WEED RESEARCH ORGANIZATION

TECHNICAL REPORT No. 55

THE ACTIVITY AND SELECTIVITY OF THE HERBICIDES CARBETAMIDE, METHAZOLE, R11913 AND OCS 21693

OCS 21693 is methyl 2,3,5,6-tetrachloro-N-methoxy-N-methylterephthalamate (Velsicol), R11913 is 3′-hydroxypropionanilide isopropylcarbamate (Stauffer)

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SUMMARY

In a series of pot experiments in the glasshouse or in the open, four herbicides were examined for pre- and/or post-emergence selectivities in 42 to 51 temperate and tropical crop and weed species. The route of action of these herbicides was examined in a separate test on six selected test species. In conjunction with the pre-emergence selectivity tests, persistence of the herbicides in the soil was examined.

Carbetamide exerted its effect through the soil rather than via the foliage and good pre-emergence control of annual grass and certain broad-leaved weeds was found while several broad-leaved crops were tolerant, such as legumes and brassicas. Residual activity in the soil was very short.

Methazole was effective both pre- and post-emergence on a range of annual broad-leaved and grass weeds. Only a few crops were tolerant, notably certain cereals but also groundnut and cotton, pre-emergence. A moderate period of soil persistence was found.

R11913 exerted its effects mainly as a post-emergence soil drench. Weed control was somewhat better post-emergence, the spectrum including broad-leaved and grass species but wheat and sorghum were the only tolerant crops. Its activity in the soil was of very short duration.

OCS 21693, although more of a soil acting, pre-emergence herbicide, was found to have considerable foliar effects on certain of the broad-leaved species in the activity experiment while grasses were tolerant. In the post-emergence test, however, only one or two broad-leaved weeds were selectively controlled in only a few, mainly grass, species.

INTRODUCTION

This report records the activity, most effective route of entry and pre- and post-emergence selectivity of carbetamide, methazole and R11913 and the activity and post-emergence selectivity of OCS 21693. These experiments were carried out between 1968 and 1969 but results were not published for various reasons. Although, therefore, of limited value for some purposes, it was felt that the results would still prove useful, for example when considering inclusion of these herbicides in mixtures and also for assessing their potential use against more recent weed problems, eg volunteer weeds such as cereals, ryegrass and brassicas.

It should be emphasised that the work was carried out on only one variety of each crop and on only one source of each weed species, in one particular soil type without intra-specific competition and at one growth stage. Finally, plant responses in pots, especially in the glasshouse, can be very different from those in the field.

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* Herbicide Group
** ODM Tropical Weeds Group

METHODS AND MATERIALS

Activity experiments These were carried out in the matter standardised by Richardson and Dean (1973a). Herbicides were applied to the standard six test species (1) as a foliar spray, avoiding contact with the soil, (2) as a post-emergence soil drench, avoiding foliage, (3) as a pre-emergence surface application and (4) as a pre-planting spray with thorough incorporation through the whole soil depth. The four annual species were raised from seed and the two perennials grown from rhizome fragments. Species data and environmental conditions are summarised in Tables 1 and 2.

Table 1. Plant data for activity experiments

Species	Cultivar/ source	No. per pot at spraying		Depth of planting (cm)	Stage of growth of post-emergence treatments (leaf numbers exclusive of cotyledons)	Stage of growth at assessment	
		pre-	post-			pre-	post-
Dwarf bean (*Phaseolus vulgaris*)	Tendergreen	2	1-2	1.8	2 unifoliate leaves	$1\frac{1}{2}$ trifoliate leaves	$1\frac{1}{2}$-$2\frac{1}{2}$ trifoliate leaves
Kale (*Brassica oleracea acephala*)	Marrowstem	10	5	0.6	2-$2\frac{1}{2}$ leaves	2-$3\frac{1}{2}$ leaves	$3\frac{1}{2}$-4 leaves
Polygonum amphibium	WRO Clone 1	6	6	1.2	4-7 leaves	4-8 leaves	5-8 leaves
Perennial ryegrass (*Lolium perenne*)	S 23	25	8	0.6	2-3 leaves	4-8 leaves, tillering	5-9 leaves, tillering
Avena fatua	Wytham 1961	6	4	1.2	3-4 leaves	5-9 leaves, tillering	5-9 leaves, tillering
Agropyron repens	WRO Clone 31	6	6	1.2	2-3 leaves	4-8 leaves, tillering	4-8 leaves, tillering

Table 2. Soil and environmental conditions

Experiment type and number	Activity experiments		Selectivity experiments	
	AE 1 Carbetamide OCS 21693	AE 2 Methazole R 11913	Pre-emergence Carbetamide Methazole R 11913	Post-emergence Carbetamide Methazole R 11913 OCS 21693
Date of spraying	20.3.68	17.7.68	12 & 13.3.69	5.9.68
Main assessment completed	18.4.68	15.8.68	19.5.69	25.9.68
Soil moisture (%)	-	-	16.0	-
Organic matter (%)	1.8	1.8	1.8	University of California formula II potting mixture
Clay content (%)	19.2	15.4	13.0	-
pH	7.0	7.3	7.3	-
John Innes base fertilizer (g/kg)	4.0	4.0	5.0	1.0
5% DDT dust (g/kg)	0.5	0.5	0.5	0.5

		Temperate	Temperate	Temperate	Tropical	Temperate	Tropical
Temperature (°C)	Mean	18	18	18	25	14	22
	Maximum	28	30	25	30	21	27
	Minimum	11	11	12	22	8	19
Relative humidity (%)	Mean	55	60	60	65	70	60
	Maximum	90	95	80	90	95	85
	Minimum	26	28	40	40	50	36

Selectivity experiments These were of the standard form as reported previously by Richardson and Dean (1973a and 1973b). Soil and environmental conditions are summarised in Table 2 and plant data and stages of growth in Appendices I and II.

In the pre-emergence experiments, soil from a field at Begbroke was placed in tins and sprayed with the herbicides. The tins were emptied and the soil thoroughly mixed to incorporate the herbicides. Individual species were sown in pots at measured depths. The pots were kept in the glasshouse and watered from overhead. Normal daylight was supplemented with 14 hours of lighting from warm-white fluorescent tubes.

In the post-emergence experiment, plants were grown in a University of California formula II potting mixture and treated at one stage of growth, following thinning to a constant number. Temperate species were raised throughout in the open on a paved area and tropical species in a glasshouse.

Radish (Raphanus raphanistrum) was included as it is easily propagated and may be regarded as a crop or weed. To improve establishment, some propugules were treated as follows:-

Chenopodium album Seeds soaked in 0.1M KNO_3, and kept in the light for 27 hours before planting (pre-emergence selectivity test).
Cyperus esculentus Tubers stored at 4°C for three weeks.

Herbicide treatment

Herbicides were applied by a laboratory sprayer embodying an 8002E Spraying System Tee jet fan nozzle operating at a pressure of 207 k Pa (30 lb/in^2) delivering a volume of 329 l/ha moving at a constant speed 30 cm above the plants or soil. All doses are in terms of active ingredient (a.i.) unless otherwise specified.

Assessment and processing of results

In the selectivity experiments surviving plants were counted and their vigour was scored on a 0-7 scale as defined by Richardson and Dean (1973a) where 0 = dead and 7 = control. A computer was used to process the selectivity experiment data as before. For each herbicide a table of results is presented which includes a pair of figures: the first represents mean plant survival and the second mean vigour score, both calculated as a percentage of untreated controls. Thus 100/100 = as control; 0/0 = complete kill. In the activity experiment a histogram is presented for each treatment, the row of x's representing mean vigour score. Each x represents a 7% increment and a "+" indicates a value in excess of 100%. "R" indicates a result based on one replicate only and "M" represents a missing treatment. It was not possible to analyse results by computer for five of the species in the pre-emergence selectivity test for the following reasons; lettuce failed to germinate, while C. dactylon, pea, fieldbean and jute showed variable germination or emergence, the three latter species also showed some symptoms of disease. However, some observations were possible and are referred to in the text.

Herbicide persistence in the soil

Samples of soil treated with the various herbicides from the pre-emergence experiment were stored in glass jars at 23°C in the dark and sub-sampled at approximately six week intervals to detect herbicide residues by pot bioassay. Sensitive species were planted and assessments made at the 2-4 leaf stage (Richardson and Dean 1973a). Untreated soil was stored and sown in a similar manner. Bioassays were run until phytotoxicity was no longer detectable; the maximum time being one year.

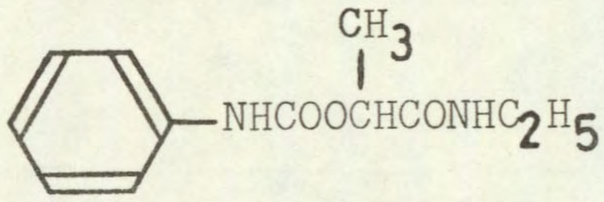
CARBETAMIDE

Code number RP 11561

Trade names Legurame
Carbetamex

Chemical name D(-)-1-(ethylcarbamoyl)ethyl phenylcarbamate

Structure



(D-isomer)

Source

Rhône Poulenc
Division Phytosanitaire
25 quai Paul Doumer
92408 Courbevoie
France

Information available and suggested uses

Approved for post-emergence use in winter against annual grasses, chickweed and speedwell in clover, lucerne, sainfoin, spring cabbage, winter field bean, sugar beet stecklings, oil seed rape and seed crops of cabbage, fodder rape, kale, turnip and swede. Also recommended in mixture with dimefuron, as 'Pradone Plus' for control of grasses and a wide range of broad-leaved weeds in winter oil seed rape.

