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SCREENING STRAWBERRIES FOR TOLERANCE TO 96 HERBICIDES
AND GROWTH REGULATORS APPLIED TO THE FOLIAGE AND ROOTS

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NOTE

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The Weed Research Division will have transferred to Long Ashton Research Station by 31 March 1986 and the Begbroke Hill site will be closed. From that date any communications on or further orders for this report should be addressed to Long Ashton Research Station, Bristol BS18 9AF.

SCREENING STRAWBERRIES FOR TOLERANCE TO 96 HERBICIDES AND GROWTH REGULATORS APPLIED TO THE FOLIAGE AND ROOTS

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SUMMARY

Results are presented on the tolerance of strawberries in pot experiments to herbicides applied to the foliage only or to the roots of plants grown in sand culture. Damage ratings are given for foliar treatments and tolerance compared with standard herbicides for root applications. Information on damage symptoms is also given. The 96 chemicals tested were mostly herbicides but included some desiccants and growth regulators. The interpretation of these results is discussed and criteria suggested for deciding on whether further development is justified.

INTRODUCTION

Field evaluation of the tolerance of strawberries to herbicides in the UK is unreliable because of the variability of results between experiments. This variation mainly arises from differences in weather and soils (Clay, 1980a; Clay, 1982). In order to overcome some of these problems and reduce the number of herbicides requiring field testing, an evaluation method using container-grown strawberries was developed at the Weed Research Organization (Clay and Davison, 1978; Clay, 1980a, b). The objectives were to provide a screening method that could deal with a large number of chemicals with the certainty of obtaining definite information on tolerance levels and on the degree of foliage and root activity. In addition the method should give information on the symptoms caused by the herbicides. Two routine test methods were developed to assess the activity of herbicides to foliage or roots separately. The results of these tests are summarised in this report.

The herbicides selected for testing were mainly those already used on other crops in the U.K. and which were known to be active against weeds that were problems in strawberries. Some promising herbicides under development for other crops were also included as were certain desiccants (for runner control) and growth regulators (for runner growth-regulation).

METHODS AND MATERIALS

The cultivar Cambridge Favourite was used in all tests. Plants were bought in from commercial sources as 'special stock' freshly-dug runners in spring or cold-stored runners in July each year, potted and treatments applied the same growing season.

Tests of foliage activity

Runners were potted in 15-20 cm diameter pots in sandy loam soil or soil/peat compost with added P, K and base fertilizer. Plants were grown outdoors and watered overhead as necessary. Herbicides were applied to three or four replicate plants using a laboratory pot sprayer fitted with an

* formerly the Weed Research Organization (WRO)

80015E or 8002E TeeJet and giving a volume rate from 240 to 480 l/ha according to requirements at a pressure of 210 kPa. Spray was prevented from reaching the soil surface by a layer of polystyrene granules or paper which was removed after spraying. Commercial formulations of herbicides were used (Table 2) at the dose normally required for weed control and at one or two higher doses. After spraying, plants were placed outside in randomised blocks on a pot standing area which could be covered when necessary by a mobile transparent cover to give rain protection. Subsequent watering was to the soil surface, avoiding wetting of the foliage.

Herbicide effects were assessed visually at intervals after treatment by scoring plant condition on a 0-9 scale shown in Table 1.

Symptoms of herbicide damage were recorded at the time of scoring using an abbreviation system shown in Table 3 (page 16). The symbols represent symptoms caused by any or all doses. Fresh weight of leaves was recorded at the end of the experiment, usually about 6 weeks after treatment.

<u>Tests of activity from root applications</u>

Runners were potted in washed silica sand in 25 cm diameter pots and grown outside. A typical sand-particle size analysis is given by Clay and Davison (1978). Pots were watered with a dilute nutrient solution (Clay and Davison, 1978), by flooding the surface of each pot with liquid when required. At the time of treatment, usually 4-6 weeks after potting, plants were moved to a rain-protected area and placed in aluminium foil saucers to prevent loss of herbicide solution. Appropriate doses of the herbicides were applied in 500 ml nutrient solution to the sand such that the surface was flooded but contact with leaves was minimised. Treatments were randomised, with normally three or four blocks. Nutrient solution was subsequently applied to the sand surface when needed by hose/rose watering. Assessments were the same as for the foliage-activity tests, the final assessment usually being 6-8 weeks after treatment.

For tests of activity via roots, ED20 and ED50 values (doses causing 20 or 50% growth inhibition respectively) were calculated using a computer programme (see Clay 1980a). In some instances where there was a very rapid change from nil to complete inhibition between adjacent herbicide doses, computation was not possible so ED values were calculated graphically. To help comparison of tolerance between different experiments, Tolerance Indices (TI) were calculated for each herbicide in relation to the simazine standard (Clay 1980a);

TI = ED20 value for test herbicide/ED20 value for simazine.

Also to aid comparisons between experiments the Response Index (Clay 1980a) was calculated for each herbicide; this indicates the rate of change of response with increasing dose

RI = ED50/E20

The TI values given in Table 2 for each herbicide are the lower of those obtained at the final assessment of plant vigour or leaf fresh weight; the corresponding RI value is also given. With some herbicides no ED values were obtained either because all doses tested caused >50% damage or <20% damage. In these instances TI values are given as <the lowest or >highest dose tested and the RI is given as not recordable (NR). In a few cases where the chemical had an effect only at the highest dose ED20 values only were obtained, so no RI was calculated.

