Proceedings 1978 British Crop Protection Conference - Weeds

# THE DEVELOPMENT OF CHLORTHAL-DIMETHYL + METHAZOLE IN THE U.K. FOR USE ON TRANSPLANTED LEAF BRASSICAE

J. Daniel

Duphar-Midox Ltd., Smarden, Kent

Summary Trials carried out from 1975 - 1977 showed the wettable powder formulation of chlorthal-dimethyl + methazole (S1445) to have a broad weed spectrum, good residual activity and adequate crop tolerance when used on transplanted-leaf brassicae. Residue trials indicated that the common rotational crops likely to follow treated brassicae may be safely sown two months after S1445 application.

## INTRODUCTION

The residual combination herbicide chlorthal-dimethyl + methazole was first tested on peas in Switzerland (Meyer, 1972) under the code S1445. Handley and King (1976) have shown that under U.K. conditions, S1445 is extremely safe to the pea crop, even on very light soils. It was subsequently approved for use on peas. Further work in Switzerland (Bosch et al, 1974) indicated its suitability for use on a range of other crops which included cauliflowers and other leaf brassicae. Development work in the U.K. commenced in 1974 on bulb onions. Crops examined in the period 1974 - 1977 include onions (six trials), dwarf beans (six trials), carrots (three trials), peas (six trials), and brassicae (eleven trials).

This report presents the results from these U.K. trials in terms of weed control and for crop safety in brassicae, which enabled an extension of Approval for the use of the mixture on transplanted-leaf brassicae.

Although much work had been undertaken on S1445 between 1972 and 1976, little if any information was available on the possible after effects to crops sown directly into previously treated ground. To obtain such data, six crops were selected which were considered the most likely to follow treated brassicae in the rotation. Two such trials were undertaken.

## METHOD AND MATERIALS

All trials were of randomised block design, the 1975 series having four replicates whilst those in 1976 and 1977 had three. In all brassicae trials, S1445 was compared with propachlor at 4.4 kg a.i./ha and untreated controls. Plot size varied between 1/300 and 1/600 ha. Site and other details are provided in Table 1.

## Table 1

### Transplanted brassicae site details

| Trial | Location | Soil | Crop | Variety | Planted | Application Pre | Application Post |
|---|---|---|---|---|---|---|---|
| 1975 | | | | | | | |
| A | Preston, Kent | SCL | B. Sprouts | F1 Hybrid | 25/6 | 26/6 | 11/7 |
| B | Finglesham, Kent | FSL | Cauliflower | Canberra | 8/7 | 25/7 | 28/8 |
| C | " " | L | Cauliflower | Tasman | 18/7 | 28/7 | 28/8 |
| 1976 | | | | | | | |
| D | Birchington, Kent | ZyL | Cauliflower | | 16/7 | 22/7 | - |
| E | Ramsgate, Kent | L | Cauliflower | | 23/7 | 27/7 | - |
| F | " " | L | Broccoli | | 26/7 | 27/7 | - |
| 1977 | | | | | | | |
| G | Saxmundham, Suffolk | S | Calabrese | Pacifica | 4/7 | 12/7 | 27/7 |
| | " " | S | Cabbage | Hol. White Winter | 7/7 | 12/7 | 27/7 |
| | " " | S | B. Sprouts | F1 Hybrid | 6/7 | 12/7 | 27/7 |
| | " " | S | Cauliflower | Kt. Protecting | 8/7 | 12/7 | 27/7 |
| H | Staple, Kent | | Cauliflower | Nevada & Louina | 22/7 | 27/7 | 15/8 |
| I | Elmstone, Kent | | Cauliflower | St. Hilary | 22/7 | 27/7 | 15/8 |
| J | Eastry, Kent | | W. Broccoli | | | 11/8 | 30/8 |
| K | Wingham, Kent | L | W. Broccoli | | 29/7 | 10/8 | 23/8 |

In the soil residue trials, there was only a single replicate, the plots on one trial being 1/500 ha and on the second, 1/1000 ha. Site details are shown in Table 2.

## Table 2

### Soil residue site details

| Trial | Location | Soil | Following Crop | Variety |
|---|---|---|---|---|
| 1 | Saxmundham, Suffolk | S | Turnip | Blue Cap Clucas |
| | | | Oilseed Rape | Maris Hoplover |
| | | | Peas | Vedette |
| | | | Dwarf Bean | Cascade |
| | | | Winter Barley | Maris Otter |
| | | | Winter Wheat | Maris Huntsman |
| 2 | Smarden, Kent | SL | Swede | Acme |
| | | | Oilseed Rape | Maris Hoplover |
| | | | Peas | Vedette |
| | | | Dwarf Beans | Purley King |
| | | | Winter Barley | Maris Otter |
| | | | Winter Wheat | Maris Freeman |

Chlorthal-dimethyl + methazole (commercial product Delozin S) is formulated as a wettable powder containing 75% total a.i. This formulation was used throughout at the undermentioned rates (Table 3). All rates are expressed as total a.i. per ha.

Table 3

S1445 treatments as kg a.i./ha

| | Pre-emergence | | | Post-emergence | | |
|---|---|---|---|---|---|---|
| 1975 | 3.4 | 4.5 | 6.8 | 3.4 | 4.5 | 6.8 |
| 1976 | 3.0 | 3.9 | 7.8 | - | - | - |
| 1977 | - | 4.5 | 9.0 | - | 4.5 | 9.0 |

In the soil residue trials, the crops following application of S1445 were drilled direct into soil treated at 4.5, 9.0, 13.5 and 18.0 kg a.i./ha at intervals of 1, 2, 3 and 4 months after treatment at 4.5 kg a.i./ha, and at 1 and 2 months following treatment at the higher rates.

An Allman motorised-pump sprayer was used to apply the treatments and was fitted with fan nozzles on a 3 m boom. Application was made in a water volume between 580 and 675 l/ha.

Weed assessments were made five to nine weeks after application when weeds were in the seedling stage, by counting on each plot at each site the number of seedlings present in a prescribed area (1 sq. m) obtained by the random throwing of a 0.5 x 0.5 m quadrat (4 throws per plot).

Visual assessments of crop vigour were recorded two months post treatment in 1975 and 1976, and between one and two months and again between two and three months post treatment in 1977. A scale of 0 - 10 was used, where 0 = dead crop and 10, full vigour.

## RESULTS

The results of assessments made for weed control appear in Table 4.

Table 4

Percentage control of individual weed species

| Weed Species | Brassicae trials 1975 - 77 | | | | All trials 1974 - 77 | | |
|---|---|---|---|---|---|---|---|
| | No. of Sites | Propachlor | S1445 Pre-em 3.0 kg | S1445 Pre-em 4.5 kg | No. of Sites | S1445 @ 4.5 kg Pre-em | S1445 @ 4.5 kg Post-em |
| *Capsella bursa-pastoris* | 8 | 91 | 95 | 96 | 10 | 90 | 76 |
| *Senecio vulgaris* | 8 | 53 | 24 | 51 | 8 | 51 | 75 |
| *Chenopodium album* | 5 | 68 | 95 | 87 | 12 | 88 | 90 |
| *Mercurialis annua* | 5 | 35 | 57 | 63 | 5 | 63 | 100 |
| *Stellaria media* | 5 | 62 | 90 | 95 | 11 | 94 | 98 |
| *Urtica urens* | 3 | 61 | 80 | 71 | 8 | 77 | 100 |
| *Poa annua* | 3 | 97 | 90 | 91 | 9 | 89 | 51 |
| *Polygonum aviculare* | 3 | 63 | - | 87 | 9 | 74 | 72 |

cont'd ...