Formulation used Emulsifiable concentrate 30% w/v a.i.

Spray volume 329.0 l/ha (29.3 gal/ac)

Results

Full results are given on pages 9-11 and potential selectivities are summarised in the following tables.

Table 3. Potential pre-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
3.36	carrot*	Galium aparine Chenopodium album Stellaria media Eleusine indica Echinochloa crus-galli Amaranthus retroflexus Cyperus esculentus + species below

* but note a stand reduction

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
1.12	species above + dwarf bean white clover kale swede sugar beet groundnut soyabean kenaf	Avena fatua Alopecurus myosuroides Poa annua Polygonum lapathifolium Agropyron repens Rumex acetosella + species below
0.37	None listed as no weeds controlled	None

Table 4. Potential post-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
6.72	None	None listed as no crops tolerant
2.24 & 0.74	None listed as no weeds controlled	None

Comments on results

Activity experiment (see page 9)

Most activity was found from the soil treatments, with pre-emergence applications being generally more effective than post-emergence soil drenches. Incorporation into the soil pre-emergence increased activity as compared with the surface spray for Agropyron repens and all three broad-leaved species. However, this difference was not apparent with the two annual grasses as kill of these by both of the pre-emergence treatments, even at the lowest dose, was complete. These facts should be borne in mind when considering the results of the pre-emergence selectivity experiment where the herbicide was fully incorporated into the soil. The foliar spray caused considerable damage to the broad-leaved species, though effects were non-lethal. Grasses were much more resistant to the foliar spray.

Symptoms

These were reminiscent of those caused by herbicides of the amide and carbamate group. Higher doses, pre-emergence, brought about a powerful inhibition of germination of grasses or sprouting of rhizome buds, while at lower doses there was often failure to emerge from the soil or from the coleoptile. Where emergence did occur leaves were usually severely stunted and dark green in colour. The foliar spray scorched leaves, particularly broad-leaved species, although this was possibly due to the solvent(s) used to formulate the herbicide.

Soil persistence

Persistence in the soil was very short. Plants of the test species, perennial ryegrass, were severely affected or killed by all three doses initially, but at the second bioassay seven weeks after treatment no phytotoxicity was detected.

Selectivities among temperate species

Pre-emergence

All grass weeds were controlled at 1.12 kg/ha and most were severely reduced at 0.37 kg/ha. Polygonaceous weeds (P. lapathifolium and Rumex acetosella) were the most sensitive of the broad-leaved species being controlled at 1.12 kg/ha. The high dose was needed to control G. aparine, C. album and S. media but Senecio vulgaris was notably resistent as were the other perennials (A. vineale, C. arvense and T. farfara).

Carrot was the most tolerant crop and although the stand was reduced at 3.36 kg/ha this was not thought to be due to the herbicide. The legumes, dwarf bean and white clover, the brassicas, kale and swede tolerated 1.12 kg/ha, as did sugar beet. Perennial ryegrass and the cereals were sensitive, particularly wheat and barley.

Post-emergence

Weed control was moderate, only five weeds being susceptible to the high dose and none to 2.24 kg/ha.

No crop tolerated the high dose of 6.72 kg/ha, but onion and carrot were reduced in vigour by only 29%. Lettuce tolerated 2.24 kg/ha. Surprisingly, the legumes, especially the clovers and lucerne, and the brassicas, failed to withstand 2.24 kg/ha although they suffered only 21 - 29% reductions in vigour.

Carbetamide shows considerable potential for controlling annual grass and a few broad-leaved weeds in a range of broad-leaved crops, particularly where it can be applied prior to, at, or very soon after weed emergence. The rather limited crop tolerance post-emergence should be treated with some caution. An emulsifiable concentrate formulation was used which might well have caused more damage to crops because of the solvent(s) it contained. Such a risk could well be overcome by the use of the current wettable powder formulation. Also, weed control may be better in soils containing less organic matter than that used in this post-emergence test. Another useful feature of this herbicide, which has perhaps not yet been appreciated, is its potential control of volunteer ryegrass and cereals, notably wheat and barley, in certain broad-leaved crops. Its short period of soil persistence should be no hazard to subsequent cropping. Its use in grassland, where it is desired to regulate the amount of ryegrass in a sward in order to encourage clovers or other legumes has already been reported (Haggar, 1974).

Selectivities among tropical species

Pre-emergence

Annual weeds were controlled only at the high dose, at which none of the tropical crops were tolerant. The poorer control of weeds at the middle dose, compared with the temperate range, is almost certainly due to the very rapid breakdown of the herbicide under warm conditions, and this compound does not appear likely to be suitable for use under tropical conditions.

Post-emergence

Lack of persistence in soil would be less important if the herbicide had useful post-emergence activity but, although weeds were stunted and retarded, none were fully suppressed, while crops were all damaged to some degree.

ACTIVITY EXPERIMENT

CARBETAMIDE

		0.74 kg a.i./ha	2.24 kg a.i./ha	6.72 kg a.i./ha
	F	xxxxxx	xxxx	xxxxxxx
DWARF	S	xxxxxxxxxxxx	xxxxxx	xxxx
BEAN	P	xxxxxxxxxxxx	xxxxxxxxx	xxxx
	I	xxxxxxxxxxxx	o	o
	F	xxxxxxxxxxx	xxxxxxxx	xxx
KALE	S	xxxxxxxxxxxx	xxxxxxxxxxx	xxxxxxx
	P	xxxxxxxxxxxxx	xxxxxxxxxxx	xxx
	I	xxxxxxxxxxx	xxxxxxxx	xxx
	F	xxxxxxxxxxxxx	xxxxxxxxxx	xxxx
POLYGONUM	S	xxxxxxxxxx	xxxxxxxxxx	xxxxxx
AMPHIBIUM	P	xxxxx	xxxx	x
	I	xxxx	x	o
	F	xxxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxxxxx
PERENNIAL	S	xxxx	xxx	xxx
RYEGRASS	P	o	o	o
	I	o	o	o
AVENA	F	xxxxxxxxxxxxx	xxxxxxxxxx	xxxxxxx
FATUA	S	xxxx	xxxx	xxx
	P	o	o	o
	I	o	o	o
	F	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxxx
AGROPYRON	S	xxxxxx	xxxxxx	xxxxxx
REPENS	P	xxxxxxxx	xxxx	o
	I	o	o	o

Control xxxxxxxxxxxxx

Key: F = Post-emergence, foliar application
S = Post-emergence, soil drench
P = Pre-emergence, surface film
I = Pre-planting, incorporated

(NB These histograms based on vigour scores only)

CARBETAMIDE

SPECIES	NO.	PRE-EMERGENCE			POST-EMERGENCE		
Temperates		0.37	1.12 kg a.i./ha	3.36	0.74	2.24 kg a.i./ha	6.72
WHEAT	(1)	83 21	0/0	0/0	100/71	100/57	100/43
BARLEY	(2)	60/21	7/7	0/0	100/71	100/57	100/43
OAT	(3)	98/36	13/14	0/0	100/57	100/50	100/29
PER RYGR.	(4)	92/79	0/0	0/0	88/50	88/36	88/29
CKSFOOT	(5)	-	-	-	100/79	100/57	100/43
TIMTHY	(6)	-	-	-	100/50	100/43	100/36
ONION	(8)	71/71	71/71	107/50	92/71	100/86	100/71
DWF BEAN	(9)	-/100	-/93	-/7	100/64	100/57	100/43
FLD BEAN	(10)	NA	NA	NA	100/86	100/79	100/64
PEA	(11)	NA	NA	NA	100/86	100/71	100/50
W. CLOVER	(12)	97/100	93/86	89/71	100/86	100/71	100/57
R. CLOVER	(13)	-	-	-	100/79	100/71	100/57
LUCERNE	(14)	-	-	-	100/93	100/79	100/50
KALE	(15)	89/100	89/86	103/64	100/86	100/71	100/43
CABBAGE	(16)	-	-	-	100/79	100/71	100/50
SWEDE	(17)	96/100	96/100	96/71	90/86	100/71	100/50
CARROT	(18)	59/100	65/100	65/93	100/86	100/79	100/71
PARSNIP	(19)	-	-	-	100/71	100/57	100/43
LETTUCE	(20)	NA	NA	NA	100/93	100/93	100/64
SUG BEET	(21)	101/100	108/86	90/43	100/86	100/71	100/57
AVE FATU	(26)	94/43	0/0	0/0	100/79	100/57	100/43
ALO MYOS	(27)	91/50	0/0	0/0	100/57	100/43	100/29
POA ANN	(28)	88/71	0/0	0/0	100/57	100/43	100/36
POA TRIV	(29)	-	-	-	100/43	100/36	100/29
SIN ARV	(30)	-	-	-	100/57	100/50	90/36
RAPH RAP	(31)	-	-	-	100/86	100/71	100/50
CHRY SEG	(32)	-	-	-	100/79	100/86	100/57
TRIP MAR	(33)	-	-	-	94/71	94/71	100/79
SEN VULG	(34)	108/93	104/93	112/93	100/86	100/86	100/57
POL LAPA	(35)	63/50	25/14	0/0	100/57	100/43	100/29
RUM CRIS	(37)	-	-	-	100/86	100/57	100/43
GAL APAR	(38)	85/79	169/71	15/21	100/100	100/86	100/71
CHEN ALB	(39)	75/71	55/64	20/21	100/71	100/57	92/29
STEL MED	(40)	103/86	86/36	64/29	100/71	100/57	100/43
SPER ARV	(41)	-	-	-	100/64	100/50	89/43