In each experiment one or more standard herbicides were included against which the activity of the test herbicide could be compared. The standards were phenmedipham and simazine for the foliage-activity and root-activity tests respectively. Other standard herbicides were sometimes included which were similar in mode of action or type of activity to particular test herbicides e.g. paraquat where potential desiccants were being tested.

RESULTS

The results of the tests on each herbicide are summarised in Table 2 with cross referencing, on the basis of Expt numbers, to the more detailed results for each experiment given in Tables 4-19. Where standard herbicides apart from simazine were tested on a number of occasions the results for the first test only are given in Table 2.

In Table 2 a damage rating is given for the overall effect of herbicides in the foliage-activity test. This is based on results of both visual scores and fresh weight measurements and gives an indication of tolerance at a standard dose as a basis for comparing herbicides in different tests. The rating criteria are shown in Table 1. With herbicides that are safe at normal doses response to higher doses gives some information on the margin of tolerance.

Results for individual experiments are given in Tables 4-19 . Relevant dates for treatments and assessments are included, together with meteorological data for the treatment date and results for visual and quantitative assessments.

DISCUSSION

The objective of the screening was to reduce the number of new herbicides tested in field experiments since experiments on container-grown plants are more economical in resources and more likely to produce definite results. The tests were carried out in the growing season to ensure that the herbicides had maximum effect and to give more rapid results. Also other factors were less likely to interfere with response. By comparing effects of test herbicides with those of herbicides already in use decisions on their likely selective use in strawberries should be easier.

Presentation of the results for herbicides alphabetically and on the basis of Selectivity Ratings for foliar-activity tests and Tolerance and Response Indices for root-activity tests (Table 2) is designed to enable products of interest to be selected readily. These assessments can only be estimates of tolerance and are not precise since values can differ according to the type of assessment and between experiments carried out in different conditions.

The interpretation of the information from tests of foliar and root activity is usually complex. In the simplest situation the new herbicide shows little or no activity in either test and can therefore be assumed to be potentially safe for use at any time of year at any crop age e.g alloxydim. Conversely some herbicides are so damaging through foliage and/or root uptake that selective use can be ruled out e.g. fluroxypyr. But a large number of herbicides are of intermediate toxicity and decisions as to their likely use can only be made by comparing their tolerance in these tests with that of recommended herbicides. In practice even the recommended herbicides can cause damage in some circumstances. Factors conducive to damage include: soil type e.g. leaf yellowing and necrosis from lenacil on very light soils; time of year e.g. simazine used on established strawberries is safe in autumn but not spring; weather conditions e.g. leaf damage from spraying phenmedipham on to soft growth in hot weather; plant size e.g. unacceptable damage on young plants but not established plants with clopyralid, simazine and 2,4-D amine. In addition, adverse effects from a herbicide may be acceptable to growers if there is no alternative herbicide e.g. slight formative effects caused by clopyralid when used for Cirsium arvense control and severe epinasty from 2,4-D amine when used for Convolvulus arvensis control; thus some phytotoxicity in use does not exclude a herbicide from consideration.

Therefore with all herbicides weather, plant age and season of application must be considered and with soil-acting herbicides, soil type and organic matter content as well. The influence of soil type on activity of residual herbicides is reflected in the recommendations for their use e.g. propyzamide not recommended in light soils; doses of lenacil and simazine adjusted according to soil texture with no recommendations on organic soils. How then should the results from sand culture tests be interpreted? The Tolerance Indices relate the toxicity of the test herbicide to that of simazine, a herbicide in widespread use but only safe in some situations. Prediction as to the relative safety of the new herbicide can therefore be made on the basis of the Tolerance Index, the dose required for weed control and the relative availability of the herbicide to the roots of the crop in the field compared with simazine. For most residual herbicides availability in the soil depends on adsorption on soil constituents, downward movement under the influence of rain or irrigation and persistence in the soil; however the importance of each factor varies between herbicides and soils. For example the TI for simazine and terbacil is similar but in practice terbacil is much more toxic because of its greater leaching in soil. Decisions as to safety are therefore a matter of judgement made on the basis of what is known of the properties of the herbicide and its behaviour in soil and the relative tolerance of strawberries at different ages and seasons and in different cultural systems.

The Response Index for the root treatment experiments given in the Tables indicates the effect of dose on response of the plants and this information may be valuable in predicting the likely effects of overdosing in the field. Where the tolerance margin is small a herbicide with a low RI is more likely to give damage with overdosing. In general photosynthesis-inhibitor herbicides have given consistently low RI's, whereas those for herbicides causing general or root growth inhibition are often higher. This may partly result from growing conditions; moisture in the sand in the pots is never limiting and this will reduce the immediate effect of root damage. The full effects of the more damaging doses of such herbicides may take longer to develop than allowed for in these tests (Clay 1980a).