## Table 4 (cont'd)

### Percentage control of individual weed species

| Weed Species | Brassicae trials 1975 - 77: No. of Sites | Propa-chlor | S1445 Pre-em 3.0 kg | S1445 Pre-em 4.5 kg | All trials 1974 - 77: No. of Sites | S1445 @ 4.5 kg Pre-em | S1445 @ 4.5 kg Post-em |
|---|---|---|---|---|---|---|---|
| Sinapis arvensis | 3 | 43 | 71 | 100 | 3 | 100 | 95 |
| Galinsoga parviflora | 2 | 50 | - | 100 | 2 | 100 | 52 |
| Lamium spp | 2 | 95 | 99 | 100 | 3 | 100 | 89 |
| Matricaria recutita | 2 | 75 | 79 | 100 | 2 | 100 | 43 |
| Solanum nigrum | 2 | 92 | - | 91 | 4 | 91 | 96 |
| Tripleurospermum maritimum | 2 | 92 | 67 | 96 | 7 | 92 | 86 |
| Fumaria officinalis | 1 | 100 | 0 | 0 | 2 | 73 | - |
| Polygonum persicaria | 1 | 0 | - | 0 | 2 | 0 | - |
| Sisymbrium officinale | 1 | 97 | - | 100 | 1 | 100 | 100 |
| Veronica spp | 1 | 100 | - | 100 | 7 | 67 | - |
| Viola arvensis | 1 | 0 | - | 100 | 2 | 100 | 100 |
| Polygonum convolvulus | | | | | 7 | 29 | - |
| Papaver rhoeas | | | | | 1 | 100 | 31 |
| Raphanus raphanistrum | | | | | 1 | 85 | 100 |

S1445 provided superior weed control to that from propachlor when applied pre-weed emergence with the exception of Poa annua and Fumaria officinalis. The latter is moderately resistant to S1445, as is the case with P. persicaria. Applied post weed emergence (2 - 4 leaves) overall weed control was somewhat inferior to S1445 applied pre-emergence, but was still better than that by propachlor. However, the susceptibility of certain weed species was changed appreciably, Senecio vulgaris, Mercurialis annua and Urtica urens being more susceptible, while Capsella bursa-pastoris, Poa annua, Galinsoga parviflora, Matricaria recutita and Papaver rhoeas less so.

### Crop tolerance, transplanted leaf brassicas

Results (not here presented) in 1975 showed full crop vigour with no crop damage at all rates of S1445, whether treatment had been made the day following planting or up to seven weeks later. In 1976, under conditions of severe drought, treatments of S1445 resulted in some chlorosis of the older leaves and reduction in crop vigour (Table 5).

## Table 5

### Crop vigour 8 weeks post treatment, 1976

| Treatment kg a.i./ha | Trial D | Trial E | Trial F | Mean |
|---|---|---|---|---|
| Control | 9.3 | 9.3 | 10 | 9.5 |
| Propachlor | 9.3 | 9.0 | 9.3 | 9.2 |
| S1445 3.0 | 8.0 | 9.0 | 8.3 | 8.4 |
| S1445 3.9 | 6.7 | 9.7 | 7.7 | 8.0 |
| S1445 7.8 | 6.7 | 8.3 | 8.3 | 7.8 |

Vigour score: 0 = dead crop 10 = full vigour

Due to adverse conditions at and after transplanting, plant establishment was rather variable, making an assessment of yield impossible, but it appeared that the effects of treatment were outgrown by harvest.

In 1976 an additional trial was laid down (not here presented) on a field of brassicae seed beds to check for varietal susceptibility. Thirty-five varieties of cauliflower and forty-six of winter broccoli were sprayed with S1445 at 3.0 and 6.0 kg a.i./ha. Seedlings varied from four true leaves up to transplant size. No damage or reduction in vigour occurred on any variety.

In 1977, crop vigour was assessed on two occasions following treatment on four of the five trials (Table 6).

Table 6

Crop vigour, 1977

| Treatment kg a.i./ha | Site: | Calabrese G | Cabbage G | B. Sprouts G | Cauliflower G | Cauliflower H | Cauliflower I | W. Broccoli J | W. Broccoli K |
|---|---|---|---|---|---|---|---|---|---|
| Control | a) | 10 | 10 | 10 | 10 | 8.3 | 9.0 | 9.3 | 8.0 |
| | b) | 10 | 10 | 10 | 10 | - | 8.7 | 9.7 | 8.3 |
| Pre-weed em. | | | | | | | | | |
| Propachlor | a) | 10 | 10 | 10 | 10 | 7.6 | 8.7 | 7.7 | 8.7 |
| 4.4 kg | b) | 10 | 10 | 10 | 10 | - | 9.3 | 8.7 | 9.0 |
| S1445 | a) | 8.7 | 8.7 | 9.0 | 9.0 | 7.3 | 8.0 | 9.0 | - |
| 4.5 kg | b) | 9.7 | 10 | 10 | 10 | - | 9.0 | 9.0 | - |
| S1445 | a) | 6.3 | 7.3 | 7.0 | 8.3 | 8.3 | 8.3 | 8.0 | 9.0 |
| 9.0 kg | b) | 8.3 | 9.3 | 9.0 | 9.7 | - | 9.3 | 8.7 | 9.3 |
| Post weed em. | | | | | | | | | |
| S1445 | a) | 8.0 | 8.7 | 9.3 | 8.0 | 7.6 | 7.0 | 7.7 | 8.3 |
| 4.5 kg | b) | 9.7 | 9.3 | 9.7 | 10 | - | 9.0 | 9.3 | 10 |
| S1445 | a) | 6.7 | 7.3 | 7.3 | 6.7 | - | - | - | - |
| 9.0 kg | b) | 8.7 | 8.7 | 8.7 | 8.3 | - | - | - | - |

Vigour score: 0 = dead crop 10 = full vigour

a) Assessed 1 - 2 months post treatment
b) Assessed 2 - 3 months post treatment

The figures in Table 6 show an initial check on most of the crops treated with S1445 and on some following the application of propachlor. Increasing rates of S1445 did not necessarily increase the check in vigour, therefore indicating that the cool, slow growing conditions experienced during the summer of 1977 had played a part in the reduced crop vigour scores. The second assessments indicate that in all cases the crop had almost completely outgrown any symptoms of crop check.

**Yields**

Yields of Brussels sprouts and cabbage from trial G in 1977 are shown in Table 7.

**Table 7**

| Treatment kg a.i./ha | | Brussels sprouts Yield kg/10 plants | Cabbage Yield kg/10 plants |
|---|---|---|---|
| Untreated | | 8.00 | 16.9 |
| **Pre-weed emergence** | | | |
| Propachlor | 4.4 kg | 4.83 | 19.1 |
| S1445 | 4.5 kg | 7.08 | 18.0 |
| S1445 | 9.0 kg | 8.00 | 18.5 |
| **Post weed emergence** | | | |
| S1445 | 4.5 kg | - | 18.6 |
| S1445 | 9.0 kg | - | 18.0 |

No significant difference between treatments or control. p = 0.1

**Soil residues**

The crop damage resulting from drilling a range of six crops into land previously treated with S1445 are shown in Table 8.