CARBETAMIDE

SPECIES	NO.	PRE-EMERGENCE			POST-EMERGENCE		
		0.37	1.12	3.36	0.74	2.24	6.72
		kg a.i./ha			kg a.i./ha		
PAP RHO	(43)	-	-	-	100/71	100/43	33/14
AG REPEN	(47)	51/50	0/0	0/0	75/64	75/50	75/43
AG STOLO	(48)	-	-	-	88/57	75/50	88/43
ALL VIN	(49)	100/100	100/100	100/71	-	-	-
CIRS ARV	(50)	-/93	-/79	-/86	-	-	-
TUS FARF	(51)	100/100	100/100	100/86	-	-	-
CONV ARV	(52)	-/86	-/64	-/50	-	-	-
RUM ACET	(53)	-/57	-/0	-/0	-	-	-
Tropicals							
MAIZE	(58)	100/86	83/36	67/29	100/79	100/57	100/57
SORGHUM	(59)	131/93	94/71	75/57	100/100	100/86	100/50
RICE	(60)	104/86	98/57	82/29	100/79	100/64	100/57
GRNDNUT	(64)	104/100	104/93	104/50	100/86	100/86	100/64
SOYABEAN	(65)	91/100	130/100	91/71	-	-	-
COTTON	(66)	38/93	13/43	63/43	100/64	100/57	100/57
JUTE	(67)	NA	NA	NA	-	-	-
KENAF	(68)	102/100	109/93	109/36	-	-	-
TOBACCO	(69)	-	-	-	100/64	100/43	100/36
ELEU IND	(74)	101/100	97/86	27/14	100/79	100/64	100/43
ECH CRUS	(75)	105/100	102/100	102/29	100/100	100/57	100/50
DIG SANG	(77)	-	-	-	100/86	100/71	100/43
AMAR RET	(78)	50/71	59/71	28/36	100/100	100/64	100/50
PORT OLE	(79)	-	-	-	100/71	100/43	100/36
CYN DACT	(82)	NA	NA	NA	-/71	-/71	-/71
CYP ESCU	(85)	-/100	-/100	-/21	-	-	-
CYP ROTU	(86)	88/86	100/93	94/79	-/93	-/71	-/71

KEY = No. of plants surviving/Vigour of survivors

Untreated = 100/100 Kill = 0/0

NA = not assessed - = not included

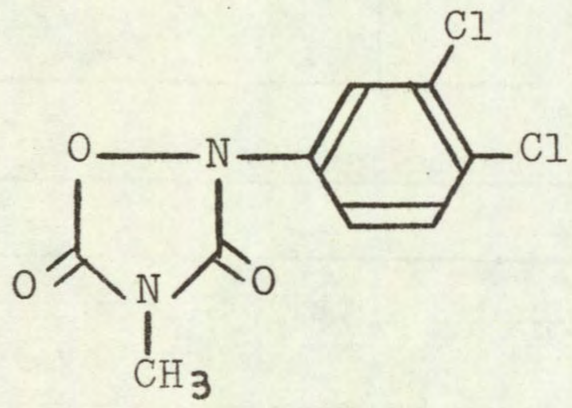
METHAZOLE

Code number VCS 438

Trade names Probe
Paxilon

Chemical name 2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione

Structure



Source

Velsicol Chemical Corporation
66 Tilehurst Road
Reading
Berks
RG3 2JH

Information available and suggested uses

Approved for control of annual broad-leaved and grass weeds post-emergence in onion and leek.

Formulation used Emulsifiable concentrate 12% w/v a.i.

Spray volume 329.0 l/ha (29.3 gal/ac)

Results

Full results are given on pages 16-18 and potential selectivities are summarised in the following tables.

Table 5. Potential pre-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
3.36	maize groundnut cotton	Alopecurus myosuroides Stellaria media Amaranthus retroflexus Avena fatua* Poa annua* Poa trivialis* Agropyron repens* + species below

* controlled at later assessment

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
1.12	species above + barley oat sorghum	Chenopodium album Cirsium arvense Rumex acetosella
0.37	None listed as no weeds controlled	None

Table 6. Potential post-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
4.48 & 1.12	None	None listed as no crops tolerant
0.28	wheat perennial ryegrass timothy sorghum rice	Sinapis arvensis Rumex crispus Chenopodium album Stellaria media Spergula arvensis Amaranthus retroflexus Portulaca oleracea

Comments on results

Activity experiment (see page 16)

Methazole is very active both pre- and post-emergence. The foliar spray caused severe damage to the two annual broad-leaved species but was somewhat less damaging to the grass species. Post-emergence soil drenches were much less active than the foliar spray on the three broad-leaved species but the differences were relatively small with the grasses. Pre-emergence treatments were at least as effective as, or much more so, than the post-emergence drenches for the grasses and Polygonum amphibium. Generally, incorporating the herbicide into the soil led to greater activity than when it was sprayed only on the soil surface, pre-emergence, this difference being particularly marked for dwarf bean and the grasses, notably Avena fatua. On kale and Polygonum, however, surface treatments were at least as active as incorporated. These facts should be borne in mind when considering the results of the pre-emergence selectivity experiment where the herbicide was incorporated into the soil.

Symptoms

These were very similar to those caused by herbicides which inhibit photosynthesis. Thus a pronounced chlorosis usually preceded necrosis or die-back in pre- and post-emergence treatments. Considerable scorch resulted from the foliar spray, often accompanied and sometimes preceded by chlorosis. Germination was not affected, plants usually dying back from an early growth stage, again usually preceded or accompanied by chlorosis.

Soil persistence

Using perennial ryegrass as the sensitive test species, a moderate period of persistence in the soil was found. Thus treatments of 1.12 and 3.36 kg/ha had to be bioassayed for periods up to 19 and 31 weeks respectively before phytotoxicity was no longer detectable. The dose of 0.37 kg/ha, however, was undetectable at the second bioassay seven weeks after treatment.

Selectivities among temperate species

Pre-emergence

At assessment, six weeks after treatment, only five weeds had been controlled at 1.12 kg/ha; the two perennials, Cirsium arvense and Rumex acetosella and the annuals Chenopodium album at 1.12 kg/ha and Alopecurus myosuroides and Stellaria media at 3.36 kg/ha. About a week after assessment, however, it was observed that the Poa species, Avena fatua and Agropyron repens had become more severely affected, such that they were eventually killed even at 1.12 kg/ha. This belated activity coincided with vastly improved weather conditions, particularly an increase in light intensity. Certain weeds showed considerable resistance, eg Galium aparine, Senecio vulgaris and the perennials Tussilago farfara, Allium vineale and Convolvulus arvensis.

Barley and oat were the only crops which tolerated 1.12 kg/ha. Most crops were either tolerant or only marginally affected at the low dose of 0.37 kg/ha. Surprisingly, onion was susceptible to 1.12 kg/ha.

Post-emergence

Five annual broad-leaved weeds were controlled at the lowest dose of 0.28 kg/ha while several others were severely reduced in vigour at this dose and controlled at 1.12 kg/ha. Some resistance was shown by the two composites, Tripleurospermum maritimum and Chrysanthemum segetum and also Galium aparine. The high dose was also necessary before control of the annual and perennial grasses was achieved.

Only three crops tolerated the lowest dose of 0.28 kg/ha, ie wheat, perennial ryegrass and timothy. Brassica and leguminous crops were generally sensitive with the possible exception of pea and lucerne. Sugar beet and lettuce were highly sensitive and again, surprisingly, as in the pre-emergence selectivity test, onion.

Although there is a reasonably good spectrum of weed control, there is a lack of a good margin of selectivity. The sensitivity of onion may have been due to either varietal susceptibility or possibly the formulation of the herbicide. However, the rather steep dose response found in these tests, especially pre-emergence, and the suggestion in this later test of the importance of environmental effects, casts some doubts on the selectivity of the e.c. formulation of methazole in arable situations. The widely used wettable powder formulation, however, may give greater crop safety at least post-emergence. The high and broad spectrum of activity of the e.c. may have some potential in non-crop situations, either alone or as a component of a mixture. It would not appear to have any potential for controlling volunteer cereals or ryegrass, but volunteer brassicas may be more susceptible.