To help in interpreting results and predicting field performance the main factors influencing the tolerance of strawberries to residual herbicides are listed below. This list is a generalisation and certain herbicides may give different effects to the norm

Crop factors	LEAST TOLERANCE		GREATEST TOLERANCE
1. Crop age	Newly-planted		Established plants (rooted for 1 year or more)
2. Crop vigour	weak (e.g. due to disease)		strong, healthy
3. Season of application	spring mid summer (+ irrigation)	summer	autumn, winter
4. Cultural method	matted rows (especially year of establishment)		spaced plants
5. Cultivar		varies with herbicide	
Soil factors			
1. Texture	v. light	medium	heavy
2. Moisture retention	low (gravelly soils free draining)		high
3. Compaction	compacted (shallow rooting)		good structure
4. Organic matter	low (2% or less)		high
Herbicide			
1. Adsorption	low (greater availability and leaching)		high
2. Persistence	long (longer exposure)		short

In spite of the complexity of interpretation a good indication of potential tolerance is given by comparing the response of a test product in these experiments with results for those already recommended in the crop (MAFF, 1982). It will be seen that relative values for recommended herbicides reflect the doses/situations in which they can be used in the crop whether restricted in terms of soil/season/dose or not e.g. chloroxuron and chlorthal-dimethyl, little restriction, compared with lenacil and simazine more restriction. One extra factor that has to be added to inferences from the TI values is the dose at which herbicides are used since this is not allowed for in the Tolerance Indices given. Thus a herbicide may appear to be similar in toxicity to simazine but in practice has to be used at much higher doses making it less likely to be safe in the crop.

There are a number of additional factors affecting response in the field which are unlikely to be detected in pot tests but must be considered. These include:

1. Herbicide volatility causing damage after spraying
2 Breakdown in soil to more toxic products
3. Transfer of herbicide by rain from sprayed leaves to more sensitive sites of uptake e.g. crown meristems or emerging leaves.
4. Splashing of herbicide from treated soil on to young foliage to give damage.
5. Effects of spraying during flower initiation on subsequent flowering and fruiting.
6. Translocation of herbicide through stolons in young matted row crops.

Information on some of these factors which affect tolerance may already be available from other work or by extrapolation from herbicides with similar modes of action.

With new legislation on the registration and use of pesticides in the U.K. imminent, which is likely to permit parties to apply for Approval of 'off-label' uses, there may be wider interest in developing treatments for minor crops such as strawberries. The type of information given in this report may help in selecting products for such uses but a number of issues relating to efficiency, economics and toxicity must be considered. Some of these are listed in Appendix 1.

A further use of the information in this report for advisers etc. is to indicate the symptoms to be expected should one of the herbicides listed be suspected of giving damage to the crop. While the symptoms described may not be comprehensive and a variety of herbicides and other agents or nutrient deficiencies can cause similar symptoms, the results will give some information on what to expect.

The results in this report are presented in the hope that they will give useful information about the response of strawberries to each herbicide, and any potential for selective use. In view of the need for careful interpretation of results from pot tests it is not realistic to list potentially useful herbicide treatments, but the results have been used to select herbicides for field testing at WRO and in collaborative work with other research institutes and ADAS (see list in References section). A number of recommendations have stemmed from this work.

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REFERENCES

BAILEY, J.A. and CLAY, D.V. (1980) The safety and efficacy of 3,6-dichloropicolinic acid for the control of _Cirsium arvense_ in strawberries. _Proceedings 1980 British Crop Protection Conference - Weeds_, 321-328.

CLAY, D.V. (1972) The response of strawberry to a range of foliage-acting herbicides. _Proceedings 11th British Weed Control Conference_, 409-416.

CLAY, D.V. (1978) The response of strawberries to propachlor, pendimethalin and trifluralin, used alone, in mixture or sequentially. _Proceedings 1978 British Crop Protection Conference - Weeds_, 175-182.

CLAY, D.V. (1980a) Indices and criteria for comparing the tolerance of strawberries to herbicides in dose-response experiments. _Weed Research_, _20_, 91-96.

CLAY, D.V. (1980b) The use of separate root and shoot tests in the screening of herbicides for strawberries. _Weed Research_, _20_, 97-102.

CLAY, D.V. (1980c) The effect of application timing and formulation on the tolerance of strawberries to oxadiazon. _Proceedings 1980 British Crop Protection Conference - Weeds_, 337-344.

CLAY, D.V. and DAVISON, J.G. (1978) An evaluation of sand culture techniques for studying the tolerance of fruit crops to soil-acting herbicides. _Weed Research_, _18_, 139-147.

CLAY, D.V.; RUTHERFORD, S.J. and WISEMAN, J.S. (1974) New herbicides for strawberries: crop tolerance and weed control performance. _Proceedings 12th British Weed Control Conference_, 337-344.

MAFF (1982) _Weed Control in Strawberries_, Booklet 2255 pp 30. MAFF Publications Alnwick, Northumberland NE66 2PF. (new revision pending)

Table 1

Explanation of tolerance and response indices, foliage damage rating and damage scoring scale

Tolerance index used to compare response to root applications

$$\text{Tolerance index (T.I.)} = \frac{\text{ED20 test herbicide}}{\text{ED20 simazine}}$$

Response index used to compare rate of change of response with dose

$$\text{Response index (R.I.)} = \frac{\text{ED50}}{\text{ED20}} \text{ test herbicide}$$

Damage rating scale used to summarize response to foliar sprays (Table 2)

Damage rating	
o	no apparent damage
*	slight transient damage
**	moderate damage, some subsequent recovery
***	Severe damage, little or no recovery

Plant damage scoring scale, 0-9, used in Tables 4-19

9 = healthiest control plant

7 = obvious damage, growth reduction (c. 15%)

5 = 50% growth inhibition

3 = severe leaf damage/growth reduction (c. 85%) but some growth from youngest leaves