**Table 8**

**Crop damage assessments**

| Treatment | kg a.i./ha | Drilling Interval post-appl. | Turnip/ Swede | | O.S. Rape | | Peas | | Dwarf Beans | | Winter Barley | | Winter Wheat | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site: | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| Untreated | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| S1445 | 4.5 | 1 month | 10 | 10 | 10 | 9.7 | 10 | 9.3 | 10 | 9.0 | 10 | 9.9 | 10 | 5.9 |
| S1445 | 4.5 | 2 " | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 6.0 | 10 | 7.0 |
| S1445 | 4.5 | 3 " | - | 10 | - | 10 | - | 8.9 | - | 10 | - | 8.8 | - | 7.0 |
| S1445 | 4.5 | 4 " | - | 8.1 | - | 6.1 | - | 8.9 | - | 10 | - | 10 | - | 8.7 |
| S1445 | 9.0 | 1 " | 10 | 10 | 10 | 9.7 | 10 | 10 | 10 | 10 | 10 | 5.1 | 10 | 5.1 |
| S1445 | 9.0 | 2 " | 10 | - | 10 | - | 10 | - | 10 | - | 10 | - | 10 | - |
| S1445 | 13.5 | 1 " | - | 8.6 | - | 10 | - | 9.7 | - | 10 | - | 9.6 | - | 6.7 |
| S1445 | 18.0 | 1 " | 3.0 | 5.9 | 9.0 | 9.7 | 10 | 10 | 8.0 | 10 | 10 | 10 | 10 | 10 |
| S1445 | 18.0 | 2 " | 7.0 | - | 9.0 | - | 10 | - | 9.0 | - | 10 | - | 10 | - |

Crop damage 0 - 10, where 0 = crop dead and 10 = full vigour

Site 1, Suffolk   Site 2, Kent

On site 1, no damage was seen on any crop drilled at one or two month intervals on land treated with S1445 at 4.5 kg a.i./ha. Site 2 showed similar safety levels on all crops excepting cereals, but a curious pattern of results occurred on this trial when the crops drilled at a greater time interval resulted in lower crop vigour scores than those drilled at shorter time intervals. S1445 at 9.0 kg a.i./ha was safe on all crops on site 1, and also showed a similar level of safety on site 2, except on barley and wheat. However, the result of S1445 at 18.0 kg a.i./ha, one month after application on site 2, showed complete crop safety, again suggesting an irregularity in the results from site 2.

## DISCUSSION

The results of trials over the four year period 1974 to 1977 showed S1445 generally to confer a superior level of weed control to that provided by propachlor when applied pre-weed emergence, particularly for Chenopodium album, Mercurialis annua, Stellaria media, Urtica urens, Polygonum aviculare, Sinapis arvensis, Galinsoga parviflora and Matricaria recutita. It has a broad weed spectrum and good residual activity. Post weed emergence treatment generally provided slightly poorer control than pre-emergence, especially of Capsella bursa-pastoris, Poa annua, and Matricaria recutita. However, many brassicae crops are transplanted during the summer months when weeds germinate rapidly, therefore a herbicide such as S1445 that provides effective pre and post-emergence weed control is especially useful.

The results have been consistent in both very dry years (1975 and 1976) as well as in wet conditions (1977). Weed control was assessed (seedling numbers) when the weeds were in the seedling stage. With hindsight it would have been advantageous to have delayed assessment until later as it was noticed towards harvest that many survivors, especially of Polygonum convolvulus, Tripleurospermum maritimum and Urtica urens had remained severely stunted, and therefore weed control later in the season was better than that shown in Table 4.

In some years the treatment slightly checked the growth of some brassicae crops, and on occasions caused chlorosis of the bottom leaves. Crop check caused by the later post weed emergence treatment resulted in a slightly greater effect. However, both pre and post-emergence treatments at 4.5 kg a.i./ha had fully recovered after the second assessment, at 9.0 kg a.i./ha pre-emergence they almost recovered, but at 9.0 kg a.i./ha post-emergence the recovery was not complete. Therefore application of S1445 to transplanted brassicae should be made soon after planting to minimise the chance of effects in the crop occurring. Later assessments showed that any delay to the crop had been outgrown by harvest and limited yield data on two crops tended to confirm this.

In the Suffolk soil residue trial, no damage was seen on any crop drilled within two months of applying S1445 at 4.5 kg a.i./ha. The trial in Kent showed similar safety levels on all crops with the exception of cereals.

S1445 at 9.0 kg a.i./ha was safe on all crops in the Suffolk trial and also showed a similar level of safety in the Kent trial, but again, with the exception of the cereals. However, on this trial, the results of S1445 at 18 kg a.i./ha one month after application showed complete crop safety.

S1445 appeared to be safe at rates of up to four times the normal after an interval of one to two months had elapsed on oilseed rape, peas and dwarf beans.

The crops proving an exception were turnips/swedes and winter cereals where a longer drilling interval is required.

## References


MEYER, J. (1972) The evaluation of new residual herbicides to control monocotyledonous and dicotyledonous weeds in processing peas. Proceedings 11th British Weed Control Conference, 559-564.

BOSCH, E., MEYER, J. & SCHAREN, W. (1974) The evaluation of a combination chlorthalmethyl + methazole (S1445) for weed control in arable and leguminous crops. Proceedings 12th British Weed Control Conference, 439-446.

HANDLEY, R.P. & KING, J.M. (1976) Experiments in peas with a mixture of chlorthal-dimethyl and methazole for residual weed control on sandy soils. Proceedings 13th British Weed Control Conference, 433-439.

Proceedings 1978 British crop Protection Conference - Weeds

# NEW HERBICIDE COMBINATION FOR WEED CONTROL OF BEANS (Phaseolus valgaris L.)

W. Kramer & W. Löttge

VEB Chemiekombinat Bitterfeld (G.D.R.) Research Dept. of Biology and Application Technique of Plant Protection Products, Bitterfeld

and H. Marlow

Academy of Agricultural Sciences of the G.D.R.
Institute of Plant Breeding, Quedlinburg

Summary The herbicidal activity of a new urea active substance with the proposed common name fenthiuron (N,N-dimethyl-N'-phenylthio-urea) is described. Results of experiments conducted with a combination of this material with nitrofen and 2,4-D applied in beans (Phaseolus vulgaris L.) are demonstrated. Spraying 2,7 to 4,05 kg a.i./ha of this mixture shortly before emergence of the crops produced a good herbicidal effect.

## INTRODUCTION

The bean (Phaseolus vulgaris L.) is a species which is comparatively susceptible to herbicides. Its physiological herbicide tolerance rate is so low that it has not been possible so far to apply leaf adsorbed herbicides to P. vulgaris after emergence. The tolerance rate of root or leaf and root adsorbed herbicides applied before emergence of the crop is more favourable. In cases where there is a low physiological tolerance rate the optimum time of application may be used to enable the application of a herbicede. This applies for example, to the active ingredient metobromuron and, in low dosages which unfortunately do not entail a full herbicide effect, to nitrofen too. It applies also to fenthiuron which is a comparatively new compound.

