocuted 101 (75%) had their stems and large leaves killed and could not have produced any viable seed.

The latest equipment is still being developed and progress is satisfactory. Using 10 kV a speed of 3.2km/h gives good weed clearance and at 13 kV 5 km/h is possible. It has not yet been found necessary to use the 17 kV supply. If the weed beet infestation is large then in spite of the high power generator, only 6 rows can be treated from about mid August onwards. Small numbers of bolters even where these occur amid dense patches of other weed, e.g. Chenopodium album, can be treated 12 rows at a time throughout the season.

DISCUSSION

The work has demonstrated that it is possible to construct a tractor driven system for controlling weed beet by electricity. Since the plants do not have a nervous system it is not possible to shock them - they must be heated up until the cellular order is destroyed. This requires a lot of energy which means that large tractors will be needed. It is not possible to construct a battery powered "back-pack" device to kill weeds that are much over 5 or 6cms in height. The tractor being used at the moment is a 100 hp one and is about the maximum size that it is practicable to use in the beet fields. The American firm Lasco recommend 120 hp tractors for the units they are now selling (Lasco 1980) one of which has been operating in Belgium this year.

Even though powerful tractors and heavy equipment are used, fuel consumption is reasonable - and is the only recurrent cost. No detailed figures are available yet for the authors' equipment but the American machines use between 4 l/ha and 16 l/ha depending upon the type and density of the weed population. (Kaufman and Schaffner 1979).

To enable large areas of ground to be covered the tractor must be able to move quickly. In 1979 with 8 kV rms only 1.6 km/h could be achieved. Raising the voltage to 10 kV and then 13 kV meant that speeds of up to 5 km/h were reached although the latter was too high for easy passage through the beet field when the plants were tall.

As with mechanical and chemical methods at least two passes through the crop will be required both early and later on in the season. The 1979 results show that not all the bolters were killed. Those that escaped were the multi stemmed type, often with only a few of the stems above the crop, the rest lying along the top or amongst the leaves. None of the present methods will combat this type unless some form of guide or lifter is used at the front, to raise and gather all the stems for treatment.

The equipment for electrical control of weeds is heavy and expensive but the method does have advantages. There is no dripping of the chemical onto surrounding crops, and as the effect is instantaneous it cannot be affected by rain following the application. Electrical methods can be applied in windy and showery weather, and there are no residues to pollute the soil. The weeds are killed by the electricity as compared to mechanical methods where only the tops are cut off; no damage is done to the crop.

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References

DIPROSE, M.F., BENSON, F.A. (1980) Weed control by electrical discharges and microwaves, Final report to the ARC. Department of Electronic and Electrical Engineering, University of Sheffield, pp 42.

DIPROSE, M.F., HACKMAN, R., and BENSON, F.A. (1978) Weed control by high voltage electric shocks. Proceedings 1978 British Crop Protection Conference - Weeds pp. 443-450

DIPROSE, M.F., HACKMAN, R., and BENSON, F.A. (1980) Electrothermal control of weed beet and bolting sugar beet. To be published.

KAUFMAN, K.R., SCHAFFNER, L.W. (1979) Excerpts from Lasco Eds Lightning Weeder evaulation report, Agricultural Engineering Department and Agricultural Economics Department, North Dakota State University, Fargo, North Dakota, USA

LASCO (1980) The EDS Lightning Weeder System, Details available from Lasco Corp Wicksburg,Mississippi

MAUGHAN, G. (1980) Weed beet-the developing situation. British Sugar Beet Review, 48, No. 2. 24.

TURNER, N. (1980) Weed beet, round up of mechnicanl control methods. British Sugar Beet Review, 48, No. 2. 22-23

BUTAM, A HERBICIDE FOR USE IN WINTER SOWN OILSEED RAPE

D.H. Spencer-Jones

Midox Ltd., Smarden, Kent

Summary Trials data show that when used pre-emergence on winter sown oilseed rape butam 72% e.c. controls a range of important grass and broadleaved weeds. TCA in tank-mix or sequential use greatly enhances control of volunteer cereals. Data from one trial showed that application before cultivating considerably enhanced control. Butam displays excellent crop tolerance, maintains crop yield and is not affected by carbon residues after stubble burning.

Résumé Les essais montrent que, appliqué en prélevée du colza d'liver, le butam c.é. à 720 g m.a. par litre maîtrise une gamme importante d'adventices mono et dicotylédones. Le TCA appliqué en mélange extemporané ou séparément renforce notablement l'efficacité sur repousses de céréales. Les résultats d'un essai montrent que l'application effectuée avant la préparation du sol augmente considérablement l'efficacité. Le butam fait preuve d'une excellente sélectivité à l'égard du colza, n'affecte pas le rendement, et son efficacité n'est pas modifiée par les résidus de carbone résultant du brûlage des chaumes.

INTRODUCTION

We first conducted trials with butam 72% e.c. in 1976 on a crop range comprising peas, beans, brassicae, potatoes and sugar beet. The following season we tested butam in mixture with certain other herbicides on brassicae, potatoes and sugar beet, and in addition, conducted trials to investigate the residual activity of butam at different rates to a selection of following crops.

In view of its successful introduction in France as a pre-emergence herbicide for use on winter sown oilseed rape, we began development on this crop in 1977, and in 1978, continued work with butam mixtures on brassicae and on its effect on following crops.

This paper is concerned only with our development programme on winter sown oilseed rape although some weed data from our brassica trials in 1978 have been included. Data is presented on weed susceptibility, crop vigour and yield; on the effect of butam residues to following crops and on the effect of cultivations and of stubble burning on the efficacy of the chemical. The properties of butam have been described by Schwartzbeck (1976).

METHOD AND MATERIALS

Trials were sited in Kent, Essex, Suffolk, Lincolnshire and Nottinghamshire and covered many soils ranging from sands to clays. An emulsifiable concentrate formulation containing 72% butam was used throughout. All rates are expressed as kg a.i./ha.

Weed data

All replicated trials were of randomised block design with 3 replicates (4 replicates in the 1979 series). Plot sizes averaged 1/600th ha. Assessments were made by recording the number of individual weed species using a quarter or half m^2 quadrat, usually making 4 random throws per plot. Application was made with an Allman motorised barrow-mounted sprayer fitted with fan nozzles in water volumes of 430 and 675 l/ha (1978 series) and 350 and 500 l/ha (1979 series). On some trials, weed density was recorded as a percentage of weed cover using a scale of 0 - 10 where 0 = bare ground and 10 = 100% weed cover. (Tables 1 - 3).