1 = all leaf dead

0 = plant dead

Table 2

Summary of response to herbicides applied to foliage or roots

Herbicide	Formulation	% Concn	Root activity TI	RI	Expt No.	Foliar activity Dose (kg/ha)	Leaf wt % Untr.	Damage Rating	Expt No.
AC222293	w.p.	50	1.7	6.9	76/81	1.0	86	**	74/81
						3.0	96	**	
Acifluorfen	e.c.	24	11	2.4	73/80	1.5	83	*	74/80
						3.0	94	**	
						6.0	80	***	
Alachlor	e.c.	48	49	4.4	73/80	2.25	102	0	74/80
						4.5	90	*	
						9.0	99	**	
Alloxydim	w.s.p.	75	185	2.3	73/80	1.5	105	0	72/78
						3.0	115	*	
						6.0	103	*	
Ametryn	w.p.	80	0.3	2.3	10/73	1.0	59	**	17/73
						2.0	62	**	
						4.0	52	**	
Amitrole++	a.c.	20	1.5	2.3	10/73	1.1	71	***	74/83
						4.4	7	***	
Ammonium sulphamate	w.s.p.	97	144	2.7	71/78	250	13	***	72/78
						500	0	***	
						1000	0	***	
Asulam	a.c.	40	44	2.5	9/74	1.1	48	***	10/74
						2.2	37	***	
						4.4	19	***	
Aziprotryne	w.p.	50	1.6	1.4	16/73	2.0	65	**	17/73
						4.0	61	**	
						8.0	50	**	
Benazolin	a.c. K salt	25	0.5	5.7	76/81	0.2	95	**	74/81
						0.6	73	***	
Bentazone	w.p.	50	7.7	7.1	16/73	2.0	74	**	17/73
						4.0	50	***	
						8.0	17	***	
Benzadox	a.c.	24	31	NR	9/74	1.4	49	**	10/74
						2.8	58	**	
						5.6	41	**	

++ + ammonium thiocyanate as Weedazol TL

Herbicide	Formu-lation	% Concn	Root activity TI	RI	Expt No.	Foliar activity Dose (kg/ha)	Leaf wt % Untr.	Damage Rating	Expt No.
Bifenox	w.p.	80	>142	NR°	16/73	2.0	111	*	17/73
						4.0	98	*	
						8.0	104	*	
Bromacil	w.p.	80	0.3	2.7	10/73	-	-	-	-
Bromofenoxim + terbuthy-lazine (Mofix 500L)	e.c.	50	-	-	-	0.5	50	**	72/78
						1.5	32	**	
						4.5	6	***	
Bromoxynil + ioxynil (Oxytril C.M.)	e.c.	40	-	-	-	0.75	45	**	72/78
						2.25	17	***	
						6.75	1	***	
Buminaphos	e.c.	40	188	NR	73/80	1.0	94	*	74/80
						3.0	75	**	
						9.0	90	**	
Carbetamide	w.p.	70	<3	NR	9/74	2.1	88	0	10/74
						4.2	100	0	
						8.4	60	**	
Chlorbromuron	w.p.	50	0.9	1.4	16/73	1.0	58	**	17/73
						2.0	54	**	
						4.0	50	**	
Chloridazon	w.p.	80	4.6	2.0	10/73	++			
Chlornitrofen	e.c.	20	> 57	NR	16/73	2.0	111	*	17/73
						4.0	79	*	
						8.0	99	*	
Chloroxuron	w.p.	50	129	7.7	10/73	4.0	109	0	17/73
						8.0	108	0	
						16.0	111	0	
Chlorpropham	e.c.	40	<0.9	NR	10/73	-	-	-	-
Chlorsulfuron	d.f.	20	0.003	4.4	73/80	0.005	17	***	74/80
						0.025	4	***	
						0.125	0	***	
						0.625	0	***	
Chlorthal-dimethyl	w.p.	75	>142	NR	16/73	4	109	0	17/73
						8	106	0	
						16	113	*	
Clopyralid	a.c.	10	0.3	9.1	71/78	0.05	100	*	72/78
						0.2	108	*	
						0.8	95	**	

° NR = not recordable
++ see Clay (1972)

Herbicide	Formulation	% Concn.	Root activity TI	RI	Expt No	Foliar activity Dose (kg/ha)	Leaf wt % Untr.	Damage Rating	Expt No.
Cyanazine	s.c.	50	0.8	1.9	16/73	2.0	92	*	17/73
						4.0	60	**	
						8.0	61	**	
Cycloate	e.c.	72	4.5	3.1	71/78	-	-	-	-
2,4-D (amine)	a.c.	32 a.e.	-	-	-	2.0	102	*	17/73
						4.0	95	**	
						8.0	51	***	
Dalapon	w.s.p.	72	4.7	15	10/73	-	-	-	-
Dikegulac	w.s.p.	20	50	2.9	76/81	2.0	69	***	74/81
						6.0	47	***	
Dimefuron	w.p.	50	0.3	1.5	72/75	1.25	78	*	10/74
						2.5	95	*	
						5.0	84	*	
Dinoseb	e.c.	25	-	-	-	2.5	9	***	74/81
						7.5	0	***	
Diphenamid	w.p.	50	19	2.8	73/80	4.5	94	0	74/80
						9.0	101	0	
						18.0	101	0	
Diuron	w.p.	80	0.2	2.0	75/83	0.5	92	**	74/83
						1.0	87	**	
						2.0	79	**	
Dowco 453	e.c.	10.4	25	4.8	78/82	0.1	97	*	77/82
						0.4	83	**	
EPTC	e.c.	72	7.5	3.5	71/78	-	-	-	-
Ethofumesate	e.c.	20	27	2.4	16/73	1.0	104	0	17/73
						2.0	111	0	
						4.0	103	*	
FBC 32197	e.c.	10	10	4.2	78/82	0.4	119	0	77/82
						1.6	100	*	
Fluazifop	e.c.	25	65	1.6	73/80	0.75	100	0	74/80
						1.5	103	0	
						3.0	100	*	
Fluroxypyr	e.c.	25	0.1	2.9	75/83	0.2	28	***	74/83
						0.6	0	***	
Fosamine	w.s.1	41.5	-	-	-	2.25	92	0	72/78
						5.0	106	*	
						10.0	100	*	
						20.0	80	**	
						40.0	56	***	