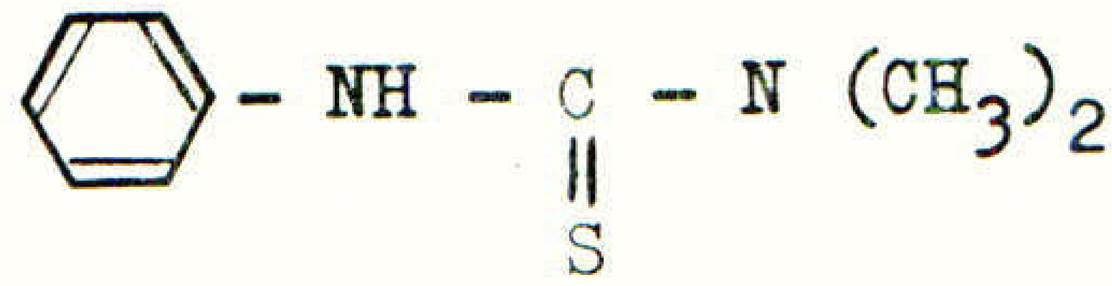
Herbicide research and the development of new products have been and still are, the main task of the plant protection industry. The demands which include the control of selected problem weeds, more stringent toxicological requirements and the need to protect the environment have significantly risen. Consequently it is no longer possible to introduce preparations into commercial practice very rapidly and without problems. Frequently large-scale application over many years and the experience thus gained enable the value of a newly developed product to be determined.

We would like to describe the results of both industrial and agricultural research conducted over a period of several years. Introducing a new active ingredient and combining it with well known substances made it possible to successfully solve an existing problem of vegetable growing.

## METHOD AND MATERIALS

Below is data on an active ingredient from the group of thioureas with the proposed common name of fenthiuron.

### Chemical and physical properties

| | |
|---|---|
| Chemical name: | N, N - dimethyl - N' - phenyl - thio - urea |
| Structural formula: |  |
| Molecular formula: | $C_9H_{12}N_2S$ |
| Solubility at 25°C: | 0,2 g/100 g water |
| Molar weight: | 180,3 |
| Physical state: | Greyish-white crystals without any characteristic smell |
| Melting point: | 129 - 133 °C |
| Density: | 1,210 g/cm$^3$ |
| Stability: | waterproof at 25 °C<br>lightproof<br>stable against atmospheric hydrogen |

### Toxicological properties

Characteristic

| application | active ingredient fenthiuron (mg/kg of body weight) | experimental product CKB 1129 (50 w.p.) (mg/kg of body weight) |
|---|---|---|
| LD 50 acute oral rat | 2 200 | 2 000 |
| LD 50 acute oral mouse | 300 | |
| LD 50 intraperitoneal rat | 320 | |
| LD 50 dermal rat | 5 000 | |

### Irritation test on rabbits (according to Draize/1959)

| | |
|---|---|
| skin | not irritant |
| eyes | not irritant |

### Toxicity tests

| | |
|---|---|
| bee LD 50 | no danger to bees |
| mutagenity test | negative |

toxicological investigations of residues in the soil, model studies on plants and investigations on harvested beans are under way and - according to the preliminary results - seen to be more favourable than for soil herbicides used at present in this crop.

## RESULTS

### Herbicide effect of the active ingredient fenthiuron

According to the findings gained so far fenthiuron first of all acts as a photosynthetic inhibitor. Additional physiological studies designed to establish exactly the mode of action have not yet been completed. The ingredient is taken up through the leaf and the root.

It may be applied before or after the emergence of the weeds. Depending on the application technique a modified range of effect is to be expected. When applied post emergence the best weed control is achieved if the weeds are in the cotyledon- or two-leaf-stage. In the advanced stages of development the weeds can no longer be controlled by fenthiuron.

**Table 1**

**Susceptibility of selected weeds by fenthiuron 50 w.p. (CKB 1129) dosed 3 to 5 kg a.i./ha**

| weed species | susceptible | susceptible under certain conditions |
|---|---|---|
| *Apera spica venti* | x | |
| *Capsella bursa pastoris* | x | |
| *Chenopodium album* | x | |
| *Echinochloa crus-galli* | | x |
| *Fumaria officinalis* | | x |
| *Galeopsis tetrahit* | x | |
| *Galium aparine* | | x |
| *Lamium ssp.* | x | |
| *Matricaria chamomilla* | x | |
| *Poa annua* | x | |
| *Polygonum convolvolus* | | x |
| *Senecio vulgaris* | x | |
| *Setaria viridis* | | x |
| *Sinapis arvensis* | x | |
| *Stellaria media* | | x |
| *Thlaspi arvense* | x | |
| *Tripleurospermum maritimum spp.* | x | |
| *Urtica urens* | x | |
| *Veronica hederifolia* | x | |
| *Viola tricolor* | X | |

*Echinochloa crus-galli* can only be controlled post emergence, i.e. from the cotyledon stage up to the formation of adventitious roots. *Galium aparine* can only be eliminated by post emergence applications (first to second two-leaf-stage). Perennial weeds not emerging from seeds cannot be eliminated.

The selectivity of fenthiuron in the case of crop plants varies. It depends on the amount applied as well as on the mode of appliation. Generally crops treated before emerging are less susceptible than those sprayed after emerging. Potatoes, winter grain species, maize, beans and peas proved to have good tolerance if the active ingredient was applied before they emerged.

## Table 2

**Phytotoxic behaviour of selected crops towards fenthiuron 50 w.p. (CKB 1129)**

| crop | beginning of phytotoxicity from ... kg a.i./ha pre-emergence | post-emergence |
|---|---|---|
| winter grain | 4 | 3 |
| maize | 6 | 4 |
| potatoes | 6 | 4 |
| beans (Phaseolus vulgaris) | 5 | 0 |
| peas | 4 | 0 |

If fenthiuron was applied after emergence of the crops winter grain and maize were very resistant. Small amounts, too, are tolerated by potatoes. Beans and peas, however, proved to be susceptible when this method of application was chosen. Thus the application after emergence does not seem to be practical for these crops. Since selectivity depends also on the amount to be applied, and the full herbicidal effect has to be obtained with a low crop tolerance rate a combination of herbicides is used. Thus, combinations of fenthiuron with various active ingredients have been tested. For the application in beans for instance, mixtures comprising fenthiuron and nitrofen proved to be suitable components. Other combinations including other active ingredients have also been found to be suitable. The following mixture, coded CKB 1133, was chosen and introduced into agriculture.

It is a w.p.-formulation consisting of 21 percent of fenthiuron 18,5 percent of nitrofen and 5,5 percent of 2,4-D-acid. The formulated mixture has an acute toxicity of more than 3 000 mg/kg of body weight (acute oral rat) and exercises no irritation or inflammation of the mucosa. It was classified to be without danger to bees, but is of high toxicity towards fishes (GC guppy test: 1 mg/l and LC guppy test: 5 mg/l).

The preparation formerly tested as CKB 1133 was official registered for weed control in potatoes and beans.

