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THE ACTIVITY AND LATE POST-EMERGENCE SELECTIVITY OF FBC 32197

FBC 32197 is quizalofop-ethyl

W G Richardson, T M West and G P White

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Agricultural Research Council Weed Research Organization, Begbroke Hill, Yarnton, Oxford, OX5 1PF

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THE ACTIVITY AND LATE POST-EMERGENCE SELECTIVITY OF FBC 32197.

W.G. Richardson*, T.M. West* and G.P. White*
Agricultural Research Council Weed Research Organization
Begbroke Hill, Yarnton, Oxford OX5 1PF

SUMMARY

FBC 32197 was examined for post-emergence selectivity on 44 crop and weed species. Its route of action was determined on six selected species in a separate test. The safener 1,8 naphthalic anhydride (NA) was used as a seed dressing on wheat, barley and maize to see if herbicide effects could be reduced.

FBC 32197 showed outstanding potential control of many grass weeds, including volunteer cereals, in onion and most broad-leaved crops. All broad-leaved weeds were resistant however. Festuca rubra and Poa annua were the two most resistant grasses but the latter species showed some susceptibility to the higher doses.

The safener, NA, did not reduce toxicity sufficiently to be of any practical use in wheat, barley or maize.

INTRODUCTION

The pre- and post-emergence selectivities and effects of new herbicides are investigated at WRO on a large number of pot-grown crop and weed species. The limitations of these investigations are that only one crop variety or source of weed species is used and growth is in one particular soil type, at only one depth of sowing without interspecific competition. Consequently the results should only be used as a guide for further work, as plant responses in pot experiments can be very different to those in the field.

This report gives indications of the post-emergence selectivity of FBC 32197. Results of an activity experiment are also included to provide information on levels of phytotoxicity, type and route of action.

METHODS AND MATERIALS

(a) Activity experiment (AE 1) This was carried out on six selected species as described previously (Richardson and Dean, 1974). Three annual species and perennial ryegrass were raised from seeds and two perennials from rhizome fragments. There were two replicates for each treatment. Herbicides were applied by four different methods:

(i) post-emergence to the foliage only, avoiding contact with the soil,
(ii) post-emergence to the soil only, as a drench avoiding foliage contact,
(iii) pre-emergence to the soil surface,
(iv) pre-emergence with thorough incorporation, before planting.

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* Herbicide Group

Experimental details are summarised in Tables 1 and 2.

(b) Post-emergence selectivity experiment

The experimental details were as previously described (Richardson and Parker, 1977). Plants were raised in 9 or 10 cm diameter plastic pots in soil taken from a field near Begbroke Hill (Yarnton). Planting dates were staggered so that the majority of species would reach a pre-determined leaf stage (2-4 leaves) by the time of spraying. However, as can be noted in Appendix I, several species were at a more advanced stage of growth. All species were raised in the open.

Table 1. Plant data for activity experiment (AE 1)

Species	Cultivar source	No.per pot at spraying		Depth of plant-ing (cm)	Stage of growth at Spraying	Assessment	
		pre-	post		post-em	pre-em	post-em
Dwarf bean (Phaseolus vulgaris)	The Prince	4	1-2	1.5	2 uni-foliate leaves	3 tri-foliate leaves	4 tri-foliate leaves
Kale (Brassica oleracea acephala)	Marrow-stem	12	6	0.5	2-2.5 leaves	5 leaves	4 leaves
Polygonum amphibium	WRO Clone 1	6	5	1.0	5.5 leaves	9 leaves	10 leaves
Perennial ryegrass (Lolium perenne)	S 23	15	10	0.5	3.5 leaves	5 tillers	6 tillers
Avena fatua	WRO 1978	12	5	1.0	3 leaves	1-2 tillers	3-5 tillers
Agropyron repens	WRO Clone 31	6	4	1.0	3 leaves	2-3 tillers	2 tillers

Table 2. Soil and environmental conditions in two experiments

Experiment type	Activity experiment	Post-emergence selectivity test
Date of spraying	14.5.82	9.6.82
Main assessment completed	18.6.82	30.6.82
Organic carbon (%)	1.3	1.3
Clay content (%)	16.0	16.0
pH (in water; 1:2 soil:water ratio)	7.5	7.5
Superphosphate (g/kg)	2.0	2.0
Vitax QS 3 fertilizer (g/kg)	2.5	2.5
Hydrated Mg SO_4 $7H_2O$ (g/kg)	0.8	0.8
Temperature (°C)	Glasshouse	Outdoors
Mean	19	17
Maximum	34	30
Minimum	10	10
Relative humidity (%)		
Mean	60	60
Maximum	90	87
Minimum	26	22

Before spraying, each species was thinned to constant number per pot. Certain plant material was pre-treated to improve establishment:- seeds of Chenopodium album and Polygonum lapathifolium were soaked in 0.1 M potassium nitrate solution and then kept in the light for two and three days respectively prior to planting; seeds of Alopecurus myosuroides were soaked in distilled water and kept in the light for 24 hours; Rumex obtusifolius seeds were dehusked; Veronica persica and Agrostis stolonifera were sown in a tray of peat compost and seedlings (1-2 true leaves) transplanted into the potting medium.