Soil residues as determined by vigour of following crops

Butam was applied in 1976 to 2 sites, one each in Suffolk (sand) and Kent (sandy loam), and in 1977 to 2 sites in Suffolk (sand and clay loam) into which following crops were drilled at the rates and intervals shown in Table 4. Crop vigour assessments were recorded when the crops on the untreated controls had reached full seedling establishment according to the scale 0 - 10 where 0 = a dead crop and 10 = 100% vigour. In 1978, butam was applied to a sand in Suffolk to a cultivated tilth which had previously been ploughed. Seven months later (24/4/79) after spring tine harrowing, crops were drilled into the areas treated with butam and assessed as above. (Table 4).

Effect of straw burning and timing of cultivations

Straw was distributed over half the trials area to simulate straw distribution after combining, and was then burned off. Wheat and barley seed were then broadcast, butam and butam + TCA being applied the following day, either immediately before or after cultivating (2 passes of a fixed tine cultivator to a depth of 13 cm). All treatments were replicated 4 times. Volunteer cereal counts were recorded after emergence using a $\frac{1}{2}$ m^2 quadrat, 2 random throws being made per plot (7 m x 3 m). (Table 5).

Crop tolerance

1) Vigour. Crop vigour assessments were recorded on a scale of 0 - 10 where 0 represents a dead plant and 10 = 100% vigour. (Table 6).

2) Yield.

1978. Yields were obtained from one trial of randomised block design with 3 replicates using a plot size of 1/500th ha. Application was made with an Allman motorised barrow-mounted sprayer fitted with fan nozzles in 675 l/ha water. Two random areas per plot, each of 0.25 m^2 were hand cut, dried and threshed on a bench thresher. Yields are expressed at 9% moisture. (Table 7).

1980. A series of 5 trials designed specifically to obtain yield data was conducted on the 1979 sown crop where, on sites in Nottingham and Lincolnshire, butam at 4.3 and 8.6 was compared with 2.8 kg/ha carbetamide + dimefuron, with 0.7 kg/ha propyzamide and with untreated controls in a 5 x 5 latin square design using plots of 1/300th ha. Application was with a modified Azo sprayer fitted with fan nozzles in 330 l/ha water. At harvest (1980) each plot was cut and swathed, field-dried for 7 - 10 days and then combined with a Claas compact combine. (Table 8).

RESULTS

WEED CONTROL

1978

Table 1

Weed control 3 - 6 weeks post application
(Mean of 4 trials)

	No. of trials	No's/m^2 Untreated	% control Butam 2.9	% control Butam 4.3
Avena fatua	1	1.6	44	50
Capsella bursa-pastoris	3	2.0	0	5
Chenopodium album	3	11.2	69	80
Poa annua	3	21.9	98	99
Polygonum aviculare	4	22.5	55	53
Polygonum convolvulus	2	3.0	60	70
Senecio vulgaris	2	4.0	0	0
Stellaria media	2	8.6	84	80
Tripleurospermum maritimum	3	2.8	0	18
Urtica urens	2	2.2	36	68
Veronica spp	4	4.0	92	90
TOTAL		83.8	52	59

1979

Table 2

Weed control (1 month) and 3 months post application

Trial 12

	No's/m^2 Untreated	% control TCA 7.4	Butam 3.6	Butam 4.3	Butam + TCA 3.6 + 7.4	Butam + TCA 3.6 + 10.4
Volunteer cereals (1 month)	(140.6)	(60)	(38)	(33)	(21)	(67)
Volunteer cereals	137.6	68	59	43	82	95
Lamium spp	8.2	94	100	100	94	100
Stellaria media	10.2	61	71	80	27	75
Tripleurospermum maritimum	82.5	3	97	98	98	98
TOTAL (3 months)	238.5	46	74	65	86	95

1979

Table 3

Weed control 3 - 7 months post application

Mean of trials 9 - 11	Ground cover Untreated	% control TCA 7.4	Butam 3.6	Butam 4.3	Butam + TCA 3.6 + 7.4	Butam + TCA 3.6 + 10.4
Volunteer cereals	5.5	31	71	56	71	82
Annual grasses*	8.7	86	99	98	99	100
Broadleaved weeds**	13.8	35	78	81	80	84

*) Poa annua and Alopecurus myosuroides dominant

**) Veronica spp., Lamium spp, Stellaria media and Tripleurospermum maritimum dominant.

Table 4

Effect of butam soil residues on following crops

	Drilling interval (months)	Crop vigour Barley	Wheat	Green Beans	Peas	Oilseed Rape	Turnip /Swede	Kale
1976 sand								
Butam 3.6	1	0	0	10	10	9	10	
" "	2	0	0	10	10	10	10	
" 7.2	1	0	0	7	6	10	10	
" "	2	0	0	8	4	10	10	
" 14.4	1	0	0	2	2	9	6	
" "	2	0	0	2	2	9	6	
1976 sandy loam								
Butam 3.6	1	3	5	10	10	10	6	
" "	2	7	7	10	10	9	8	
" "	4	3	3	7	9	10	10	
" 7.2	1	0	0	10	10	9	10	
" 14.4	1	0	0	10	8	10	10	
1977 sand								
Butam 4.3	1	1	3	10	10	10	10	9
" "	2	2	4	10	10	10	10	10
" "	4	3	1	10	10	10	10	10
" 8.6	1	1	0	10	9	10	10	8
" "	2	2	2	10	10	10	10	10
" "	4	1	2	10	5	8	9	10
" 17.3	1	0	0	3	7	10	10	2
" "	2	1	2	4	7	10	10	10
" "	4	0	0	10	3	6	7	9
1977 clay loam								
Butam 4.3	1	1	2	10	9	10	10	8
" "	2	1	3	10	10	10	10	9
" "	4	4	4	10	10	10	10	10
" 8.6	1	0	0	10	7	10	10	8
" "	2	0	0	10	9	10	10	8
" "	4	2	2	10	10	10	10	10
" 17.3	1	0	0	8	4	10	7	4
" "	2	0	0	8	5	10	8	7
" "	4	2	4	10	5	10	10	9
1978 sand								
Butam 4.3	7	10	10	10	10			
" 8.6	7	9	8	9	9			

Note: Crop vigour assessments were made when crops on the untreated controls had reached full seedling establishment.