### Herbicide effect of the mixture CKB 1133

Some of the results obtained from the pre-emergence application of CKB 1133 in beans in 1976 and 1977 are shown in table 3. This study was conducted under direction of the Institute of Plant Breeding of the Academy of Agricultural Sciences of the G.D.R. at Quedlinburg. Experiments on locations of different soil charakteristics have been successfully conducted and compatibility, yield and herbicide effect measured.

Table 4 demonstrates the results obtained in comparison with metobromuron. The results gained with both preparations do not differ significantly. The comparison of the mean values of 1976 an 1977 given in table 5, makes this evident.

## Table 3

**Results of pre-emergence application of CKB 1133 in dwarf beans in 1976 and 1977**

| Experiment site | type | kg/ha (a.i.) | site conditions (soil type) | cultivar | Tolerance of beans: phytotoxicity a | b | c (+++) | yield° (rel.) | tgw (+) | ga (++) | Weed control %: 4 weeks post-appl. | 8 weeks post-appl. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1st year of experiment 1976** | | | | | | | | | | | | |
| An | K+) | 4,05 | LS | Saxanova | 8 | 9 | 9 | - | 100 | 96 | -- | - |
| Al | K | 4,5 | sL Loe | Berggold | 9 | 9 | 9 | - | - | - | 65 | 63 |
| As | K | 4,5 | sL | strain 21 | 8 | 8 | 9 | 268 | 105 | 95 | 76 | 96 |
| IQ | K | 4,5 | L Loe | Hacogold | 9 | 6 | 7 | 125 | 138 | - | 89 | 91 |
| IQ | K | 4,5 | L Loe | Saxanova | 9 | 8 | 9 | 173 | 98 | - | - | - |
| As | G++) | 4,5 | L Loe | Valja | 7 | 7 | - | - | - | - | - | - |
| Wi | G | 3,6 | LS | Saxanova | 9 | 9 | 9 | - | - | - | 92 | 82 |
| **2nd year of experiment 1977** | | | | | | | | | | | | |
| Al | K | 4,05 | sL Loe | Saxanova | 9 | 8 | - | - | - | - | 64 | 63 |
| IQ | K | 4,05 | L Loe | Hacogold | 8 | 9 | 9 | 96 | 104 | 100 | 97 | 97 |
| IQ | K | 4,05 | L Loe | Saxanova | 9 | 9 | 8 | 140 | 98 | - | - | - |
| Na | K | 4,05 | L Loe | Esto | 9 | 9 | 8 | 117 | 109 | - | 84 | 85 |
| As | G | 4,05 | L Loe | Esto | 9 | 9 | 9 | - | - | - | 96 | 94 |
| VQ | G | 4,05 | sL Loe | Valja | 8 | 8 | 9 | - | - | - | 100 | - |
| Wi | G | 2,7 | LS | Saxanova | 9 | 9 | - | - | - | - | 95 | 79 |

+) micro plot trial
++) large plot trial

(+) thousand grain weight
(++) germination ability

sL = sandy loam
LS = loamy sand
Loe = loess

+++) assessment dates

a = 4 weeks post-application
b = 8 weeks post-application
c = 12 weeks post-application

o = untreated = 100

1 = completely controlled
9 = no damage

Table 4

Results of pre-emergence application of metobromuron in dwarf beans in 1976 and 1977

| Experiment site | Experiment type | kg/ha (a.i.) | site conditions (soil type) | cultivar | Tolerance of beans: phytotoxicity a | b | c (+++) | yield° | tgw (+) | ga (++) | Weed control %: 4 weeks post-appl. | 8 weeks post-appl. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1st year of experiment 1976** | | | | | | | | | | | | |
| An | K +) | 1,25 | LS $D_2$ | Saxanova | 9 | 9 | 9 | - | 102 | 95 | - | - |
| A1 | K | 1,5 | sL Loe | Berggold | 9 | 9 | 9 | - | - | - | 80 | 72 |
| As | K | 1,5 | sL | strain 21 | 9 | 9 | 9 | 280 | 103 | 100 | 67 | 72 |
| IQ | K | 1,5 | L Loe | Hacogold | 9 | 7 | 8 | 132 | 136 | - | 68 | 80 |
| IQ | K | 1,5 | L Loe | Saxanova | 9 | 9 | 9 | 158 | 97 | - | - | - |
| **2nd year of experiment 1977** | | | | | | | | | | | | |
| A1 | K | 1,5 | sL Loe | Berggold | 9 | 9 | 9 | - | - | - | 34 | 53 |
| IQ | K | 1,5 | L Loe | Hacogold | 7 | 7 | 8 | 190 | 109 | 98 | 97 | 98 |
| IQ | K | 1,5 | L Loe | Saxanova | 9 | 9 | 9 | 152 | 100 | - | - | - |
| Na | K | 1,5 | L Loe | Esto | 9 | 9 | 9 | 133 | 105 | - | 100 | 100 |
| AS | G ++) | 1,5 | L Loe | Esto | 9 | 9 | 9 | - | - | - | 96 | 92 |
| VQ | G | 1,5 | sL Loe | Valja | 9 | 8 | 9 | - | - | - | 100 | - |
| Wi | G | 1,0 | LS | Saxanova | 9 | 9 | - | - | - | - | 99 | 91 |

+) micro plot trial
++) large plot trial

sL = sandy loam
LS = loamy sand
Loe = loess

+++) assessment dates: 1= completely controlled; 9= no damage

(+) thousand grain weight
(++) germination ability

a = 4 weeks post application
b = 8 weeks post-application
c = 12 weeks post application

0 = untreated = 100

Table 5

Mean values comparison of 1976 and 1977

gained with CKB 1133 and metobromuron in P. vulgaris

| Material | Tolerance of beans phytotoxicity °) a | b | c | yield+) (rel.) | tgw+) (rel.) | ga++) | weed control % 4 weeks post appl. | post appl. |
|---|---|---|---|---|---|---|---|---|
| CKB 1133 | 8,6 | 8,4 | 8,6 | 153 | 108 | 97 | 86 | 83 |
| metobromuron | 8,8 | 8,6 | 8,8 | 157 | 108 | 97 | 82 | 82 |

Key see table 3 or 4

Weed species controlled by the mixture CKB 1133

Table 6 shows the range of weeds susceptible to CKB 1133 and metobromuron.