Selectivities among tropical species

Pre-emergence

Small-seeded species were severely damaged at 3.36 kg/ha but were not completely suppressed and although cotton, maize and groundnut showed excellent tolerance, the high doses required for weed control suggest that this compound

can only be of practical value for pre-emergence use if the price is relatively low.

Post-emergence

Much greater activity was shown by post-emergence treatments and two small-seeded broad-leaved species, including Portulaca, were almost completely killed at 0.28 kg/ha. Good selectivity would appear possible against these in sorghum and rice and perhaps also groundnut and cotton but annual grasses would not be controlled and mixtures would be needed in most situations.

ACTIVITY EXPERIMENT

METHAZOLE

		0.28 kg a.i./ha	1.12 kg a.i./ha	4.48 kg a.i./ha
	F	xxxxxx	x	o
DWARF	S	xxxxxxxxxxxxxx	xxxxxxxxxx	xx
BEAN	P	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxx
	I	xxxxxxxxxxxxxx	xxx	o
	F	xxxxxx	x	o
KALE	S	xxxxxxxxxxxx	xxxx	o
	P	xxxxxxxxxx	x	o
	I	xxxxxxxxxxxxx	o	o
POLYGONUM	F	xxxxxxxxxxx	xxxxxx	xxxx
AMPHIBIUM	S	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxxxx
	P	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxx
	I	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxx
	F	xxxxxxxxxx	xxxxxxx	xxxx
PERENNIAL	S	xxxxxxxxxxxxx	xxxxxx	o
RYEGRASS	P	xxxxxxxxxxxxxx	xxxx	o
	I	xxxxxxxxxxxxx	o	o
AVENA	F	xxxxxxxxxxxxx	xxxxxxxxxx	xxxxxx
FATUA	S	xxxxxxxxxxxxx	xxxxxxxxxxx	xxxx
	P	xxxxxxxxxxxxx	xxxxxxxxxxxxxx	x
	I	xxxxxxxxxxxxx	o	o
	F	xxxxxxxxxxx	xxxxxxxxxx	xxxxxx
AGROPYRON	S	xxxxxxxxxxxx	xxxxxxxxx	xxx
REPENS	P	xxxxxxxxxxxxx	xxxxxxxxxxx	xxxxxx
	I	xxxxxxxxxx	xxxxxx	x

Control xxxxxxxxxxxxx % vigour

Key: F = Post-emergence, foliar application
S = Post-emergence, soil drench
P = Pre-emergence, surface film
I = Pre-planting, incorporated

(NB These histograms based on vigour scores only)

METHAZOLE

SPECIES	NO.	PRE-EMERGENCE			POST-EMERGENCE		
		0.37	1.12	3.36	0.28	1.12	4.48
Temperates		kg a.i./ha			kg a.i./ha		
WHEAT	(1)	113/100	105/79	113/57	100/86	100/71	50/29
BARLEY	(2)	80/100	107/100	87/71	100/79	100/64	63/29
OAT	(3)	104/100	98/86	91/64	100/79	100/71	63/43
PER. RYGR	(4)	105/100	103/71	92/43	88/86	88/50	25/14
CKSFOOT	(5)	-	-	-	100/79	100/64	0/0
TIMTHY	(6)	-	-	-	100/86	100/57	25/14
ONION	(8)	114/86	29/21	0/0	92/57	50/36	0/0
DWF BEAN	(9)	-/100R	-/43	-/21	100/36	0/0	0/0
FLD BEAN	(10)	NA	NA	NA	25/7	0/0	0/0
PEA	(11)	NA	NA	NA	100/79	100/50	100/14
W. CLOVER	(12)	80/79	0/0	0/0	63/29	0/0	0/0
R. CLOVER	(13)	-	-	-	100/50	44/29	0/0
LUCERNE	(14)	-	-	-	100/79	100/64	75/43
KALE	(15)	113/79	117/29	80/14	100/57	0/0	0/0
CABBAGE	(16)	-	-	-	100/71	10/14	0/0
SWEDE	(17)	102/79	102/14	102/14	90/50	0/0	0/0
CARROT	(18)	85/86	33/21	0/0	100/71	100/57	8/14
PRSNIP	(19)	-	-	-	100/71	100/71	67/36
LETTUCE	(20)	NA	NA	NA	0/0	0/0	0/0
SUG BEET	(21)	97/100	101/71	65/29	50/36	0/0	0/0
AVE FATU	(26)	113/93	122/71	122/57	100/79	100/71	50/21
ALO MYOS	(27)	101/79	88/43	91/29	100/93	100/64	38/29
POA ANN	(28)	97/93	77/64	88/57	100/79	100/50	100/29
POA TRIV	(29)	-	-	-	100/79	100/50	21/7
SIN ARV	(30)	-	-	-	30/29	0/0	0/0
RAPH RAP	(31)	-	-	-	80/50	0/0	0/0
CHRY SEG	(32)	-	-	-	100/93	92/64	25/21
TRIP MAR	(33)	-	-	-	94/64	44/50	44/43
SEN VULG	(34)	119/93	96/71	100/64	92/50	25/43	0/0
POL LAPA	(35)	72/100	80/86	101/57	100/71	33/14	0/0
RUM CRIS	(37)	-	-	-	42/29	0/0	0/0
GAL APAR	(38)	123/86	92/79	115/71	100/64	92/50	17/7
CHEN ALB	(39)	89/79	7/7	0/0	25/36	0/0	0/0
STEL MED	(40)	111/100	64/36	42/14	25/29	0/0	0/0
SPER ARV	(41)	-	-	-	78/29	0/0	0/0

METHAZOLE

SPECIES	NO.	PRE-EMERGENCE			POST-EMERGENCE		
		0.37	1.12	3.36	0.28	1.12	4.48
		kg a.i./ha			kg a.i./ha		
PAP RHO	(43)	-	-	-	67/57	0/0	0/0
AG REPEN	(47)	103/93	86/79	103/64	88/57	63/64	13/14
AG STOLO	(48)	-	-	-	88/79	100/64	50/14
ALL VIN	(49)	92/100	100/86	100/79	-	-	-
CIRS ARV	(50)	-/79	-/21	/0	-	-	-
TUS FARF	(51)	100/100	100/100	100/93	-	-	-
CONV ARV	(52)	-/79	-/57	-/64	-	-	-
RUM ACET	(53)	-/93	-/0	-/0	-	-	-
Tropicals							
MAIZE	(58)	100/100	100/100	100/93	100/71	75/64	0/0
SORGHUM	(59)	150/100	94/100	37/36	100/93	80/64	0/0
RICE	(60)	87/86	93/64	98/57	100/86	100/64	0/0
GRNDNUT	(64)	104/100	104/93	104/86	100/79	100/36	100/21
SOYABEAN	(65)	78/100	130/64	130/43	-	-	-
COTTON	(66)	138/100	138/100	125/100	100/79	100/50	100/21
JUTE	(67)	NA	NA	NA	-	-	-
KENAF	(68)	102/100	102/71	14/14	-	-	-
TOBACCO	(69)	-	-	-	17/29	0/0	0/0
ELEU IND	(74)	90/100	109/79	94/57	100/79	75/43	0/0
ECH CRUS	(75)	105/100	89/64	80/43	100/86	17/21	0/0
DIG SANG	(77)	-	-	-	100/86	42/57	0/0
AMAR RET	(78)	95/93	36/71	25/29	0/0	0/0	0/0
PORT OLE	(79)	-	-	-	8/7	0/0	0/0
CYN DACT	(82)	NA	NA	NA	-/79	-/71	-/29
CYP ESCU	(85)	-/100	-/64	-/86	-	-	-
CYP ROTU	(86)	100/100	94/100	112/86	-/86	-/71	-/86

KEY = No. of plants surviving/Vigour of survivors

Untreated = 100/100
NA = not assessed

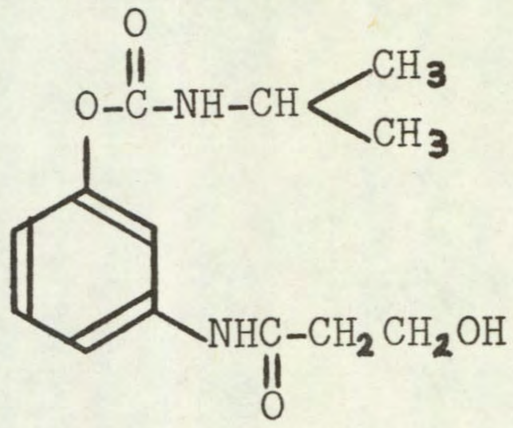
Kill = 0/0
- = not included

R-11913

Code number R-11913

Chemical name 3'-hydroxypropionanilide-3-isopropylcarbamate

Structure



Source

Stauffer Chemicals
Baystrait House
Station Road
Biggleswade
Beds SG18 8AL

Information available and suggested uses

Originally suggested for annual grass and broad-leaved weed control pre- and post-emergence in sugar beet, alfalfa, wheat, barley, peas, lentils, sorghum, potatoes, established trees and vines at 1.12 to 4.48 kg a.i./ha. Weeds must be less than 5 cm high in post-emergence use.