Table 5

Effect of straw burning and of butam incorporation on volunteer cereal stubble

Timing	Treatment	No's/m^2 (% control) of volunteer cereals Untreated	Butam 4.3	Butam + TCA 4.3 + 7.4
Sprayed after cultivation	No straw	50.2	16.5(67)	8.5(83)
	Straw burned	63.0	22.7(64)	6.7(89)
MEAN		56.6	19.6(65)	7.6(86)
Sprayed before cultivation	No straw	49.5	10.0(80)	3.7(92)
	Straw burned	57.2	12.5(78)	2.0(96)
MEAN		53.4	11.2(79)	2.8(94)

CROP TOLERANCE

1) Crop Vigour

Table 6

Tolerance of oilseed rape

Crop vigour, 0 = dead crop, 10 = 100% vigour

	Untreated	TCA	Butam				Butam + TCA		
		7.4	3.6	4.3	8.6	17.3	2.9+7.4	3.6+7.4	3.6+10.4
1978									
Trial 6 (loam)	8.7	-	8.3	8.0	8.5	-	8.0	-	-
" 8 (clay)	10.0	-	10.0	10.0	10.0		10.0		
1979									
Trial 9 (clay	10.0	9.5	10.0	10.0	-	-	-	10.0	10.0
" 10 (sandy loam)	9.0	7.8	8.3	7.5	-	-	7.3	7.3	6.8
" 13 (sand)	8.3	-	-	10.0	8.7	4.3	-	-	-

2) Crop Yields
1977/78

Table 7

Yield - tonnes/ha

Treatment	Yield
Untreated	4.3
Butam 4.3	4.9
" 5.7	5.3
" 8.6	6.5

1979/80

Table 8

Yield - tonnes/ha

Treatment	Variety Rate/Trial	Jet Neuf 1	2	3	4	Rafal 5	Mean
Untreated		5.75	4.75	4.66	4.48	4.94	4.92
Butam	4.3	5.93	5.14	4.42	4.57	4.93	4.99
Butam	8.6	5.16	4.98	4.3	4.71	4.32	4.69
Carbetamide + dimefuron	2.8	5.51	5.0	4.48	4.13	3.84	4.59
Propyzamide	0.7	5.43	4.84	4.48	4.05	4.60	4.68
S.E. ±		0.29	0.22	0.23	0.41	0.86	0.23

DISCUSSION

Weed control.

From data from our early work (not presented here) we were able to establish certain trends in weed control, for example, species resistant to butam such as *Capsella bursa-pastoris*, *Sinapis arvensis* and *Solanum nigrum* and, by contrast, some susceptible species such as *Chenopodium album*, *Papaver rhoeas*, *Poa annua*, *Stellaria media* and *Tripleurospermum maritimum*. These results were strengthened by data from the trials we conducted on brassicae in the summer of 1978, (Table 1) with the exception of *T. maritimum*, but excellent control of this weed was again obtained in 1979 and 1980.

In 1978, after an initial trial the previous year, we commenced a full programme of work on winter sown oilseed rape, under prolonged dry autumn conditions which persisted well into the following New Year. Butam had by then been commercialised in France at 2.9 kg/ha but under different husbandry conditions where the land is commonly ploughed and cultivated before drilling. In the U.K., oilseed rape is more often drilled direct into cereal stubbles or given minimum cultivations before drilling. Our replicated trials were supported by 26 grower trials, widely located over the oilseed rape acreage and carefully monitored, in which butam at 2.9 kg/ha was compared with 4.3 kg/ha. These results which are not presented here showed firstly, that under U.K. conditions of husbandry, 2.9 kg/ha was not sufficient for consistently good weed control and secondly, that for the control of volunteer cereals, a major problem weed, the activity of butam needed some enhancement particularly when applied to minimal cultivated sites. TCA in tank mix with butam or in sequential treatment has proved suitable.

In 1979 we compared butam at 3.6 kg/ha in tank-mix with TCA at 7.4 or 10.4 kg/ha against butam on its own at 3.6 and 4.3 kg/ha. (Tables 2 and 3). For consistent control of volunteer cereals, these results confirmed the value of using TCA in conjunction with butam and that in so doing, 3.6 kg/ha butam proved an adequate dose, particularly under conditions in which volunteer cereals were likely to be a major problem following minimal cultivation or on direct drilled sites. If the crop follows mould board ploughing and subsequent cultivation, 4.3 kg/ha butam without TCA in our opinion will provide adequate control of volunteer cereals and a good control of susceptible broadleaved weeds.

Under dry conditions, butam is very slow in taking effect. The autumn of 1979 was extremely dry and it can be seen from Table 2 that treatment did not greatly reduce volunteer cereal numbers until the autumn drought had ended some 3 months after application. This 3 month assessment illustrates still further the need for TCA where volunteer cereal infestation is heavy, as do the data in Table 5 where for each cultivation/straw burning treatment, the addition of 7.4 kg/ha TCA to 4.3 kg/ha butam very considerably reduced the number of surviving volunteer cereals.

Effect of butam residues on following crops

Should butam treated winter sown oilseed rape fail, because of some factor unrelated to the use of the chemical such as pest damage, the grower needs to know which spring crops may safely follow butam applied the previous autumn. It was to provide an answer that we investigated the residual effect of butam on succeeding crops by drilling these into land previously treated with butam at different rates and at varying intervals after its application (Table 4). In general, all crops tested, with the exception of cereals, tolerated rates up to 8.6 kg/ha when drilled one month after butam had been applied. Oilseed rape itself proved exceptionally tolerant, even in 1977, to a dose of 17.3 kg/ha. However, when butam was applied as a normal pre-emergence treatment on sand at 17.3 kg/ha, crop damage resulted. (Table 6). Field evidence indicates that butam applied in the autumn does not have an adverse effect on cereals drilled the following autumn.

Effect of straw burning and timing of cultivations in relation to spraying

Nyffeler and Blair (1978) have shown that the ash from burned straw decreases the activity of chlortoluron and of isoproturon against *Alopecurus myosuroides*. Likewise, would the activity of butam also be adversely affected bearing in mind that winter oilseed rape invariably follows cereals, stubble burned, prior to drilling or cultivating? Our results (Table 5) showed this not to be so in terms of volunteer cereal control. We compared the application of butam both before and after cultivating. Our results showed that on a sand the first method was more effective.