Table 6

Results of pre-emergence application of metobromuron and CKB 1133 in dwarf beans in 1976 and 1977

- range of weed control -

| weed species | nos. of trials | weeds in untreated area | weed control as % CKB 1133 | metobromuron |
|---|---|---|---|---|
| 1. 4 weeks after pre-emergence application | | | | |
| Urtica urens | 3 | 10,5 | 88 | 80 |
| Lamium amplexicaule | 1 | 4,8 | 100 | 92 |
| Amaranthus retroflexus | 1 | 3,0 | 100 | 100 |
| Solanum nigrum | 2 | 5,6 | 89 | 54 |
| Thlaspi arvense | 1 | 9,8 | 90 | 100 |
| Atriplex patula | 1 | 8,8 | 94 | 100 |
| Capsella bursa-pastoris | 1 | 5,1 | 100 | 100 |
| Galinsoga parviflora | 1 | 5,3 | 100 | 100 |
| Senecio vulgaris | 1 | 5,0 | 100 | 92 |
| 2. 8 weeks after pre emergence application | | | | |
| Urtica urens | 3 | 21,0 | 69 | 73 |
| Lamium amplexicaule | 1 | 8,3 | 97 | 95 |
| Amaranthus retroflexus | 1 | 6,6 | 98 | 100 |
| Solanum nigrum | 2 | 15,9 | 85 | 78 |
| Thlaspi arvense | 1 | 27,6 | 90 | 100 |
| Atriplex patula | 3 | 17,1 | 92 | 99 |
| Capsella bursa-pastoris | 1 | 13,8 | 100 | 100 |
| Galinsoga parviflora | 1 | 16,3 | 100 | 100 |
| Senecio vulgaris | 2 | 10,1 | 88 | 83 |
| Chenopodium album | 2 | 7,3 | 84 | 76 |
| Polygonum aviculare | 1 | 5,1 | 100 | 100 |
| Stellaria media | 2 | 5,7 | 76 | 100 |

The degree of the ground cover by the weeds is indicated for untreated plots. The success of the controll is presented in percent, referring to the degree of the covered area (as mean value of 1976 and 1977). Table 6 refers only to those weeds which occurred during the field trials. There is a good effect upon Echinochloa crus-galli and Galium aparine if they have emerged at the date of application.

Perennial weeds not germinating from seeds are not controlled.

Crop effect and yields

The test results presented in tables 3 to 5 are derived from plots and large scale experiments under field conditions. The evaluation of phytotoxicity of beans was conducted according to a scheme of Bolle (1964). The value of phytotoxicity 7 indicates for example only slight damage to the beans. It should, however, be taken into consideration that different cultivars of beans may vary as to their compatibility. Some yellow-pod cultivars are known to be susceptible towards metobromuron (table 4). For CKB 1133 the situation seems to be simular (table 3). The cultivar Hacogold, for example, with slight symptoms of damage may show decreased yield, thus once more emphasizing the susceptibility of P. vulgaris mentioned at the beginning. Largescale application to new cultivars not yet tested, therefore, should be preceded by small plot trials, since the cultivars tested here do not cover the complete range.

The relative values of the yields, the thousand-grain weight (tgw) and germination ability (ga) in table 3 to 5 refer to untreated control plots cultivated by machine in the normal way. The remaining weed infestation was removed by hand afterwards. The weed control rate is presented in percent of weed matter killed, related to the degree of the covered area. The herbicide effect of both products is approximately the same. Slight variations are within the limits of error an cannot be statistically proved.

DISCUSSION

The herbicidal combination CKB 1133 contains the ingredients mentioned, in dosages tolerated by beans, which used alone do not have sufficient herbicidal effect, but in mixture are sufficiently effective, covering a wide range of weeds. Synergistic effects on some weed there were no detected synergistic effects with regard to the probable increase of damage symptoms.

Annual weeds in bean cropping are satisfactorally controlled with a dose range of 6 to 9 kg/ha of the commercial product (= 2700 to 4050 g a.i./ha). The depth of sowing should not exceed 5 cm. The lower rate applies to light, sandy soils and the higher one to heavy, humus and fine structured soils (see table 3). Application may be made from sowing to shortly before emergence of the beans. According to the mode of action of the ingredients the best effect will be obtained if the weeds have emerged at the time of application. Since the beans, however, must not have emerged at that date it is quite obvious that a compromise settlement cannot be avoided. Sufficient soil moisture at the date of application helps to improve effect.

The combination of ingredients described gives a good indication that other interesting mixtures will be found.

References

BOLLE, F. (1964) Bonitierungsschema für die Prüfung herbizider Mittel Nachrbl.Dt. Pflanzenschutzd. (Braunschweig) 16, p. 92-93

DRAIZE, J.H. (1959) Dermal toxicity FDA: Appraisal of the safety of chemicals in food, drugs an cosmetics, Austin, Texas, p. 46

Proceedings 1978 British Crop Protection Conference - Weeds

# TRIALS IN THE U.K. WITH DICLOFOP-METHYL FOR CONTROL OF WILD OATS (*AVENA FATUA*) IN VEGETABLE CROPS

T. H. Manning and R. T. Hewson

Hoechst U.K. Ltd., Agriculture Division, Salisbury Road, Hounslow, Middlesex

Summary Thirty-six trials with diclofop-methyl for post-emergence control of *Avena fatua* in pea, carrot, onion, parsnip, cabbage and potato are described. Excellent control and selectivity was achieved with 1.25 kg/ha a.i. applied irrespective of crop growth but when the majority of *A. fatua* plants had 2 to 4 leaves and the largest had begun to tiller. When applied later than this, control usually decreased progressively although in some cases kill of larger *A. fatua* plants than expected was achieved. Pre-emergence activity against *A. fatua* germinating close to the soil surface under moist conditions was also recorded. The excellent crop safety of diclofop-methyl was particularly noticeable when compared with barban in peas in 1976. In 1977 diclofop-methyl gave better control in peas than barban due to its activity against larger *A. fatua*. Diclofop-methyl was found to be compatible in a tank mix with linuron 20% emulsion (Afalon) and ioxynil + linuron (Certrol-Lin onions) but a mixture with bentazone requires further investigation.

Résumé les résultats de trente six essais conduits en Grande-Bretagne avec le diclofop-méthyl pour la destruction en post-levée de *Avena fatua* dans les cultures de pois, carottes, oignons, panais, choux et pomme de terre sont rapporté par les autuers. L'efficacité et la sélectivité du diclofop-méthyl ont été satisfaisantes à la dose de 1.25 kg/m.a./ha quel que soit le stade des cultures au moment des traitements mais lorsque la majorité de *A. fatua* avait 2 à 4 feuilles et au plus 1 talle. En applications plus tardives l'efficacité diminuait progressivement bien que dans certains cas le niveau de contrôle était plus élève qu'on avait pu l'imaginer à priori. Une action de pré-levée vis-à-vis de *A. fatua* a été observé lorsque l'adventice était issue de semences germant près de la surface du sol. Le diclofop-méthyl s'est montré sélectif du pois particulièrement en 1976 en comparison du barbane. En 1977 le diclofop-méthyl a manifesté une meilleure efficacité que celle due barbane en raison d'une action plus complète vis-à-vis de *A. fatua* à des stades de développement avancés. Le diclofop-méthyl s'est révélé compatible en mélange extemporané avec le Linuron (Afalon CE) et l'association Ioxynil + Linuron (Certrol-Lin oignon), par contre le mélange avec Bentazone nécessite des vérifications complémentaires.

## INTRODUCTION

Diclofop-methyl is a post-emergence herbicide for the control of wild oats (*Avena* spp.) and other annual grass weeds in small grain cereals, onion and broad-leaf crops. It belongs to the phenoxy-phenoxy propionic acid group of compounds discovered by Hoechst A.G. Its mode of action is to strongly inhibit root growth and meristematic activity of the shoot so that a complete kill of the plant is achieved (Köcher and Lötzch, 1975).