Formulation used Wettable powder 75% w/w a.i.

Spray volume 329.0 l/ha (29.3 gal/ac)

Results

Full results are given on pages 22-24 and potential selectivities are summarised in the following tables.

Table 7. Potential pre-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
5.04	None	None listed as no crops tolerant
1.68	wheat barley oat dwarf bean carrot maize cont'd over	Rumex acetosella Amaranthus retroflexus

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
	rice groundnut soyabean kenaf	
0.56	None listed as no weeds controlled	None

Table 8. Potential post-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
6.72 and 2.24	None	None listed as no crops tolerant
0.74	wheat sorghum	Alopecurus myosuroides Poa trivialis Sinapis arvensis Polygonum lapathifolium Papaver rhoeas Amaranthus retroflexus

Comments on results

Activity experiment (see page 22)

Most phytotoxicity occurred with the soil applications, particularly with the post-emergence soil drenches, which were the only treatments to cause effects at the lowest dose. The foliar spray caused some minor effects on only three of the species, kale, Polygonum amphibium and perennial ryegrass. Pre-emergence treatments caused considerably toxicity at the two higher doses, particularly the surface treatment. This should be taken into consideration with regard to the pre-emergence selectivity experiment where treatments were incorporated.

Symptoms

A general inhibition of growth and chlorosis or a mild yellowing were the most common symptoms in both pre- and post-emergence treatments and was generally followed by necrosis. Scorch symptoms were often seen on treated foliage, but germination and emergence were not usually affected by pre-emergence treatment. Thus the symptoms are more typical of photosynthetic inhibiting herbicides such as ureas and triazines rather than the amide or carbamate group of herbicides to which R-11913 belongs according to its chemistry.

Soil persistence

Using swede as the sensitive test species, a very short period of persistence in the soil was found. Thus no phytotoxicity was detectable at the second bioassay, seven weeks after treatment.

Selectivities among temperate species

Pre-emergence

Rumex acetosella was the only weed to be selectively controlled at 1.68 kg/ha. At 5.04 kg/ha all broad-leaved weeds, except *Galium aparine*, *Cirsium* and *Tussilago* were controlled. *Alopecurus myosuroides* was the only annual grass weed controlled at this dose, although the others were severely reduced. Apart from *R. acetosella*, *Convolvulus arvensis* was the only other perennial weed to show any degree of susceptibility.

No crop tolerated the highest dose of 5.04 kg/ha. At 1.68 kg/ha, the cereals, (wheat, barley and oat), dwarf bean and carrot were tolerant while sugar beet, perennial ryegrass and onion were reduced in vigour by only 21 to 29%. The brassicas, kale and swede were very sensitive at this dose however.

Post-emergence

Five annual weeds were controlled at the lowest dose of 0.74 kg/ha while at 2.24 kg/ha *Avena fatua* and *Galium aparine* were the only two annual weeds to survive treatment, as did the two perennial grasses, *A. repens* and *A. stolonifera*.

Wheat was the only crop to withstand the lowest dose of 0.74 kg/ha, but barley, lucerne, sugar beet and pea suffered only minor vigour reductions, the latter in fact being reduced by only 29% in vigour at 2.24 kg/ha. Brassica crops were sensitive, as were timothy and lettuce.

Although R-11913 possesses some interesting features with regard to its herbicidal activity, it would appear to lack a sufficient margin of selectivity, pre- and post-emergence. It may have been more selective pre-emergence as a surface spray rather than as an incorporated treatment. The high level of activity in the post-emergence selectivity test, on both weeds and crops, must be assumed to be due to its ease of uptake via the soil. This showed up in the activity experiment, where soil drenches post-emergence were much more active than the foliar spray. This is surprising as the soil in the post-emergence test contained a relatively high level of organic matter (1:1 peat: sand by volume). Whether this would prove to be of practical importance, however, is doubtful in view of the low selectivity margins. The control of *Alopecurus myosuroides* and some other annual weeds in wheat is interesting but shows no apparent advantage over existing herbicides used in this situation.

Selectivities among tropical species

Pre-emergence

Only *Amaranthus* and jute were susceptible to 1.68 kg/ha, at which dose several crops were tolerant. As grass weeds require a much higher dose the compound does not appear to be suitable for general weed control but it could be of interest for testing on problem broad-leaved weeds in broad-leaved crops such as soyabean and kenaf provided the very short residual life in the soil does not make it too unreliable.

Post-emergence

Small-seeded broad-leaved species proved susceptible to the lowest dose but only sorghum proved tolerant among the crops and the potential for the compound as a post-emergence treatment, therefore, appears very limited.

ACTIVITY EXPERIMENT

R 11913

		0.28 kg a.i./ha	1.12 kg a.i./ha	4.48 kg a.i./ha
	F	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxxxxxx
DWARF	S	xxxxxxxxxx	x	o
BEAN	P	xxxxxxxxxxxxxx	xxxxxxxxxxxx	xxxx
	I	xxxxxxxxxxxxx	xxxxxxxxxxxxxx	o
	F	xxxxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx
KALE	S	xxxxx	o	o
	P	xxxxxxxxxxxxxx	xxx	o
	I	xxxxxxxxxxxxx	xxxxxxxxxxxx	o
	F	xxxxxxxxxxxxx	xxxxxxxxxx	xxxxxxxx
POLYGONUM	S	xxxxxxxx	xxxxx	xxx
AMPHIBIUM	P	xxxxxxxxxxxxxx	xxxxxxxxxxxx	xxxxx
	I	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxx
	F	xxxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxxxxxx
PERENNIAL	S	xxxxxxxxxx	xxxxx	xx
RYEGRASS	P	xxxxxxxxxxxxxx	xxxxxxxxxx	xxxxx
	I	xxxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxx
	F	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx
AVENA	S	xxxxxxxxxxxx	xxxx	x
FATUA	P	xxxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxx
	I	xxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxx
	F	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxx
AGROPYRON	S	xxxxxxxxxxxxxx	xxxxxxxx	xxxx
REPENS	P	xxxxxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxx
	I	xxxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxx

Control xxxxxxxxxxxxx % vigour

Key: F = Post-emergence, foliar application
S = Post-emergence, soil drench
P = Pre-emergence, surface film
I = Pre-planting, incorporated

(NB These histograms based on vigour scores only)

SPECIES	NO.	PRE-EMERGENCE			POST-EMERGENCE		
		0.56	1.68	5.04	0.74	2.24	6.72
Temperates			kg a.i./ha			kg a.i./ha	
WHEAT	(1)	105/93	105/93	105/50	100/86	100/36	88/21
BARLEY	(2)	107/100	93/93	87/50	100/79	100/57	100/21
OAT	(3)	104/100	104/86	104/21	100/71	100/36	63/14
PER RYGR	(4)	103/100	94/79	75/43	88/50	38/14	6/7
CKSFOOT	(5)	-	-	-	100/57	83/21	8/7
TIMTHY	(6)	-	-	-	56/29	0/0	0/0
ONION	(8)	129/93	79/71	86/50	100/71	83/50	33/21
DWF BEAN	(9)	-/100	-/93	-/0	100/57	0/0	0/0
FLD BEAN	(10)	NA	NA	NA	100/36	0/0	0/0
PEA	(11)	NA	NA	NA	100/79	100/71	100/64
W. CLOVER	(12)	106/100	46/57	0/0	100/43	38/29	0/0
R. CLOVER	(13)	-	-	-	100/71	100/43	81/29
LUCERNE	(14)	-	-	-	100/79	81/64	94/43
KALE	(15)	89/86	89/50	94/21	60/29	0/0	0/0
CABBAGE	(16)	-	-	-	100/71	20/7	0/0
SWEDE	(17)	96/86	96/29	85/14	70/36	40/7	0/0
CARROT	(18)	59/93	91/100	26/29	75/57	8/7	0/0
PARSNIP	(19)	-	-	-	92/71	58/36	8/7
LETTUCE	(20)	NA	NA	NA	0/0	0/0	0/0
SUG BEET	(21)	108/100	85/79	68/14	100/79	100/64	92/50
AVE FATU	(26)	122/93	131/86	131/36	100/79	100/50	100/43
ALO MYOS	(27)	84/86	88/71	44/21	69/29	38/14	13/7
POA ANN	(28)	102/100	95/71	83/36	100/36	50/14	0/0
POA TRIV	(29)	-	-	-	79/29	29/21	0/0
SIN ARV	(30)	-	-	-	60/21	0/0	0/0
RAPH RAP	(31)	-	-	-	90/57	0/0	0/0
CHRY SEG	(32)	-	-	-	100/64	83/29	17/7
TRIP MAR	(33)	-	-	-	69/64	38/29	0/0
SEN VULG	(34)	112/79	46/36	0/0	100/71	25/29	0/0
POL LAPA	(35)	101/100	46/86	0/0	50/14	17/7	0/0
RUM CRIS	(37)	-	-	-	100/57	42/21	0/0
GAL APAR	(38)	138/100	108/93	154/71	100/93	100/86	92/21
CHEN ALB	(39)	95/86	72/71	10/14	100/86	75/29	0/0
STEL MED	(40)	100/100	100/71	36/14	94/57	6/7	0/0
SPER ARV	(41)	-	-	-	67/36	0/0	0/0
PAP RHO	(43)	-	-	-	8/21	0/0	0/0