Crop vigour and yield

From the crop vigour data presented in Table 6 butam has no adverse effect on the vigour of oilseed rape at rates up to 8.6 kg/ha but severely depressed the crop at 17.3 kg/ha. Crop yields in 1978 improved with increasing rate of butam (Table 7) and, in 1980, yields from the areas treated with butam matched those from the propyzamide and carbetamide + dimefuron treatments. (Table 8). Crop yields were not affected when butam was applied at the double rate of 8.6 kg/ha.

In replicated and grower trials butam has been tested on the varieties Quinta, Jet Neuf, Primor, Rafal and Rapora without any evidence of varietal intolerance.

Our results show butam to be a safe and effective herbicide for pre-emergence use in winter sown oilseed rape. Within our overall programme we have provided answers to some of the questions which might be anticipated from growers.

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References

BLAIR, A.M. and NYFFELER, A. (1978) The Influence of Burnt Straw Residues or Soil Compaction on Chlortoluron and Isoproturon Activity. Proc. 1978, British Crop Protection Conference - Weeds, 113-119

SCHWARTZBECK, R.A. (1976) Butam, N-benzyl-N-isopropyltrimethylacetamide, for pre-emergence weed control. Proc. 1976, British Crop Protection Conference - Weeds, 739-743

Proceedings 1980 British Crop Protection Conference - Weeds

THE ADDITION OF 3,6-DICHLOROPICOLINIC ACID TO PROPYZAMIDE IN WINTER OILSEED RAPE FOR CONTROL OF MATRICARIA MATRICARIOIDES, M. RECUTITA AND TRIPLEUROSPERMUM MARITIMUM SSP. INODORUM

C Sinclair

Pan Britannica Industries Ltd., Britannica House, Waltham Cross, Herts

R Cox

Rohm and Haas (UK) Ltd., Lennig House, Croydon, Surrey

Summary Propyzamide and 3,6-dichloropicolinic acid have been used either as a tank mix or as a formulated product in winter oilseed rape trials in U.K. for three years. Propyzamide alone is well established for control of a wide range of grass and broad-leaved weeds, but some Compositae (the mayweeds) are virtually resistant. 3,6-dichloropicolinic acid has a narrower weed spectrum, but mayweed (*Matricaria matricarioides, M.recutita and Tripleurospermum maritimum ssp. inodorum*) have been shown to be susceptible. Trials have demonstrated that the combination of propyzamide and 3,6-dichloropicolinic acid gives effective control of mayweed as well as grasses and other broad-leaved weeds at 700 + 70 g a.i./ha respectively. For best weed control correct post-emergence timing of application is important. Double rates have been shown to give a wide margin of safety to the crop.

Résumé Le propyzamide et l'acide dichloropicolinique 3,6 sont utilisés, soit en mélange de réservoir ou en tant que produit formulé pour les essais sur l'huile de graine de colza d'hiver, depuis trois ans au Royaume-Uni. Le propyzamide seul est bien établi pour le contrôle de nombreuses mauvaises herbes, y compris celles à feuilles larges, mais certains composés (l'aubépine) y résistent en fait. L'acide dichloropicolinique 3,6 couvre un spectre plus restreint de mauvaises herbes, mais l'aubépine (*Matricaria matricarioides, M.recutita et Tripleurospermum maritimum ssp. inodorum*)y est susceptible, selon certaines expériences. Les essais ont montré qu'un mélange de propyzamide et d'acide dichloropicolinique assure un contrôle effectif de l'aubepine, de même que des mauvaises herbes, y compris celles qui ont de larges feuilles, à raison de 700 + 70 a a.i./ha respectivement. Pour un contrôle amélioré des mauvaises herbes, l'application après leur apparition est importante. Il a été prouvé que des rations doubles assurent une large marge de sécurité à la récolte.

INTRODUCTION

Independent surveys on weed control in winter oilseed rape have shown that mayweeds (Matricaria matricarioides, M.recutita and Tripleurospermum maritimum ssp. inodorum) have become a serious problem on about 35% of the U.K. crop acreage due mainly to widespread removal of other weed species. Other major weed species are Stellaria media and grasses including volunteer cereals. Background work has shown that propyzamide will control Stellaria media and grasses and that 3,6-dichloropicolinic acid will control mayweeds. A combination of these two components into a single product to control these three weed groups and others in winter oilseed rape seemed worthy of investigation.

Propyzamide in winter oilseed rape was originally reported by Nuttall and Peddie (1974), and has since been compared with a wide range of herbicides by Proctor and Finch (1976 and 1978) and by Rea et al (1976), where a rate of 700 g a.i./ha gave 90-100% control of grasses, but unsatisfactory control of mayweed. Optimum control of grasses was achieved only when application was made during the early winter months. Walker (1976) showed that an increase in both temperature and soil moisture increased the rate of propyzamide degradation, temperature being the more important factor. Propyzamide alone or in mixture was therefore applied only from October to January inclusive.

The chemical, physical and toxicological properties of 3,6-dichloropicolinic acid were first reported by Haagsma (1975) and Brown and Uprichard (1976). Soil residues, metabolic studies and species susceptibility are given in a Technical Information Bulletin from Dow Chemical Company Ltd., (personal communication), including work showing that post emergence application of up to 200 g a.i./ha to oilseed rape has given no detectable residues in extracted oil.

3,6-dichloropicolinic acid applied post emergence shows selectivity to Brassicae and graminaceous crops. It is absorbed by leaves and roots and is readily translocated. Plants of susceptible species show typical hormone - type symptoms, especially from foliar application to young actively growing plants. The control of all commonly occurring mayweeds in various crops with 3,6-dichloropicolinic acid has been reported by Gilchrist and Lake (1978), and in winter oilseed rape by Proctor and Finch (1978) whilst Rea et al (1976) showed that 3,6-dichloropicolinic acid + a benazolin ester at 60 + 250 g a.i./ha increased yield and percentage oil.