Herbicide	Formulation	% Concn.	Root activity TI	RI	Expt No.	Foliar activity Dose (kg/ha)	Leaf wt % Untr.	Damage Rating	Expt No.
Glufosinate	w.s.c.	20	8.0	5.2	76/81	0.5	5.0	***	74/81
						1.5	0.0	***	
Glyphosate	a.c.	36	17	5.2	10/73	++	-	-	-
Hexazinone	w.s.p.	90	0.1	1.6	73/80	2.0	36	**	74/80
						4.0	0	***	
						8.0	0	***	
Ioxynil	e.c.	25	-	-	-	0.75	44	**	72/78
						2.25	28	**	
						6.75	12	***	
Isocarbamid	w.p.	80	35	1.6	16/73	4.0	95	*	17/73
						8.0	86	*	
						16.0	111	*	
Isoproturon	w.p.	75	<1	NR	9/74	1.0	62	**	10/74
						2.0	47	**	
						4.0	11	***	
Lenacil	w.p.	80	3.2	4.3	10/73	2.0	116	0	17/73
						4.0	100	0	
						8.0	107	0	
Linuron	w.p.	50	1.2	2.1	16/73	1.0	58	**	17/73
						2.0	57	**	
						4.0	48	**	
MBR 18337	w.s.c.	24	6.6	9.2	76/81	0.25	Grown on	**	74/81
						0.75		**	
MCPA	a.c. K salt	25 a.e.	-	-	-	1.0	74	**	17/73
						2.0	61	***	
						4.0	17	***	
						8.0	0	***	
MCPB	a.c. Na salt	40 a.e.	-	-	-	1.0	52	***	17/73
						2.0	16	***	
						4.0	14	***	
						8.0	1	***	
Mecoprop	a.c. K salt	63 a.e.	-	-	-	1.0	85	**	17/73
						2.0	73	**	
						4.0	46	***	
						8.0	0	***	
Mefluidide	a.c.	24	8.5	6.3	76/81	0.25	Grown on	**	74/81
						0.75		**	
Metamitron	w.p.	70	5.4	2.9	9/74	1.5	90	*	10/74
						3.0	75	**	
						6.0	79	**	

++ see Clay (1972)

Herbicide	Formulation	% Concn.	Root activity TI	RI	Expt No.	Foliar activity Dose (kg/ha)	Leaf wt % Untr.	Damage Rating	Expt No.
Metazachlor	s.c.	50	0.6	40	78/82	1.25	86	**	77/82
						3.75	62	***	
Methabenz-thiazuron	w.p.	70	1.7	1.2	72/75	++	-	-	-
Methazole	w.p.	75	0.9	2.0	16/73	1.5	66	**	17/73
						3.0	71	**	
						6.0	56	**	
Metobromuron	w.p.	50	0.7	1.7	16/73	1.0	62	**	17/73
						2.0	58	**	
						4.0	45	**	
Metoxuron	-	-	-	-	-	++	-	-	-
Monisouron	w.p.	50	0.2	NR	76/81	0.25	68	**	74/81
						0.75	59	**	
Napropamide	w.p.	50	6.0	5.4	78/82	3.0	104	*	77/82
						9.0	120	*	
Norflurazon	w.p.	80	1.4	7.3	16/73	1.0	101	0	17/73
						2.0	94	0	
						4.0	92	0	
Oxadiazon	e.c.	25	>57	NR	16/73	1.25	52	**	10/74
						2.5	34	***	
						5.0	28	***	
Oxyfluorfen	e.c.	24	4.0	8.9	9/74	0.5	45	**	10/74
						1.0	36	***	
						2.0	29	***	
Paclobutrazol	s.c.	25	0.3	NR	76/81	1.0	Grown on	***	74/81
						3.0		***	
Paraquat	a.c.	20	-	-	-	0.56	3	***	72/78
						1.12	0	***	
						2.24	0	***	
Pendimethalin	e.c.	33	3.9	3.2	16/73	1.0	101	*	17/73
						2.0	102	*	
						4.0	112	*	
Pentanochlor	e.c.	40	>142	NR	16/73	2.0	112	*	17/73
						4.0	98	*	
						8.0	79	**	

++ see Clay (1972)