R-11913

SPECIES	NO.	PRE-EMERGENCE			POST-EMERGENCE		
		0.56	1.68	5.04	0.74	2.24	6.72
		kg a.i./ha			kg a.i./ha		
AG REPEN	(47)	103/100	103/93	103/64	63/64	38/50	13/7
AG STOLO	(48)	-	-	-	75/50	88/36	63/14
ALL VIN	(49)	92/100	100/100	100/71	-	-	-
CIRS ARV	(50)	-/86	-/86	-/79	-	-	-
TUS FARF	(51)	100/100	100/100	100/93	-	-	-
CONV ARV	(52)	-/93	-/57	-/29	-	-	-
RUM ACET	(53)	-/93	-/29	-/0	-	-	-
Tropicals							
MAIZE	(58)	100/100	100/100	100/79	100/79	100/64	100/14
SORGHUM	(59)	75/86	56/71	75/57	100/93	80/57	60/29
RICE	(60)	104/100	109/86	109/50	100/71	100/43	50/21
GRNDNUT	(64)	104/100	104/93	104/71	100/79	100/57	100/29
SOYABEAN	(65)	104/100	157/100	157/29	-	-	-
COTTON	(66)	138/93	113/71	100/29	100/79	100/79	100/21
JUTE	(67)	NA	NA	NA	-	-	-
KENAF	(68)	109/100	82/93	75/50	-	-	-
TOBACCO	(69)	-	-	-	0/0	0/0	0/0
ELEU IND	(74)	74/100	109/100	78/36	100/71	100/57	67/29
ECH CRUS	(75)	70/100	77/100	54/43	100/71	67/36	0/0
DIG SANG	(77)	-	-	-	100/86	83/43	17/7
AMAR RET	(78)	101/100	14/36	0/0	25/7	0/0	0/0
PORT OLE	(79)	-	-	-	83/36	0/0	0/0
CYN DACT	(82)	NA	NA	NA	-/64	-/57	-/57
CYP ESCU	(85)	-/100	-/100	-/71	-	-	-
CYP ROTU	(86)	88/93	82/93	71/64	-/79	-/64	-/50

KEY = No. of plants surviving/Vigour of survivors

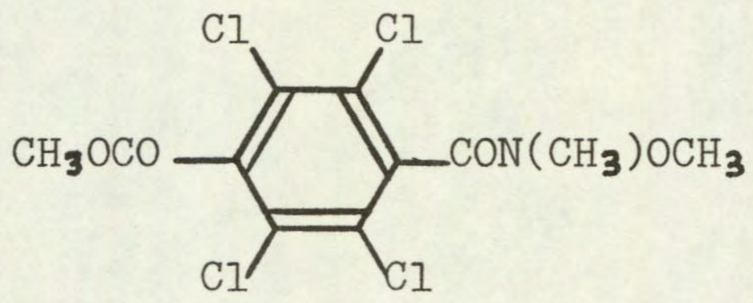
Untreated = 100/100
NA = not assessed
Kill = 0/0
- = not included

OCS 21693

Code number OCS 21693

Chemical name Methyl 2,3,5,6-tetrachloro-N-methoxy-N-methylterephthalamate

Structure



Source

Velsicol Chemical Corporation
66 Tilehurst Road
Reading
Berks RG3 2JH

Information available and suggested uses

Originally suggested for pre-emergence control of annual grass weeds at 3.36 kg/ha and broad-leaved weeds at 5.60 kg/ha in rice, groundnut, soyabean, cotton, lettuce, grain sorghum, snap and lima beans and potatoes, either alone or combined with DNBP or OCS 21799. Its herbicidal properties in rice culture have been reported by Furness, 1968.

Formulation used Emulsifiable concentrate 24% w/v a.i.

Spray volume 329.0 l/ha (29.3 gal/ac)

Results

Full results are given on pages 27-29 and potential post-emergence selectivities are summarised in the following table.

Table 9. Potential post-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
10.08	None	None listed as no crops tolerant
3.36	barley perennial ryegrass cocksfoot parsnip rice	Chenopodium album
1.12	None listed as no weeds controlled	None

Comments on results

Activity experiment (see page 27)

Some phytotoxicity was found with the soil treatments, particularly with the pre-emergence applications, which were generally more effective than post-emergence soil drenches. Incorporation, pre-planting, led to greater activity than the surface spray for the larger seeded and perennial species, but the reverse was true for the smaller seeded kale and perennial ryegrass. The foliar spray was relatively active on kale and dwarf bean (more so than the pre-emergence treatments) but Polygonum amphibium and the grass species were much less affected which prompted the post-emergence selectivity test (see below).

Symptoms

The principal effect of most of the treatments was a severe inhibition of growth, often accompanied by chlorosis in some species or a darker green colouration in others. This was followed by necrosis and die-back. The foliar spray caused wilting and scorch symptoms within a few days of spraying, more notably on the broad-leaved species and this was also often accompanied by either chlorosis or a darker green colouration of leaves.

Post-emergence selectivity among temperate species

Chenopodium album was the only weed controlled at 3.36 kg/ha and at the highest dose of 10.08 kg/ha, Papaver rhoeas was the only other susceptible species although several were severely reduced in vigour. Composite, polygonaceous weeds, Galium aparine and several others were still quite resistant however.

No crop withstood 10.08 kg/ha, while only barley, perennial ryegrass, cocksfoot and parsnip tolerated 3.36 kg/ha.

Post-emergence selectivity among tropical species

The relatively high tolerance of rice was confirmed but no effective control of weeds was achieved at the doses used and there is no evidence for useful effects from post-emergence application. Unfortunately, pre-emergence selectivity has not been studied in this series of experiments.

ACTIVITY EXPERIMENT

OCS 21693

		1.12 kg a.i./ha	3.36 kg a.i./ha	10.08 kg a.i./ha
	F	xxxxxxxxxxx	xxxxxxx	xxxx
DWARF	S	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxxxx
BEAN	P	xxxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxx
	I	xxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxx
	F	xxxxxxxxxxxx	xxxxxx	xx
KALE	S	xxxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxxxxx
	P	xxxxxxxxxx	xxxxxx	xxxx
	I	xxxxxxxxxxxx	xxxxxxxxxxxx	xxxx
	F	xxxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxxxxxxx
POLYGONUM	S	xxxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxxxxxx
AMPHIBIUM	P	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxx
	I	xxxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxx
PERENNIAL	F	xxxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx
RYEGRASS	S	xxxxxxxxxxx	xxxxxxxx	xxxxx
	P	xxxxxxx	x	o
	I	xxxxxxxxxxx	xxxxx	x
	F	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxxxxx
AVENA	S	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxx
FATUA	P	xxxxxxxxxxxx	xxxxxxx	xxxxxxxxxx
	I	xxxxxxxxxxx	xxxxxx	xxxx
	F	xxxxxxxxxxxxx	xxxxxxxxxxxxx	xxxxxxxxxxx
AGROPYRON	S	xxxxxxxxxxxx	xxxxxxxx	xxxxxx
REPENS	P	xxxxxxxxxxxx	xxxxxxxxxx	xxxxxxxxx
	I	xxxxxxxxxxxxx	xxxxxxx	xx

Control xxxxxxxxxxxxx % vigour

Key: F = Post-emergence, foliar application
S = Post-emergence, soil drench
P = Pre-emergence, surface film
I = Pre-planting, incorporated

(NB These histograms based on vigour scores only)

QCS 21693

SPECIES	NO.		POST-EMERGENCE	
		1.12	3.36	10.08
Temperates			kg a.i./ha	
WHEAT	(1)	100/79	100/79	100/79
BARLEY	(2)	100/79	100/86	100/79
OAT	(3)	100/71	100/71	100/71
PER RYGR	(4)	88/86	88/86	88/71
CKSFOOT	(5)	100/79	100/86	100/79
TIMTHY	(6)	100/86	100/57	100/79
ONION	(8)	100/71	100/79	100/64
DWF BEAN	(9)	100/79	100/64	100/64
FLD BEAN	(10)	100/64	100/64	100/57
PEA	(11)	100/86	100/71	100/64
W. CLOVER	(12)	100/79	100/71	100/57
R. CLOVER	(13)	100/86	100/79	100/64
LUCERNE	(14)	100/71	100/64	100/50
KALE	(15)	100/71	90/57	100/43
CABBAGE	(16)	100/71	100/64	100/50
SWEDE	(17)	100/79	100/64	100/43
CARROT	(18)	100/86	100/79	100/71
PRSNIP	(19)	100/93	100/86	100/79
LETTUCE	(20)	100/57	100/50	92/43
SUG BEET	(21)	100/79	100/79	100/71
AVE FATU	(26)	100/79	100/71	100/71
ALO MYOS	(27)	100/79	100/86	100/57
POA ANN	(28)	100/86	100/79	100/71
POA TRIV	(29)	100/86	93/64	100/43
SIN ARV	(30)	100/57	100/57	100/36
RAPH RAP	(31)	100/71	90/57	90/43
CHRY SEG	(32)	100/93	100/71	100/57
TRIP MAR	(33)	100/86	100/50	94/57
SEN VULG	(34)	100/71	100/71	100/71
POL LAPA	(35)	100/86	100/79	100/64
RUM CRIS	(37)	100/86	100/71	100/64
GAL APAR	(38)	100/93	100/86	100/86
CHEN ALB	(39)	100/64	100/29	92/14
STEL MED	(40)	100/93	100/71	100/64