METHOD AND MATERIALS

Trials in U.K. were carried out during three years up to 1979-80, using the trials design and conditions as shown in Table 1, and treatments as in Tables 2 and 3. Propyzamide + 3,6-dichloropicolinic acid was used either as a tank mix at a range of rates of the latter component, or as a formulated product at 700 + 75 g a.i./ha (1978-79) or 700 + 70 g a.i./ha (1979-80),

Assessments were made of crop vigour over 3 years (Table 2), plant populations in 1 year, 1 trial, (Table 2) and weed control over 2 years (Table 3). Weed control is given as percentage control of mayweed obtained from plant counts in March/April, using 3 or 9 x 1 sq.ft quadrats per plot, (high infestations), or whole plot estimates (low infestations). Mayweed infestation on untreated plots is shown as the number of plants per m^2. Where drilling was particularly early, TCA was used pre-emergence to remove volunteer cereals. Yields were taken in 1979-80 by combine harvester (Table 3 (b)).

Table 1

Trials Design and Conditions

	1977-78	1978-79	1979-80
No. of trials	6 (replicated)	10 (replicated)	12 (grower)
Plot size	3.8 x 9.1m	3.8 x 9.1m	1 ha
Replications	3	3	-
Sprayer	Oxford Precision	Oxford Precision	Farm (various)
Nozzles	Fan No. 'O'	Fan No. 'O'	-
Water rate l/ha	200	200	200 - 300
Pressure: bars	2	2	2.7 - 4
Location	S. counties	E. England Home counties	UK
Varieties	Quinta Erra Primor Expander	Primor Quinta Jet Neuf	Jet Neuf
Soil types	Light Medium Heavy	Light Medium Heavy	Medium Heavy Very heavy
Timing: Crop (leaf stage)	3-6	3-10	3-5
: Mayweed	4-10	3-10	2-9
Date of application	Sept - Dec	November	Oct - Dec

RESULTS

TABLE 2

Crop Safety Data Over 3 Years Trials

Treatment Rate g a.i./ha		Plant population ('000/ha)	Crop Vigour 0-10 where 0=dead and 10=healthy (spring assessment)		
Year :		1977-78	1977-78	1978-79	1979-80
Mean of:		1 trial	6 trials	10 trials	12 trials
Design :		replicated	replicated	replicated	grower
Untreated		659	10	10	10
Propyzamide	3,6-dichloropicolinic acid				
Tank mix					
700 +	50	711	10		
700 +	70			10	
700 +	75	756	10		
700 +	100	608	10	10	
700 +	300	731	10		
Formulated					
700 +	70				10
700 +	75			10	
1400 +	140-150			10	
700		815	10	10	
1400				10	
	50	734	10		
	75	692	10		
	100	650	10		
Carbetamide+dimefuron 2800			10	9.8	
Propyzamide+benazolin/3,6-dichloropicolinic acid	700 + 1000 (product)		10	10	
		S.E.49			

Table 3(a)

Percentage control of Mayweed (1978-79) (Infestations below 3/m^2 omitted)

Treatment Rate g a.i./ha	Design: Trial No:	1	2	3	4	5	6	7	8	9	MEAN
		Replicated									
Untreated	(No./m^2)	(65)	(47)	(75)	(5)	(6)	(13)	(3)	(48)	(102)	(40)
Propyzamide Tank mix	3,6-dichloropicolinic acid										
700 +	60	83	77	90	83	73	0	83	–	–	70
700 +	65	95	93	96	82	80	10	98	–	–	79
700 +	70	88	84	100	84	86	80	98	–	–	89
700 +	75	95	93	100	85	89	90	100	–	–	93
700 +	100	100	100	100	87	92	–	–	–	–	–
Formulated											
700 +	70										
700 +	75	88	100	96	80	90	90	98	95	83	91
1400 +	140-150	100	93	100	88	98	98	100	100	97	97
700		0	0	0	10	10	0	0	6	0	3
1400		12	13	14	21	12	–	–	–	–	–
(Feb.appln) 700 +	75	–	72	85	–	–	–	–	85	–	–
Carbetamide+ dimefuron	2800	83	84	96	83	92	80	95	65	45	80
Propyzamide+ benazolin/ 3,6-dichloropicolinic acid 700 +	1000 (product)	95	100	96	83	92	80	98*	100	89	–
	S.E.	3.3	4.8	2.5	–	–	6.5	2.8	6.7	6.4	

*Benazolin alone

Table 3(b)

Percentage control of Mayweed (infestations below $3/m^2$ omitted) and Crop Yields (1979-80)

Treatment Rate g a.i./ha		Design : Trial No:	15	16	17	18	19	20	21	22	MEAN	Crop yield (t/ha) Mean of 15,17,18&19	Crop yield (t/ha) Mean of 16&18	Crop yield (t/ha) 23
			% Control of Mayweed: Grower											
Untreated		(No. $/m^2$)	(324)	(150)	(66)	(6)	(89)	(11)	(82)	(62)	(99)			(<3)
Propyzamide	3,6-dichloro-picolinic acid													
Formulated														
700 +	70		90	95	91	89	95	89	85	74	89	4.4	4.3	2.9
700			10	-	29	0	13	-	-	-	-	4.0	-	2.9
Carbetamide + dimefuron	2800											-	-	2.8
Propyzamide+ benazolin/ 3,6-dichloro-picolinic acid 700 +	1000 (product)		-	96	-	72	91	-	-	77*	-	-	4.3	-

*Benazolin alone

DISCUSSION

Having established that propyzamide + 3,6-dichloropicolinic acid is potentially an important contribution to weed control in winter oilseed rape, trials followed a logical progression from a wide dosage rate range on the crop in the first year, to a narrower range with detailed observations on weed control in the second year, and to grower trials with the formulated product in the third year. Crop safety was established in replicated trials using double rate of both components, (also quadruple rate of 3,6-dichloropicolinic acid).

Optimum timing is dictated by both crop and mayweed stages. On the crop, as with propyzamide, application should be as soon as possible after the 3 leaf stage. On mayweed, since the herbicidal action is mainly contact, and is maximal on young plants, optimum timing has been shown to be as soon as possible after there is reasonable weed emergence. Specific observations on later applications (Table 3a) showed that control may be reduced considerably if application is made to mayweed beyond the 12 leaf stage.