Herbicide	Formulation	% Concn	Root activity TI	RI	Expt No.	Foliar activity Dose (kg/ha)	Leaf wt % Untr.	Damage Rating	Expt No.
Perfluidone	w.p.	50	>71	NR	16/73	1.0	108	0	17/73
						2.0	89	*	
						4.0	102	0	
Phenmedipham	e.c.	11.4	-	-	-	1.0	108	0	17/73
						2.0	114	0	
						4.0	106	*	
Prodiamine	w.p.	50	21	NR	71/78	1.1	120	0	72/78
						2.2	103	*	
						4.4	112	*	
Prometryn	w.p.	50	0.5	1.7	10/73	1.0	73	**	17/73
						2.0	54	***	
						4.0	27	***	
Propachlor	w.p.	65	75	2.8	16/73	4.5	116	*	17/73
						9.0	97	*	
						18.0	104	*	
Propyzamide	w.p.	50	1.0	1.6	10/73	1.0	108	0	17/73
						2.0	107	0	
						4.0	109	0	
Pyridate	w.p.	50	>337	NR	78/82	2.0	75	**	77/82
						6.0	64	**	
R 40244	e.c.	24	1.2	NR	78/82	0.5	53	**	77/82
						1.5	22	***	
RU 12068	w.p.	75	3.3	2.0	16/73	1.0	106	0	17/73
						2.0	95	0	
						4.0	101	0	
RU 12709	w.p.	75	0.9	1.6	16/73	1.0	97	*	17/73
						2.0	67	**	
						4.0	59	**	
SAN 52123	w.p.	80	1.4	1.5	16/73	1.0	86	**	17/73
						2.0	76	**	
						4.0	77	**	
Sethoxydim	e.c.	18.4	44	2.6	73/80	1.5	90	*	74/80
						3.0	115	**	
						6.0	76	**	
Simazine	w.p.	50	1	1.6	10/73	1.0	111	0	17/73
						2.0	97	0	
						4.0	101	0	
SMA	w.s.p	90	67	2.3	71/78	22.5	46	***	74/81
						67.5	7	***	

Herbicide	Formulation	% Concn	Root activity TI	RI	Expt No.	Foliar activity Dose (kg.ha)	Leaf wt % Untr.	Damage Rating	Expt No
SMA (Herbon Ion)	w.p.	75	-	-	-	22.5	0	***	74/81
						67.5	0	***	
Sodium Chlorate	w.s.p	100	151	16	16/73	100	51	**	17/73
						200	42	***	
						400	32	***	
TCA	w.s.p	81	48	8.0	10/73	-	-	-	-
Tebutam	e.c.	72	40	3.5	73/80	4.3	105	*	74/80
						8.6	105	**	
						17.2	66	***	
Tebuthiuron	w.p.	80	-	-	-	1.0	31	***	10/74
						2.0	26	***	
						4.0	0	***	
Terbacil	w.p.	80	0.9	2.4	10/73	0.5	93	*	17/73
						1.0	87	*	
						2.0	66	**	
Terbuthylazine	w.p.	80	1.2	2.1	16/73	1.0	78	**	17/73
						2.0	79	**	
						4.0	65	***	
Terbutryn	w.p.	50	1.2	3.8	16/73	1.0	58	**	17/73
						2.0	42	**	
						4.0	32	***	
Triclopyr (ester)	e.c.	48	0.6	1.6	71/78	0.2	3	***	72/78
						0.8	0	***	
						3.2	0	***	
Trietazine	w.p.	50	8.1	2.0	10/73	1.0	105	*	17/73
						2.0	99	*	
						4.0	111	*	
						8.0	87	*	
Trietazine + simazine (Remtal)	w.p.	56	-	-	-	1.37	98	*	72/78
						2.74	101	*	
						5.48	84	*	
Trifluralin	e.c.	48	3.0	3.1	10/73	-	-	-	-
Trifop-methyl	e.c.	36	25	2.6	17/78	1.5	80	**	72/78
						3.0	91	**	
						6.0	91	**	
U 27267	w.p.	75	40	1.9	16/73	2.0	100	*	17/73
						4.0	112	*	
						8.0	113	*	
UNI-N252	w.p.	50	-	-	-	0.5	99	*	72/78
						1.5	112	*	
						4.5	88	**	

Table 3

Symbols used for describing herbicide damage symptoms on leaves

Code	Type of symptom
b	flaccid
c	chlorosis (general yellowing)
e	epinasty
f	formative effects (typical of some phenoxy alkanoic 'hormone' herbicides)
h	thickening
k	distortion
l	curl, rolling
n	necrosis (death of tissue)
r	discolouration (from normal)
s	stunting
t	translocated effect (from foliar sprays)
w	shiny surface on young leaves
x	many small new leaves
y	senescence (abnormal)
A	normal new leaves being produced

Suffix code

	Extent or zone of damage (chlorosis or necrosis)
(i)	interveinal
(m)	marginal
(o)	discrete spots
(p)	irregular patches
(t)	tip
(v)	veinal
(y)	young leaves only affected

	Type of leaf curling effect
(d)	towards upper surface
(s)	side to middle
(t)	towards lower surface

Table 4

Summary - Foliage treatments Expt 17/73

Planted: July 1973
Treated: 14.8.73
Spray volume 413 l/ha
Met data on 14.8.73
Temps ^{o}C: 9 a.m. 16.3
Max. 23.8 Min. 11.5
% RH: 93
Sunshine hours: n.a.*

Assessments:
Score 1 12.9.73
Score 2 12.10.73
Fresh wt 15.10.73

Results

Herbicide	Dose kg/ha	Score (0-9) 4 wks	Score (0-9) 8 wks	F. Weight % Control	Symptoms
Ametryn	1	4.7	7.7	59	n(mi)cnA
	2	5.0	6.3	62	
	4	3.7	6.0	52	
Aziprotryne	2	5.3	6.3	65	
	4	4.3	6.0	61	cnA
	8	4.0	5.7	50	
Bentazone	2	5.7	7.0	74	
	4	4.3	6.7	50	c(y)nx
	8	2.0	2.3	17	
Bifenox	1	7.3	7.7	111	
	2	6.7	7.0	98	r(o)rk(y)
	4	6.3	7.0	104	sA
Chlorbromuron	1	5.7	7.0	58	
	2	4.3	6.7	54	cnA
	4	4.7	6.7	50	
Chloroxuron	4	8.7	9.0	109	
	8	8.7	9.0	108	b(y)l(y)c(m)A
	16	8.3	8.3	111	
Chlornitrofen	2	7.7	7.7	111	
	4	7.3	7.7	79	rs(y)k(y)A
	8	6.7	7.3	99	
Chlorthal-dimethyl	2	9.0	8.7	119	
	4	9.0	9.0	109	
	8	9.0	8.3	106	
	16	8.3	8.3	113	c(my)
Cyanazine	2	6.7	7.3	92	
	4	5.7	6.7	60	cn
	8	5.7	6.0	61	