CCS 21693

SPECIES	NO.	POST-EMERGENCE		
		1.12	3.36	10.08
		kg a.i./ha		
SPER ARV	(41)	100/86	100/64	100/57
PAP RHO	(43)	100/64	92/36	0/0
AG REPENS	(47)	100/79	75/71	75/64
AG STOLO	(48)	88/86	100/86	100/64
ALL VIN	(49)	-	-	-
CIRS ARV	(50)	-	-	-
TUS FARF	(51)	-	-	-
CONV ARV	(52)	-	-	-
RUM ACET	(53)	-	-	-
Tropicals				
MAIZE	(58)	100/93	100/79	75/79
SORGHUM	(59)	100/86	80/79	20/36
RICE	(60)	100/86	100/86	100/79
GRNDNUT	(64)	100/79	100/79	100/79
SOYABEAN	(65)	-	-	-
COTTON	(66)	100/71	100/64	100/57
JUTE	(67)	-	-	-
KENAF	(68)	-	-	-
TOBACCO	(69)	100/64	100/50	100/43
ELEU IND	(74)	100/79	100/79	67/64
ECH CRUS	(75)	100/86	100/79	100/57
DIG SANG	(77)	100/71	100/71	92/64
AMAR RET	(78)	100/71	100/64	100/57
PORT OLE	(79)	100/71	100/57	100/50
CYN DACT	(82)	-/71	-/71	-/64
CYP ESCU	(85)	-	-	-
CYP ROTU	(86)	-/79	-/79	-/71

KEY = No. of plants surviving/Vigour of survivors

Untreated = 100/100 Kill = 0/0

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Appendix I. Species abbreviations, varieties, cultivars and stages of growth at assessment for pre-emergence selectivity experiment.

Species	Designation and computer serial number	Cultivar or source	No. of seed or plant material per pot	Depth of planting (cm)	Stage of growth at assessment (untreated controls
TEMPERATES					
Wheat (Triticum aestivum)	WHEAT (1)	Kolibri	8	1.2	3-3½ leaves
Barley (Hordeum vulgare)	BARLEY (2)	Proctor	8	1.2	3 leaves
Oat (Avena sativa)	OAT (3)	Condor	8	1.2	3 leaves
Perennial ryegrass (Lolium perenne)	PER RYGR (4)	S23	25	0.6	3-3½ leaves
Onion (Allium cepa)	ONION (8)	Rijnsburger	15	0.6	2-3 leaves
Dwarf french bean (Phaseolus vulgaris)	DWF BEAN (9)	Tendergreen	3	1.8	1-2 trifoliates
Field bean (Vicia faba)	FLD BEAN (10)	Maris Bead	4	1.8	3-4 leaves
Pea (Pisum sativum)	PEA (11)	Dark Skinned Perfection	4	1.8	4-5 leaves
White clover (Trifolium repens)	W. CLOVER (12)	S 100	20	0.6	2½ trifoliates
Kale (Brassica oleracea acephala)	KALE (15)	Marrowstem	15	0.6	2-2½ leaves
Swede (Brassica napus)	SWEDE (17)	Bangholm	10	0.6	2-2½ leaves
Carrot (Daucus carota)	CARROT (18)	Chantenay Red Core	10	0.6	3½ leaves
Lettuce (Lactuca sativa)	LETTUCE (20)	Borough	14	0.6	nil germination
Sugar beet (Beta vulgaris)	SUG BEET (21)	'Klein E'	15	1.2	2 leaves
Avena fatua	AVE FATU (26)	WRO 1964	8	1.2	3 leaves

Appendix I. (Continued)

Species	Designation and computer serial number	Cultivar or source	No. of seed or plant material per pot	Depth of planting (cm)	Stage of growth at assessment
Alopecurus myosuroides	ALO MYOS (27)	WRO 1967	30	0.6	3 leaves
Poa annua	POA ANN (28)	WRO 1964	25	0.6	3 leaves
Senecio vulgaris	SEN VULG (34)	WRO 1968	20	0.6	5½ leaves
Polygonum lapathifolium	POL LAPA (35)	WRO 1968	15	0.6	3-5 leaves
Galium aparine	GAL APAR (38)	Bletchingdon 1967	15	0.6	5 whorls
Chenopodium album	CHEN ALB (39)	Wytham 1965	25	0.6	6-8 leaves
Stellaria media	STEL MED (40)	WRO 1968	20	0.6	16-18 leaves
Agropyron repens	AG REPEN (47)	WRO Clone 31	6+	1.2	3 leaves
Allium vineale	ALL VIN (49)	WRO 1968	6*	1.2	2-2½ leaves
Cirsium arvense	CIRS ARV (50)	WRO Clone 1	4++	1.2	7-10 leaves
Tussilago farfara	TUS FARF (51)	WRO Clone 1	4+	1.8	2½-3½ leaves
Convolvulus arvensis	CONV ARV (52)	WRO Clone 1	4++	1.2	not recorded
Rumex acetosella	RUM ACET (53)	WRO Clone 1	4++	1.2	14-16 leaves
TROPICALS					
Maize (Zea mays)	MAIZE (58)	Inra 200	6	1.2	4½-5 leaves
Sorghum (Sorghum vulgare)	SORGHUM (59)	SB 68,	6	1.2	4-5 leaves
Rice (Oryza sativa)	RICE (60)	Kogbandi,	10	1.2	2-3 leaves

Appendix I. (Continued)

Species	Designation and computer serial number	Cultivar or source	No. of seed or plant material per pot	Depth of planting (cm)	Stage of growth at assessment
Groundnut (*Arachis hypogea*)	GRNDNUT (64)	Natal Common	6	1.2	3-4 leaves
Soyabean (*Glycine max*)	SOYABEAN (65)	Altona	4	1.8	2 trifoliate leaves
Cotton (*Gossypium hirsutum*)	COTTON (66)	Samaru 26J	6	1.2	2 leaves
Jute (*Corchorus olitorius*)	JUTE (67)	ex-Trinidad 1968	12	0.6	3 leaves
Kenaf (*Hibiscus cannabinus*)	KENAF (68)	Thai Native 1968	8	1.2	2 leaves
Eleusine indica	ELEU IND (74)	WRO 1964	15	0.6	3-3½ leaves
Echinochloa crus-galli	ECH CRUS (75)	UFS Wytham 1961	20	0.6	4-4½ leaves
Amaranthus retroflexus	AMAR RET (78)	WRO 1968	20	0.6	4-5 leaves
Cynodon dactylon	CYN DACT (82)	WRO Clone 2 (ex Sudan)	2+	1.2	-
Cyperus esculentus	CYP ESCU (85)	WRO Clone 2 (ex South Africa)	5**	1.2	5-6 leaves
Cyperus rotundus	CYP ROTU (86)	WRO Clone 1 (ex Rhodesia)	5**	1.2	1-3 shoots

\+ one node rhizome pieces
++ 4 cm root sections

* aerial bulbils
** tubers

Appendix II Species, abbreviations, cultivars and stages of growth at spraying and assessment for post-emergence selectivity experiment

Species	Designation and computer serial no.	Cultivar or source	No.plants at spraying	Stage of growth at spraying	Stage of growth at assessment (untreated controls)
TEMPERATES					
Wheat (Triticum aestivum)	WHEAT (1)	Kloka	4	2 leaves	5 leaves, tillering
Barley (Hordeum vulgare)	BARLEY (2)	Proctor	4	2½-3 leaves	7 leaves, tillering
Oat (Avena sativa)	OAT (3)	Condor	4	2-2½ leaves	6 leaves, tillering
Perennial ryegrass (Lolium perenne)	PER RYGR (4)	S 23	8	1-2 leaves	4½ leaves
Cocksfoot (Dactylis glomerata)	CKSFOOT (5)	S 37	6	3 leaves	6 leaves, tillering
Timothy (Phleum pratense)	TIMTHY (6)	S 48	8	2½ leaves	7 leaves, tillering
Onion (Allium cepa)	ONION (8)	Rijnsburger	6	2 leaves	2-2½ leaves
Dwarf bean (Phaseolus vulgaris)	DWF BEAN (9)	Tendergreen	2	½-1 trifoliate	1½-2 trifoliates
Field bean (Vicia faba)	FLD BEAN (10)	Maris Bead	2	2½ leaves	8 leaves
Pea (Pisum sativum)	PEA (11)	Dark Skinned Perfection	2	3-3½ leaves	Several leaves
White clover (Trifolium repems)	W CLOVER (12)	S 100		1-1½ trifoliates	7 trifoliates
Red Clover (Trifolium pratense)	R CLOVER (13)	S 123	8	1-1½ trifoliates	2½ trifoliates
Lucerne (Medicago sativa)	LUCERNE (14)	Du Puits	8	1½-2½ trifoliates	5½ trifoliates
Kale (Brassica oleracea acephala)	KALE (15)	Marrowstem	5	2 leaves	3½ leaves
Cabbage (Brassica oleracea capitata)	CABBAGE (16)	Primo	5	1½-2 leaves	3½-4 leaves
Swede (Brassica napus)	SWEDE (17)	Bangholm	5	2 leaves	4-4½ leaves
Carrot (Daucus carota)	CARROT (18)	Chanteney Red Core	6	2 leaves	4-5 leaves
Parsnip (Pastinaca sativa)	PRSNIP (19)	Hollow Crown Improved	6	1½ leaves	3½ leaves
Lettuce (Lactuca sativa)	LETTUCE (20)	Borough Wonder	6	1-1½ leaves	6 leaves
Sugar beet (Beta vulgaris)	SUG BEET (21)	Klein E	6	2 leaves	4½ leaves