Mayweed control in 1978-79 averaged 89% (tank mixed) and 91% (formulated), whilst in 1979-80 large scale grower trials with the formulated product also gave 89% control. In comparison, propyzamide + benazolin/3,6-dichloropicolinic acid gave essentially similar control, whilst carbetamide + dimefuron was inferior. Mayweed control appears to be related to yield (Table 3b), the high level of control given by propyzamide + 3,6-dichloropicolinic acid showing a bigger yield than the limited control of propyzamide alone, whereas the similar levels of control given by the two propyzamide + additive products is reflected in identical yields. Where mayweed was absent, yield was unaffected. Data on other important weed species such as volunteer cereals and Stellaria media, although not reported, confirmed that propyzamide + 3,6-dichloropicolinic acid gave excellent control, at least equal to that of propyzamide alone, whether or not TCA had been applied.

The individual components of the mixture have been evaluated to determine their respective contribution. Propyzamide alone was shown to give some control of mayweed (3% and 13% in 1978-79 and 1979-80 respectively), and excellent control of volunteer cereals, grass weeds, Stellaria media and other susceptible species (not reported). Propyzamide and 3,6-dichloropicolinic acid were used separately and together in 1977-78 at a range of rates, and mean results from 3 trials involving 9 weed species including mayweed showed that propyzamide : 3,6-dichloropicolinic acid : propyzamide + 3,6-dichloropicolinic acid gave a weed control ratio of 78: 11: 100% respectively. Both these results indicate that there is undoubtedly an additive effect of the two components on mayweed. Comparisons between various rates of 3,6-dichloropicolinic acid in mixture (Table 3a) showed that 65 g a.i./ha is marginally inadequate, whilst 70 and 75 g a.i./ha gave satisfactory weed control with only minimal difference between rates. Hence, a final acceptable rate of the combined formulated product is 700 + 70 g a.i./ha.

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References

BROWN, J.G. and UPRICHARD, S.D. (1976). Control of problem weeds with 3,6-dichloro-picolinic acid and mixtures with phenoxy herbicides. Proceedings British Crop Protection Conference - Weeds, 1, 119-125

GILCHRIST, A.J. and LAKE, C.T. (1978). The development of 3,6-dichloropicolinic acid as a tank mix and/or sequential application for the control of annual and perennial weeds in sugar beet. Proceedings British Crop Protection Conference - Weeds, 1, 285-292

HAAGSMA, T. (1975) Dowco 290 herbicide - a coming new selective herbicide. Down to Earth, 30, No. 4, 1-2

NUTTALL, A.M. and PEDDIE, A. (1974). Control of annual grasses and broad-leaved weeds in winter oilseed rape with propyzamide. Proceedings 12th British Weed Control Conference, 2, 573-580

PROCTOR, J.M. and FINCH, R.J. (1976). Chemical weed control in winter oilseed rape Proc. 1976 British Crop Protection Conference - Weeds, 2, 509-516

PROCTOR, J.M. and FINCH, R.J. (1978). Chemical weed control in winter oilseed rape. 1977 and 1978 harvest years. Proceedings 1978 British Crop Protection Conference - Weeds, 2, 527-534

REA, B.L., PALMER, R.A. and DE ST. BLANQUAT, A. (1976). Weed control in rape seed with benazolin ester/3,6-dichloropicolinic acid mixtures. Proceedings 1976 British Crop Protection Conference - Weeds, 2, 517-524

WALKER, A. (1976). Effect of varying weather conditions on the persistence of three herbicides in soil. Proceedings British Crop Protection Conference - Weeds, 2, 635-642

THE CONTROL OF SORGHUM HALEPENSE GROWING FROM SEEDS AND RHIZOMES USING FLUAZIFOP-BUTYL, ALLOXIDIM SODIUM, ALACHLOR, DIPHENAMID AND TRIFLURALIN IN SOYABEAN

N Sarpe and C Dinu

Research Institute for Cereals and Technical Crops Fundulea, Romania

Summary The experiments described were carried out on a chernozem soil containing 3.5% humus and 36% clay. Populations of Sorghum halepense were from 300-700 plants/m^2. There was only partial control of Sorghum halepense by alachlor, diphenamid and trifluralin and crop yields from these treatments were only 46-51% of the hoed control (2.86 tonne/ha). Alloxidim sodium gave improved but still incomplete control and a crop yield of 64-73%. Complete control of both seedlings and growth from rhizomes of S halepense was given by fluazifop-butyl + bentazon (0.75 + 1.92 kg ai/ha) resulting in a crop of 3.15 tonnes/ha, 110% of control.

Regeneration of S halepense foliage from rhizomes occurred between 30-40 days after treatment with alloxidim sodium but fluazifop-butyl gave virtually complete control and no regeneration.

INTRODUCTION

Soil and climatic conditions in Romania are very favourable for soya beans and there has been a large increase over the last 10 years in the area grown, from 25,800 hectares in 1970 to 202,525 hectares in 1978.

The weeds occurring most frequently in soya bean crops are as follows: Sinapis arvensis, Raphanus raphanistrum, Setaria glauca, Digitaria sanguinalis, Amaranthue retroflexus, Setaria viridis, Chenopodium album, Thlaspi arvense, Polygonum convolvulus, Portulaca oleracea, Solanum nigrum, Abutilon theophrasti, Xanthium strumarium, Sorghum halepense, Cirsium arvense, Convolvulus arvensis. Existing control recommendations are for the application pre-emergence of grass weed herbicides such as trifluralin and alachlor in combination with metribuzin or post-emergence application of bentazon (Sarpe et al 1967, 1973, 1975, 1976). Similar recommendations are also made in other countries (Luib 1972, Ubrizsy and Gimesi 1969, Saghir 1970, Vasileiv 1973, Regnault 1973, Vratarici 1975). However these herbicides do not control S halepense growing from rhizomes, thus farmers prefer to use traditional methods of hand or mechanised hoeing, although these involve greater effort, higher fuel consumption and greater costs. To solve this problem experiments started in 1979 with new herbicides based on alloxidin sodium and fluazifop-butyl.

METHOD AND MATERIALS

Two field trials were carried out and one in the glasshouse. The field trials were at Fundulea on a chernozem soil, containing 3.5% humus and 36% clay, severely infested by S halepense and with populations of dicotylendonous weeds including Amaranthus retroflexus, Chenopodium album, Erigeron canadiensis and Convolvulus arvensis.

In the first trial pre-planting incorporated trifluralin, alachlor and diphenamid, alone or in tank mix with metribuzin were compared with post-emergence application of herbicides based on alloxidim-sodium and fluazifop-butyl applied alone or in tank mix with bentazon. Rates of application are shown in Table 1.