* not available

Table 4 cont'd

Summary - Foliage treatments <u>Expt 17/73</u> cont'd

Herbicide	Dose kg/ha	Score (0-9) 4 wks	8 wks	F. Weight % Control	Symptoms
2,4-D (amine)	1	5.3	6.3	87	
	2	4.7	6.3	102	
	4	4.7	5.7	95	erl(y)nf(y)
	8	4.0	3.7	51	
Ethofumesate	1	9.0	9.0	104	c(y)w(y)xsA
	2	8.7	9.0	111	
	4	7.3	7.7	103	
Isocarbamid	4	7.0	7.0	95	c(mp)r(m)
	8	6.3	7.0	86	n(m)A
	16	6.3	7.3	111	
Lenacil	2	9.0	9.0	116	
	4	9.0	9.0	100	
	8	9.0	9.0	107	
Linuron	1	4.3	7.3	58	
	2	5.3	7.3	57	nA
	4	4.3	5.7	48	
MBR 8251	1	9.0	8.7	108	
	2	8.7	8.3	89	
	4	8.7	9.0	102	c(y)
MCPA (K salt)	1	4.0	3.7	74	
	2	3.7	3.0	61	ernl(y)f(y)x
	4	2.0	1.0	17	
	8	1.0	0	0	
MCPB (Na salt)	1	4.0	4.0	52	
	2	3.3	2.3	16	
	4	2.7	2.0	14	eryb(y)f(y)x
	8	1.3	0.3	1	
Mecoprop (K salt)	1	6.0	5.7	85	
	2	5.3	5.3	73	
	4	4.7	5.0	46	ernx
	8	1.3	0	0	
Metabromuron	1	5.3	7.0	62	c(m)n(mi)nA
	2	4.3	6.7	58	
	4	4.7	6.7	45	
Methazole	1.5	6.0	7.0	66	
	3	5.7	7.3	71	cn(i)nA

Table 4 cont'd

Summary - Foliage treatments. Expt 17/73 cont'd

Herbicide	Dose kg/ha	Score (0-9) 4 weeks	8 weeks	F. weight % control	Symptoms
Norflurazon	1	8.7	8.7	101	
	2	8.3	8.3	94	c(vpy)A
	4	9.0	9.0	92	
Oxadiazon	1	6.3	7.3	74	
	2	6.0	7.3	91	r(oy) rn A
	4	6.0	6.7	86	
Pendimethalin	1	6.7	6.7	101	
	2	6.0	6.7	102	c (py) l(sd)
	4	6.0	6.3	112	s(y)
Pentanochlor	2	7.0	7.7	112	
	4	6.3	7.0	98	r (oy) n c(y) A
	8	6.3	7.3	79	
Phenmedipham*	1	8.0	9.0	108	
	2	8.3	8.7	114	c (pm) nc A
Prometryn	1	6.0	6.7	73	n(i) c(m) cn A
	2	4.7	6.7	54	
	4	3.0	4.3	27	
Propachlor	4.5	8.3	7.7	116	
	9	7.0	7.0	97	n(p) c(vy)rn A
	18	6.7	7.0	104	
Propyzamide	1	9.0	9.0	108	
	2	8.7	9.0	107	c(p) A
	4	9.0	9.0	109	
RU 12068	1	9.0	9.0	106	
	2	8.7	9.0	95	c(o)
	4	8.3	8.3	101	
RU 12709	1	7.3	8.0	97	c(m)n A
	2	5.3	6.0	67	
	4	5.0	7.0	59	
SAN 52123	1	6.0	7.3	86	c(m)n(m)A
	2	6.3	8.0	76	
	4	5.7	7.0	77	
Simazine	1	9.0	9.0	111	
	2	9.0	9.0	97	
	4	8.3	9.0	101	c

* Spray volume 225 l/ha

Table 4 cont'd

Summary - Foliage treatments. Expt 17/73 cont'd

Herbicide	Dose kg/ha	Score (0-9) 4 weeks	8 weeks	F. weight % control	Symptoms
Sodium chlorate	100	4.7	5.3	51	c(v)cnsA
	200	4.3	5.0	42	
	400	3.7	4.3	32	
Terbacil	0.5	7.0	7.7	93	
	1	6.3	7.3	87	c(m) cn A
	2	6.0	7.0	66	
Terbuthylazine	1	6.0	6.7	78	cnA
	2	6.0	7.0	79	
	4	5.7	6.0	65	
Terbutryn	1	4.7	7.0	58	
	2	4.0	6.0	42	c(m)n(i)nA
	4	3.0	4.7	32	
Trietazine	1	7.3	8.0	105	c(m)nA
	2	7.3	7.7	99	
	4	7.0	7.0	111	
	8	6.3	7.0	87	
U27267	2	8.3	9.0	100	sA
	4	9.0	8.7	112	
	8	9.0	8.7	113	
Untreated controls	-	9.0	9.0	100 (46.6 g)	
S.E. $\pm$ (treated v untreated)		0.24	0.32	2.6	