Initial crop screening in the U.K. showed good tolerance by a range of broad-leaf species (Roberts, 1974). Only slight symptoms were noted on lettuce, carrot, parsley, turnip, red beet, onion, leek, dwarf French and runner beans, and none on cabbage, radish, parsnip, broad bean or pea. This tolerance by broad-leaf crops was confirmed by Richardson and Parker (1976) and Richardson et al (1976) who included sugar beet, rape and kale. Swede and carrot were the only crops to show a slight initial effect at twice-normal rate whereas all species were tolerant at the normal dose.

The chemistry, toxicology and early biological work on diclofop-methyl has been described previously by Langelüddeke et al (1975) and Schumacher and Shwerdtle (1975). Of the common grass weeds in the U.K., diclofop-methyl will control Avena spp. and also Poa trivialis, Lolium spp. and Alopecurus myosuriodes up to the early tillering stage.

Results of several years' work with diclofop-methyl against Avena spp. have been reported previously from the U.K. in cereals (Hewson, 1976) and peas and beans (King and Handley, 1976) and from Germany and other European countries in cereals and sugar beet (Breidert, 1977; Breidert et al, 1977). Excellent control of Lolium spp. in sugar beet, oilseed rape, cabbage, field bean and red fescue has also been reported from several European countries (Ziegenbein, 1976; Breidert, 1977).

The need for good control of wild oats (Avena spp.) in crops grown for processing has been shown by Gane (1968).

The objective of the work described below was to investigate the efficacy and crop safety of diclofop-methyl on vegetable crops under field conditions in the U.K.

## METHOD AND MATERIALS

A total of thirty-six replicated trials was carried out during 1975-1978 in commercial crops of pea, carrot, onion, parsnip, cabbage and potato located in Eastern England. Soil types varied from silty loams to clay loams and fen peats.

Plot size was 2 metres by 5 metres and all treatments, which included standard materials where appropriate, and untreated controls, were arranged in randomised blocks with three replicates. All applications were made with a Van der Weij "AZO" Sprayer at a pressure of 2.5 bar using fan jets delivering 300 l/ha.

Diclofop-methyl was formulated as a 36% e.c. and applied at the standard rate of 1.25 kg/ha a.i. Treatment timing was based solely on growth of the A. fatua. In most cases this was when the majority of plants had 3 to 4 expanded leaves and the largest were at the beginning of tillering. The standard material used in peas was barban (12.5% e.c.) at 0.63 kg/ha a.i., in other crops comparative products were not available.

A. fatua was assessed by counting the panicles in a number of 0.5m$^2$ quadrats placed at random in each plot. Crop vigour was assessed at intervals by scores on a 1-9 log. scale.

## RESULTS

Results are presented separately for the different crops.

### Pea

The mean results obtained each year from trials where panicle counts were obtained are shown in Table 1.

Table 1

Percentage control of *A. fatua* in peas

| Compound | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|
| Diclofop-methyl | 72 | 93 | 92 | 95 |
| Barban | - | 96 | 68 | - |
| Range of *A. fatua* panicles/$m^2$ on controls (means) | 13-204 (72) | 31-170 (105) | 21-46 (34) | 149-317 (233) |
| Number of trials | 4 | 6 | 3 | 2 |

No phytotoxicity was recorded from diclofop-methyl treatments in 1975 to 1977. In 1978, diclofop-methyl caused slight leaf scorch in one trial but this was soon outgrown and was probably caused by the abnormal growing conditions. Barban caused slight leaf scorch in 1975 but severe stunting in 1976.

In 1976 and 1977 trials were carried out to confirm the optimum application time for diclofop-methyl described by Hewson (1976) from trials in cereals. Timing was based on the stage of growth of the weed and not the crop. Results are shown in Table 2.

From the two years, the most consistent results were obtained when the *A. fatua* were at the 2 to 4 expanded leaf stage.

### Carrot

In trials carried out from 1975 to 1978 no phytotoxicity was recorded on carrots from the use of diclofop-methyl. Mean results for *A. fatua* control are shown in Table 3.

In one trial in 1977 there was poor control where *A. fatua* plants had past the tillering stage at application.

### Onion

No phytotoxicity was recorded from diclofop-methyl treatments from 1975 and 1977. In 1978 very slight leaf scorch was noted but this did not affect crop growth. Results for control of *A. fatua* in onions (Table 4) clearly demonstrate that diclofop-methyl will kill *A. fatua* plants in the absence of crop competition.

Table 2

Percentage control of *A. fatua* in peas following application of diclofop-methyl at different growth stages

| Year | Crop Stage | *A. fatua* stage | Compound (kg/ha a.i.) Diclofop-methyl 1.25 | Diclofop-methyl 2.5 | Barban | Range of *A. fatua* panicles/$m^2$ on controls (means) | Number of trials |
|---|---|---|---|---|---|---|---|
| | 3-5 cm | 1-2½ leaf | 95 | 98 | 96 | 31-170 | |
| 1976 | 8-15 cm | 2-4 leaf | 93 | 99 | 89 | (105) | 4 |
| | 10-30 cm | early-mid tillering (1-4 tillers) | 89 | 93 | 55 | | |
| | 5 cm | 1-2½ leaf | 75 | 78 | 68 | 21-46 | |
| 1977 | 8-10 cm | 2-4 leaf | 92 | 98 | - | (34) | 2 |
| | 20-25 cm | Mid tillering - shooting | 82 | 96 | - | | |

Table 3

Percentage control of *A. fatua* in carrots

| Year | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|
| Diclofop-methyl | 98 | 88 | 78 | 94 |
| *A. fatua* panicles/$m^2$ on controls (means) | 27 | 20 | 22-167 (95) | 213 |
| Number of trials | 1 | 1 | 2 | 1 |

Table 4

Percentage control of *A. fatua* in bulb onions

| Year | 1975 | 1977 | 1978 |
|---|---|---|---|
| Diclofop-methyl | 98 | 83 | 95 |
| *A. fatua* panicles/$m^2$ on controls (means) | 40 | 190 | 35, 137 (86) |
| Number of trials | 1 | 1 | 2 |

## Parsnip

Diclofop-methyl was applied to parsnips (cv. Cambridge Improved) in two trials, one each in 1976 and 1977, and gave 95% and 90% reduction in the number of *A. fatua* panicles, respectively. Numbers in the untreated controls averaged 30 and 50/m$^2$. Crop vigour was unaffected from an application of diclofop-methyl at twice-normal rate when the crop plants had 1 or 3 expanded leaves.

## Cabbage

In one trial in 1978 on cv. Drumhead, diclofop-methyl gave a 96% reduction in *A. fatua* panicles where the initial infestation was 142/m$^2$. Crop and weed stages at application were 3 leaf and early-mid tillering respectively.

## Potato

In two potato trials carried out in 1977, *A. fatua* control was 91% where the mean number of panicles/m$^2$ on untreated plots was 69/m$^2$. There was no phytotoxicity to either of the varieties Desirée or Pentland Crown, with application of up to twice that recommended, made when the plants were 15-30 cm tall.

## Taint Tests

No taints have been recorded in trials carried out over the past four years on crops of peas, broad and dwarf French beans and carrots (Table 5). Further tests with carrot and broad bean are in progress.