In the second trial trifluralin + metribuzin (0.9 + 0.35 kg ai/ha) were applied pre-planting overall in order to limit the occurrence of S halepense to plants arising only from rhizomes. After the soyabean plants had emerged and the shoots of S halepense were 30-60 cm high, alloxidim sodium and fluazifop-butyl were applied at normal and high rates in order to determine the rate needed to kill the rhizomes and deprive the weed of the capacity to regenerate the next year.

The treatments were replicated 4 times in plots of 25-30 square meters. The herbicides were applied by a "Solo" knapsack sprayer at a volume of 1000 l/ha.

Observations were made using EWRS scales on the selectivity of the herbicides towards the crop and their efficiency in weed control. In the first trial the dry weight of weeds was assessed before harvesting and recording the yield of soya beans.

RESULTS AND DISCUSSION

Tables 1-3 give details of the weed control efficiency of the herbicides for both S halepense and other species and of grain production from the crop. Table 4 provides information on the extent of regeneration of S halepense from rhizomes after herbicide treatment in the field and in the glasshouse.

The selectivity towards soya beans of the pre-emergence herbicides alachlor, diphenamid, trifluralin and metribuzin is well established. Alloxidim sodium and fluazifop-butyl applied after crop emergence proved to be very safe at crop height stage 10-20 cm and also at the flowering stage even at the maximum application rates used, 6.0 kg ai/ha alloxidim sodium and 3.0 kg fluazifop-butyl. (Data not presented).

From data in Table 1 it is clear that alachlor, diphenamid and trifluralin did little to reduce the infestation of S halepense. These herbicides controlled 95-100% of the plants growing from seed but a large number of plants growing from the rhizomes were unaffected. Alloxidim sodium gave very efficient control of seedling S halepense at the 2-6 leaf stage, the plants dying 10-12 days after treatment, but is had a much smaller effect on the plants growing from rhizomes. The young shoots became necrotic and yellow and partially withered 20 days after treatment, but after 30 days new shoots developed which after a further 60-90 days appeared to be almost completely healthy (EWRS scale 7-8) and by harvest some of these shoots had flowered and produced viable seed.

On plots treated with fluazifop-butyl, necrosis and yellowing of S halepense growing both from seed and from rhizomes occurred much more rapidly (Table 1). All the S halepense seedlings were dead 10-15 days after treatment while shoots arising from rhizomes were dead within 30 days. No regeneration occurred. These effects are shown more strikingly in the data for the weight of weeds at harvest (Table 2). In the unweeded control plot the weight of S halepense plants was 8,000 kg/ha; it

Table 1

The efficiency of various herbicides in controlling Sorghum halepense growing from seed and rhizomes (Trial No. 1 Fundulea 1979)

Herbicides	Rate kg ai/ha	Time of applic.	Score after postemergence treatment (EWRS scale)*					
			10 days	15 days	25 days	30 days	60 days	90 days
Control II	-	-	9	9	9	9	9	9
Alachlor	4.8	ppi	8	8	8	8	8	8
Alachlor + metribuzin	4.8 + 0.35	ppi	8	8	8	8	8	8
Diphenamid	5.0	ppi	8	8	8	8	8	8
Diphanamid + metribuzin	5.0 + 0.35	ppi	8	8	8	8	8	8
Trifluralin	0.96	ppi	8	8	8	8	8	8
Trifluralin + metribuzin	0.96 + 0.35	ppi	8	8	8	8	8	8
Alloxidim - sodium + bentazon	1.5 + 1.92	post-em	7	5	2	4	7	8
Alloxidim - sodium + bentazon	3.0 + 1.92	post-em	7	5	2	3	7	8
Fluazifop-butyl	0.25	post-em	5	2	1	1	1	1
Fluazifop-butyl	0.50	post-em	5	2	1	1	1	1
Fluazifop-butyl + bentazon	0.75+1.92	post-em	5	2	1	1	1	1

*EWRS : 9 = normal growth in Sorghum halepense

1 = 98-100% of Sorghum halepense plants dead

Table 2

The efficiency of various herbicides in controlling Sorghum halepense and other weed species in soybean crops (Trial No. 1 Fundulea 1979)

Treatments	Rate kg ai/ha	Dry weight of weeds before harvesting				Yield soya-bean grain	
		A halepense		Other species kg/ha	Total kg/ha	kg/ha	%
		kg/ha	%				
Control I - 3 hoeings	-	350	4	400	750	2859	100
Control II- not hoed	-	8000	100	900	8900	350	12
Alachlor	4.88	6950	86	890	7840	1480	51
Alachlor + metribuzin	4.8+0.35	6800	85	320	7120	1690	59
Diphenamid	5.0	6650	83	720	7370	1350	47
Diphenamid + metribuzin	5.0+0.35	6890	86	420	7310	1540	54
Trifluralin	0.96	6890	86	750	7640	1320	46
Trifluralin + metribuzin	0.96+0.35	6940	87	70	7010	1792	63
Alloxidim - sodium+bentazon	1.5+1.92	4500	56	500	5000	1829	64
Alloxidim - sodium + bentazon	3.0+1.92	2100	26	500	2600	2100	73
Fluazifop-butyl	0.25	0	0	1600	1600	2450	86
Fluazifop-butyl	0.5	0	0	1500	1500	2800	98
Fluazifop-butyl + bentazon	0.75+1.92	0	0	550	550	3150	110

LSD 5% 270 kg
1% 420 kg
0.1% 640 kg

Table 3

<u>Effect of herbicides on foliage of *Sorghum halepense* growing from rhizomes (Trial 2 - Fundulea 1979)</u>

Vigour score EWRS scale*

Herbicides	Rate kg ai/ha	Number days after treatment					
		10 days	15 days	25 days	33 days	52 days	82 days
Control - non treated	-	9	9	9	9	9	9
Fluazifop-butyl	0.5	7	3	1	1	1	1
Fluazifop-butyl	1.0	6	2	1	1	1	1
Fluazifop-butyl	2.0	6	2	1	1	1	1
Fluazifop-butyl	3.0	6	2	1	1	1	1
Alloxidim-sodium	1.12	8	4	2	5	7	9
Alloxidim-sodium	2.25	7	3	2	3	5	8
Alloxidim-sodium	3.0	6	2	1	2	4	7
Alloxidim-sodium	6.0	6	2	1	2	4	7

*EWRS : 9 = No effect on *Sorghum halepense*
1 = Total withering in *Sorghum halepense* plants