Table 5

Summary - foliage treatments   Expt 10/74

Planted: July 1974
Treated: 14.8.74
Spray volume rate 413 l/ha

Assessments:
Score 1 13.9.74
Score 2 2.10.74
Fresh wt 10.10.74

Met data on 14.8.74
Temps ^{o}C: 9 a.m. 19.1
Max. 20.6 Min. 15.3
RH%: 91
Sunshine hours: 11.4

Results

Herbicide	Dose kg/ha	Score (0-9) 4 weeks	8 weeks	Fresh wt % control	Symptoms
Asulam	1.1	5.0	5.3	48	
	2.2	4.7	3.3	37	c(y)sn
	4.4	4.3	2.3	19	
Bentazone	1.5	2.3	3.3	13	cns
	2.0	3.3	3.3	18	
	3.0	2.3	3.0	9	
Benzadox	1.4	5.3	7.7	49	
	2.8	5.7	7.0	58	csl(sty)n
	5.6	5.3	5.7	41	
Carbetamide	2.1	8.7	9.0	88	
	4.2	8.3	8.7	100	c(y)s l(st)
	8.4	6.0	6.3	60	
Dimefuron	1.25	8.3	8.0	78	
	2.5	8.7	9.0	95	c(mp)n(o)nA
	5.0	8.0	9.0	84	
Ethofumesate	1.0	8.7	9.0	100	n(o)cwA
	2.0	9.0	9.0	100	
	4.0	9.0	9.0	81	
Isoproturon	1.0	7.0	8.3	62	cnA
	2.0	6.7	7.0	47	
	4.0	3.3	3.7	11	
Lenacil	1.0	8.0	9.0	92	
	2.0	8.0	9.0	80	
	4.0	9.0	9.0	96	
Metamitron	1.5	7.3	8.7	90	c(im)n(m)nA
	3.0	7.0	8.3	75	
	6.0	8.0	8.7	79	

Table 5 cont'd

Summary - foliage treatments. Expt 10/74 cont'd

Herbicide	Dose kg/ha	Score (0-9) 4 weeks	8 weeks	Fresh wt % control	Symptoms
Oxadiazon	1.25	7.0	8.0	52	
	2.5	5.0	7.3	34	n
	5.0	3.3	4.0	28	
Oxyfluorfen (50% wp)	0.25	9.0	9.0	106	
	0.5	9.0	9.0	113	
	1.0	8.7	9.0	97	
	2.0	9.0	8.7	94	s
Oxyfluorfen (ec)	0.25	5.7	8.0	51	
	0.5	5.7	7.3	45	c (m) n s
	1.0	5.0	6.0	36	
	2.0	5.3	6.7	29	
Pendimethalin	0.5	8.7	9.0	103	c(y)l(sd)s
	1.0	8.0	8.7	91	
	2.0	8.3	8.7	87	
	4.0	8.3	8.0	75	
Phenmedipham*	0.8	8.0	9.0	106	
	1.1	8.3	9.0	89	
	2.2	7.3	9.0	86	c (p) n(o)nA
Tebuthiuron	1.0	5.0	7.7	31	c (m) n
	2.0	4.7	4.7	26	
	4.0	0.0	0.0	0	
Trietazine	1.0	7.0	8.7	80	c(m)n(m)A
	2.0	7.0	9.0	77	
	4.0	6.7	8.3	67	
Untreated control		9.0	9.0	100 (69.0 g)	
S.E. $\pm$ (treated v untreated)		0.24	0.33	8.6	

* Spray volume rate 224 l/ha

Table 6

Summary - Foliage treatments Expt 72/78

Planted: Spring 1978
Treated: 7.6.78
Spray volume rate: 394 l/ha
Met data on 7.6.78
Temps ^{o}C: 9 a.m. 16.2
Max. 19.9 Min. 12.4
% RH: 81
Sunshine hours: 1.2

Assessments:
Score 1 6.7.78
Score 2 31.7.78
Fresh wt 1.8.78

Results

Herbicide	Dose kg/ha	Score (0-9) 4 wks	7 wks	F. Wt % Control	Symptoms
Alloxydim	1.5	8.8	8.0	105	
	3.0	7.8	7.5	111	r(m)n(m)hkA
	6.0	7.0	7.0	103	
Ammonium sulphamate/	250	2.8	1.8	13	cn
	500	1.8	0.0	0	
	1000	1.5	0.0	0	
Bromofenoxim + terbuthylazine	0.5	4.8	5.3	50	cnA
	1.5	4.0	4.0	32	
	4.5	1.3	1.5	6	
Bromoxynil + ioxynil	0.75	4.8	5.0	45	cnA
	2.25	3.0	3.0	17	
	6.75	0.5	0.5	1	
Clopyralid	0.05	8.0	8.0	100	hsfc A
	0.2	6.0	6.8	108	
	0.8	4.3	5.3	95	
Fosamine*	2.25	9.0	7.5	92	
	5	7.3	7.3	106	
	10	5.3	6.3	100	
	20	3.5	4.3	80	csnk(y)x
	40	2.8	2.3	56	
	80	2.8	2.0	42	
Ioxynil	0.75	4.3	4.5	44	
	2.25	3.3	3.8	28	cnA
	6.75	3.0	2.5	12	

* + Agral (0.25%)
/ Spray volume rate 788 l/ha

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