Table 5

Details of the Taint Tests

| Crop | Pea | | Broad bean | | Carrot | | Dwarf French Bean | |
|---|---|---|---|---|---|---|---|---|
| Method of processing | Canned | Quick frozen | Canned | Quick frozen | Canned | Quick frozen | Canned | Quick frozen |
| 1974 | 2 | 1 | - | - | - | - | - | - |
| 1975 | 3 | 2 | - | - | - | - | - | - |
| 1976 | 2 | - | 1 | - | - | - | - | - |
| 1977 | - | 4 | 1 | 2 | 1 | 1 | 1 | 1 |

## Compatibility

### Pea

The incompatibility of diclofop-methyl with phenol derivatives (e.g., dinoseb-amine or acetate) resulting in reduced *A. fatua* control and with cyanazine + MCPB causing crop damage, has been previously recorded.

In 1978, a tank mix of diclofop-methyl with bentazone was investigated in two trials. In one there was no reduction in A. fatua control (diclofop-methyl 94%, diclofop-methyl + bentazone 95%; the mean number of panicles on the controls was $149/m^2$). At a second site when the infestation was higher ($317/m^2$), diclofop-methyl gave 96% control of A. fatua, whereas with the tank mix it was 86%. Further work is therefore necessary to confirm the compatibility of these products.

Carrot

Diclofop-methyl was found to be compatible with linuron 20% emulsion (as Afalon) in two trials, one each in 1977 and 1978 (Table 6).

Table 6

Percentage control of A. fatua in carrots with diclofop-methyl applied alone or as a tank mix with linuron

| Year | Diclofop-methyl | Diclofop-methyl + linuron | Panicles/$m^2$ on controls |
|---|---|---|---|
| 1977 | 83 | 88 | 22 |
| 1978 | 94 | 91 | 213 |

Onions

There were also single trials in 1977 and 1978 to investigate the compatibility of diclofop-methyl with an ioxynil + linuron formulation (Certrol-Lin Onions) for use on onions. Due to the relatively advanced stage of growth of the A. fatua in 1977, the level of control was reduced (Table 7). Taking a mean of the two years there was no loss of control from the mixture.

Table 7

Percentage control of A. fatua in onions with diclofop-methyl applied alone or as a tank mix with a formulation of ioxynil + linuron

| Year | Diclofop-methyl | Diclofop-methyl + ioxynil + linuron | Panicles/$m^2$ on controls |
|---|---|---|---|
| 1977 | 76 | 87 | 194 |
| 1978 | 91 | 83 | 35 |

## DISCUSSION

These results show that diclofop-methyl is capable of giving very effective control of Avena fatua when applied at the recommended stage. The timing trials in pea show the importance of spraying before all the A. fatua have past the early-tillering stage. After this stage the A. fatua become progressively less sensitive and only by applying higher rates can equivalent control be achieved. This effect is shown in Table 2 by comparing the double rate of 2.5 kg/ha a.i. with the recommended rate when applied at the mid-tillering to shooting stage in 1977. A relatively low level of control was achieved also in pea in 1975 (Table 1) and in carrot in 1977 (Table 3) when diclofop-methyl was applied too late to achieve optimum results. In the 1977 carrot trials, a low average value for control was obtained due to poor control in one trial where 70% of the *A. fatua* were tillering with approximately 40% at the mid-late tillering stage. In 1978 however, in one onion trial (Table 4), where 30% of *A. fatua* were at the 5 to 6 leaf stage (mid-tillering), 100% control was achieved. This was probably due to the abnormal growing conditions of the year, when the *A. fatua* were growing rapidly in response to warm weather after a cold period.

Early application of diclofop-methyl may result in poor control in some years. In the 1977 pea trials (Table 2), when applied at the 1-2½ leaf stage of *Avena* spp. (correct time for barban) control with diclofop-methyl was less. Richardson and Parker (1976) and Richardson *et al* (1976) showed that diclofop-methyl had pre- as well as post-emergence activity but that post-emergence treatment was the most effective. Thus, although in many years *A. fatua* emerging after treatment will be killed, the extremely erratic germination period in 1977 allowed many *A. fatua* to escape. In other cases, these late germinating *A. fatua* will not reach the seeding stage at harvest as shown by King and Handley (1976).

The excellent safety of diclofop-methyl compared with barban was especially clear in peas in 1976. This agrees with King and Handley (1976) who reported that barban caused severe chlorosis, necrosis and weakening of the stem leading to tillering by harvest time and uneven crop maturity. The present work also confirms the tolerance of a range of other broad-leaf crops to diclofop-methyl.

Diclofop-methyl is therefore a very useful new herbicide for control of *A. fatua* and other annual grass weeds post-emergence in vegetable crops.

## Acknowledgements

The authors would like to thank the many farmers who kindly provided trials sites and their colleagues in the Technical Department of Hoechst U.K. for their assistance.

## References

BREIDERT, D. (1977) Control of wild oats in various crops with Illoxan (Hoe 23408). *Med. Fac. Landbouww Rijksuniv. Gent, 42/2*, 1591-1596

BREIDERT, D. *et al* (1977) Illoxan (Hoe 23408, Diclofop-methyl) ein selektives Nachauflaufmittel gegen Flughafer und Hirsen. *Z.f. Pflanzenkrankheiten, special issue VIII*, 441-447

GANE, A.J. (1968) Weed Control requirements in crops grown for processing *Proc. 9th Br. Weed Control Conf*, 1219-1222

HEWSON, R.T. (1976) Trials in the U.K. with phenoxy-phenoxypropionic acid derivatives for grass weed control in winter cereals *Proc. 13th Br. Weed Control Conf.*, 55-62

KING, J.M. and HANDLEY, R.P. (1976) Control of wild oats (*Avena fatua*) with Hoe 23408 in peas and broad beans. *Proc. 13th Br. Weed Control Conf.*, 419-423

KÖCHER, H. und LÖTZSCH, K. (1975) Ein beitrag zur wirkungswaise der Herbizid vom Typ der Phenoxyphenoxypropionsävre-Derivate. Proc. European Weed Research Society Symposium "Status and Control of Grassweeds in Europe", Paris, 430-437

LANGELÜDDEKE, P et al (1975) Hoe 23408 (H), ein neues Herbizid gegen Flughafer und Schadhirsen. 40. Deutsche Pflanzenschutzagung, Oldenburg

RICHARDSON, W.G. and PARKER, C (1976) The activity and post-emergence selectivity of some recently developed herbicides: Hoe 22870, Hoe 23408, flamprop-methyl metamitron and cyperquat. Technical Report Agricultural Research Council Weed Research Organisation, (39) pp 56.

RICHARDSON, W.G. et al (1976) The activity and pre-emergence selectivity of some recently developed herbicides: metamitron, Hoe 22870, Hoe 23408, RH 2915 and RP 20630. Technical Report Agricultural Research Council Weed Research Organisation (38) pp 55.

ROBERTS, H.A. (1974) Personal communication.

SCHUMACHER, H. and SCHWERDTLE, F. (1975) Hoe 23408 (H), ein neues Herbizid zur bekämpfung von Flughafer in Weizen und Beta-Ruben. Proc. European Weed Research Society Symposium "Status and Control of Grassweeds in Europe", Paris.

ZIEGENBEIN, GERTA (1976) Control of Lolium species in red fescue by a phenoxy-phenoxy acid compound Proc. 13th Br. Weed Control Conf, 665-667.