Table 4

The effect of herbicides on the regeneration of Sorghum halepense from rhizomes under field conditions (Trial No. 1 - Fundulea 1979-1980)

Treatments carried out in 1979		Determinations made in 1980					
Herbicides	Dose kg ai/ha	May 5		June 3		June 20	
		Vigour* score	Foliage height cm	Vigour* score	Foliage height cm	Vigour* score	Foliage height cm
Control I 1-3 hoeings	-	1.0	0	1.0	0	1.0	0
Control II not hoed	-	9.0	29	9.0	60	9.0	110
Alachlor	4.8	9.0	27	9.0	65	9.0	100
Alachlor + metribuzin	4.8+0.35	9.0	31	9.0	63	9.0	120
Diphenamid	5.0	9.0	33	9.0	65	9.0	120
Diphenamid + metribuzin	5.0+0.35	9.0	30	9.0	70	9.0	110
Trifluralin	0.96	9.0	28	9.0	68	9.0	105
Trifluralin + metribuzin	0.96+0.35	9.0	32	9.0	60	9.0	100
Alloxidim - sodium + bentazon	1.5+1.92	9.0	28	9.0	70	9.0	100
Alloxidim - sodium + bentazon	3.0+1.92	9.0	30	9.0	67	9.0	120
Fluazifop-butyl	0.25	2.5	10	2.5	30	2.5	50
Fluazifop-butyl	0.50	1.5	12	1.5	24	1.5	45
Fluazifop-butyl + bentazon	0.75 + 1.92	1.0	10	1.5	27	1.5	40

* EWRS scale   1 = no regeneration
                 9 = regeneration from all rhizomes

was only slightly lower in the areas treated with alachlor, diphenamid and trifluralin. In the area treated with alloxidim sodium there were between 2000-4000 kg of S halepense per hectare while in areas treated with fluazifop-butyl there were no plants of S halepense remaining, even at the lowest rate of application, 0.25 kg ai/ha.

In unweeded areas grain production was reduced to only 12% of that in the weeded crop, a loss of more than 2.3 tonne/ha. In areas treated by alachlor, diphenamid and trifluralin yields were also low, 46-63% of the weeded yield due to competition from incomplete control of S halepense growing from rhizomes. In the areas treated with alloxidim sodium yields were higher, 64-73% of the crop in weeded areas, seedlings of S halepense having been killed and the vigour of the shoots arising from rhizomes having been reduced. The highest yield of soya beans (3.15 tonne/ha) was obtained in the area treated with fluazifop-butyl tank mixed with bentazon. Here there was 95% control of S halepense and other weeds. In areas treated with fluazifop-butyl alone yields were 2-14% lower due to competition from dicotyledoneous weeds which are resistant to this herbicide.

In the second trial particular attention was paid to the efficiency of these two herbicides against S halepense growing from rhizomes, including late application when S halepense shoots had reached a height of 20-60 cm and the soya crop had formed pods. (Table 3.) Foliage kill was complete 15-25 days after treatment with all rates of fluazifop-butyl (0.5 - 3.0 kg ai/ha) and no regrowth had occurred by the autumn. On plots treated with alloxidim sodium there was complete foliage kill 25 days after treatment but only at rates of 3 and 6 kg ai/ha. Regrowth occurred 50 days after treatment and these shoots were able to flower and set seed by autumn.

To determine if the fluazifop-butyl had been translocated to the rhizomes and killed them, sections of treated rhizome were planted in the glasshouse. No growth occurred. Rhizomes from plants treated with alloxidim sodium gave some regrowth but at a lesser rate than untreated rhizomes which by March 1980 had given rise to shoots 80-130 cm in height which were in ear.

Field observations on the recovery of S halepense after treatment with herbicides were continued in 1980. To avoid damage by ploughing or frost over winter an area was left undisturbed and soya beans were sown again in spring 1980 by direct drilling. In the areas treated with alachlor, diphenamid, trifluralin and alloxidim sodium there was new and vigorous growth of S halepense from rhizomes. In areas treated in 1979 with fluazifop-butyl there was very little regrowth, that which occurred apparently being due to uneven application rather than ineffectiveness of the herbicide. (Table 4)

This work has shown that fluazifop-butyl is a promising herbicide for the control of S halepense in soya beans.

References

LUIB, M. and VAN DER WEERD (1972) Trial results obtained in soya bean with bentazon. 11th British Weed Control Conference, Brighton 547 - 552

REGNAULT, V. et. coll (1973) Deux annees d'etude des herbicides du tournesol et du soja.
7e Conference du Paris COLUMA Tome I 217 - 227

SAGHIR, A. R. and BHATTI, M.S. (1970) The influence of herbicides on the chemical composition of soya bean seeds.
10th British Weed Control Conference, Brighton 384 - 389

SARPE, N. (1975) Effet de herbicide Treflan applique seul et associe aux herbicides triaziniques dans la lutte contre les adventices du soja irrigue.
11 the Jugoslav Weed Control Conference, Novi-Sad 233-240

SARPE, N., TOMOROGA, P., SEGARCEANU, O., APOSTOL, V. (1975) Effet des herbicides trifluraline, butylate, nitroanlline et metetilachlore associes aux metribuzin, chlorbromuron et autres herbicides dans la lutte contre les mauvaises herbes des cultures de soja et de tournesol.
8e Conference du COLUMA Paris, Tome 2 599 - 610

SARPE, N., CIORLAUS, A., GHINEA, L., VLADUTU, I (1976) Erbicidele - principiile si practica combaterii buruienilor.
Editura "Ceres" Bucuresti. Editia II-a, 195 - 209

UBRIZSY, G., GIMESI, A (1969) A vegyszeres gyomirtas gyakorlata.
Mezogazdasagi Kiado, Budapest, 1 - 310

VASILIEV, F S (1973) Sroki i sposobi vnesenia treflana na posevah sciei
Himia v selshkom hoziaistve, Moskva 48 - 50

VRATARICI, M. (1975) New herbicides for the weed control in soya bean.
11th Jugoslav Weed Control Conference, Novi-Sad, 241 - 249

PLOWMAN, R. E., STONEBRIDGE W.L., HAWTREE J.N., (1980) Fluazifop-butyl - a new selective herbicide for the control of annual and perennial grass weeds.
Proceedings 1980 British Crop Protection Conference - Weeds (in press)