Appendix II (Continued)

Species	Designation and computer serial no.	Cultivar or source	No. plants at spraying	Stage of growth at spraying	Stage of growth at assessment (untreated controls)
Avena fatua	AVE FATU (26)	Wytham 1964	4	3-5 leaves	7 leaves, tillering
Alopecurus myosuroides	ALO MYOS (27)	WRO 1966	8	2 leaves	Several leaves, tillering
Poa annua	POA ANN (28)	WRO 1966	8	3½-4 leaves	Several leaves, tillering
Poa trivialis	POA TRIV (29)	Watts 1964	6 or 8	3 leaves	Several leaves, tillering
Sinapis arvensis	SIN ARV (30)	WRO 1967	5	3-3½ leaves	5½-6½ leaves
Raphanus raphanistrum	RAPH RAP (31)	Long Black Spanish	5	1½-2 leaves	4½ leaves
Chrysanthemum segetum	CHRY SEG (32)	WRO 1965	6	6-8 leaves	14 leaves
Tripleurospermum maritimum	TRIP MAR (33)	WRO 1963	8	3½ leaves	14 leaves
Senecio vulgaris	SEN VULG (34)	WRO 1967	6	4 leaves	9 leaves
Polygonum lapathifolium	POL LAPA (35)	WRO 1966	6	1½ leaves	7 leaves
Rumex crispus	RUM CRIS (37)	Bletchingdon 1967	6	1½-2½ leaves	6 leaves
Galium aparine	GAL APAR (38)	WRO 1966	6	3 whorls	Several whorls
Chenopodium album	CHEN ALB (39)	Wytham 1965	6	4 leaves	10 leaves
Stellaria media	STEL MED (40)	WRO 1967	6	6 leaves	Several leaves
Spergula arvensis	SPER ARV (41)	WRO 1967	4 or 6	2 whorls	Several whorls
Papaver rhoeas	PAP RHO (43)	Suttons 1966	6	2 leaves	10 leaves
Agropyron repens	AG REPEN (47)	WRO Clone 31	4+	2½ leaves	7 leaves, tillering
Agrostis stolonifera	AG STOLO (48)	WRO Clone 1	2++	5 leaves	7 stolons

Appendix II (Continued)

Species	Designation and computer serial no.	Cultivar or source	No. plants at spraying	Stage of growth at spraying	Stage of growth at assessment (untreated controls)
TROPICALS					
Maize (Zea mays)	MAIZE (58)	Inra 200	2	4 leaves	7½ leaves
Sorghum (Sorghum vulgare)	SORGHUM (59)	Uganda 1968	2 or 3	3½-4 leaves	6-7 leaves
Rice (Oryza sativa)	RICE (60)	Dickwee	4	2-2½ leaves	5 leaves
Groundnut (Arachis hypogea)	GRNDNUT (64)	Natal Common	2	3-3½ leaves	8½ leaves
Cotton (Gossypium hirsutum)	COTTON (66)	Samaru	2	1-1½ leaves	4 leaves
Tobacco (Nicotiana tabacum)	TOBACCO (69)	Yellow Mammoth	6	2½ leaves	5½-6½ leaves
Eleusine indica	ELEU IND (74)	Kenya 1961	6	4-4½ leaves	8 leaves, tillering
Echinochloa crus-galli	ECH CRUS (75)	WRO 1966	6	3-3½ leaves	6 leaves, tillering
Digitaria sanguinalis	DIG SANG (77)	ex Shell Research 1965	6	4-5 leaves	Several leaves, tillering
Amaranthus retroflexus	AMAR RET (78)	ex Shell Research 1965	6	6-7 leaves	Not recorded
Portulaca oleracea	PORT OLE (79)	Israel 1966	6	4 leaves	Several leaves
Cynodon dactylon	CYN DACT (82)	WRO Clone 2 (ex Sudan)	2+	2-4 stolons	4-5 stolons
Cyperus rotundus	CYP ROTU (86)	WRO Clone 1 (ex Rhodesia)	1**	8-10 leaves	Several leaves

\+ one node rhizome pieces ++ 2 node stolon pieces ** tubers

ABBREVIATIONS

ångstrom	Å	freezing point	f.p.
Abstract	Abs.	from summary	F.s.
acid equivalent*	a.e.	gallon	gal
acre	ac	gallons per hour	gal/h
active ingredient*	a.i.	gallons per acre	gal/ac
approximately equal to*	≃	gas liquid chromatography	GLC
aqueous concentrate	a.c.	gramme	g
bibliography	bibl.	hectare	ha
boiling point	b.p.	hectokilogram	hkg
bushel	bu	high volume	HV
centigrade	C	horse power	hp
centimetre*	cm	hour	h
concentrated	concd	hundredweight*	cwt
concentration	concn	hydrogen ion concentration*	pH
concentration x time product	ct	inch	in.
concentration required to kill 50% test animals	LC50	infra red	i.r.
cubic centimetre*	cm^3	kilogramme	kg
cubic foot*	ft^3	kilo ($x10^3$)	k
cubic inch*	in^3	less than	<
cubic metre*	m^3	litre	l.
cubic yard*	yd^3	low volume	LV
cultivar(s)	cv.	maximum	max.
curie*	Ci	median lethal dose	LD50
degree Celsius*	^oC	medium volume	MV
degree centigrade	^oC	melting point	m.p.
degree Fahrenheit*	^oF	metre	m
diameter	diam.	micro ($x10^{-6}$)	µ
diameter at breast height	d.b.h.	microgramme*	µg
divided by*	: or /	micromicro (pico: $x10^{-12}$)*	µµ
dry matter	d.m.	micrometre (micron)*	µm (or µ)
emulsifiable concentrate	e.c.	micron (micrometre)*†	µm (or µ)
equal to*	=	miles per hour*	mile/h
fluid	fl.	milli ($x10^{-3}$)	m
foot	ft	milliequivalent*	m.equiv.
		milligramme	mg
		millilitre	ml

† The name micrometre is preferred to micron and µm is preferred to µ.

millimetre*	mm
millimicro* (nano: $x10^{-9}$)	n or mμ
minimum	min.
minus	-
minute	min
molar concentration*	M (small cap)
molecule, molecular	mol.
more than	>
multiplied by*	x
normal concentration*	N (small cap)
not dated	n.d.
oil miscible concentrate	o.m.c. (tables only)
organic matter	o.m.
ounce	oz
ounces per gallon	oz/gal
page	p.
pages	pp.
parts per million	ppm
parts per million by volume	ppmv
parts per million by weight	ppmw
percent(age)	%
pico (micromicro: $x10^{-12}$)	p or μμ
pint	pint
pints per acre	pints/ac
plus or minus*	±
post-emergence	post-em
pound	lb
pound per acre*	lb/ac
pounds per minute	lb/min
pound per square inch*	lb/in^2
powder for dry application	p. (tables only)
power take off	p.t.o.
precipitate (noun)	ppt.
pre-emergence	pre-em.
quart	quart
relative humidity	r.h.
revolution per minute*	rev/min
second	s
soluble concentrate	s.c.
soluble powder	s.p.
solution	soln
species (singular)	sp.
species (plural)	spp.
specific gravity	sp. gr.
square foot*	ft^2
square inch	in^2
square metre*	m^2
square root of*	$\sqrt{}$
sub-species*	ssp.
summary	s.
temperature	temp.
ton	ton
tonne	t
ultra-low volume	ULV
ultra violet	u.v.
vapour density	v.d.
vapour pressure	v.p.
varietas	var.
volt	V
volume	vol.
volume per volume	v/v
water soluble powder	w.s.p. (tables only)
watt	W
weight	wt
weight per volume*	w/v
weight per weight*	w/w
wettable powder	w.p.
yard	yd
yards per minute	yd/min

* Those marked * should normally be used in the text as well as in tables etc.

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40. The activity and pre-emergence selectivity of some recently developed herbicides: RP 20810, oxadiazon, chlornitrofen, nitrofen, flamprop--isopropyl. August 1976. W G Richardson, M L Dean and C Parker. Price - £2.75.

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