To protect from soil-borne pathogens all seeds except wheat, barley, oat, sugar beet, Avena fatua and those soaked in KNO_3 solution were pretreated with one of the following: thiram, Harvesan organomercury, thiram + benlate (onion). Root fragments of Cirsium arvense were washed in a colloidal copper solution (2 ml $litre^{-1}$) prior to planting. For dwarf bean, field bean and certain brassicas (kale, rape, cabbage, radish) 6% gum arabic solution was included with the thiram fungicide seed dressing to improve adhesion, as most of these species are susceptible to "damping off" diseases.

A series of treatments was included to investigate possible uses for safeners. Maize, wheat and barley were treated with NA (1,8-naphthalic anhydride) at 0.5% a.i. w/w of seeds.

The herbicide was applied using a laboratory sprayer operating at a pressure of 207 kPa (30 lb/in^2) with an 8002 Tee Jet band spray nozzle moving at 0.5 m sec^{-1}, 45 cm above the stationary plants. There were two replicates for each treatment. Stages of growth at spraying and assessment are summarised in Appendix I. After spraying, the plants were protected from rainfall for 24 hours and then watered overhead from a rose at the end of a trigger hose

attached to the mains water supply, to wash any residues off the foliage. The pots were then returned to their original position in the open. Watering throughout the experiment was done from overhead. Additional fertilizer in solution was applied to all species at one week intervals after spraying (5 ml litre^{-1} Vitafeed 301). Insecticide and fungicide solutions were applied to individual species as required.

(c) Assessment and processing of results

Results were assessed and processed as before (Richardson and Dean, 1974). Survivors were counted and scored for vigour on a 0-7 scale as previously, where 0 = dead and 7 = as untreated control.

Histograms are presented for the results of each treatment, the upper of each pair represents mean plant survival and the lower, mean vigour score, both calculated as percentages of untreated controls. Actual percentage figures are displayed to the left of each row of x's (in selectivity test only). The same information is displayed in the histograms, each 'x' representing a 5% increment, but in the activity experiment each 'x' represents a 7% increment. A '+' indicates a value in excess of 100%. A value of 100 = as untreated control and 0 = a complete kill. 'R' indicates results based on one replicate only.

A table of observed selectivities, using the criteria specified, is presented along with comments to highlight salient points. Radish (Raphanus raphanistrum) which was included because it is easy to propagate may be regarded as a crop or weed.

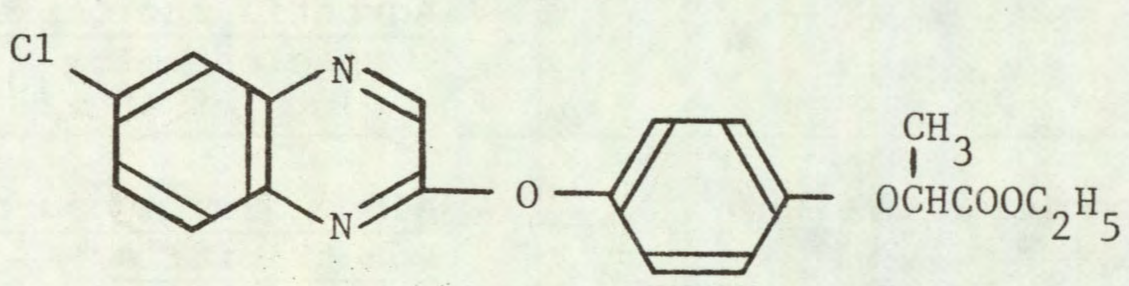
Several species, notably the perennials, were kept for extra periods to observe later effects or the degree of recovery from injury.

FBC 32197

Code numbers FBC 32197
NCI 96683

Chemical name Ethyl 2-[4-(6-chloroquinoxalin-2-yloxy)phenoxy] propionate

Structure



Source FBC Limited
Agrochemicals Division
Chesterford Park Research Station
Saffron Walden
Essex CB10 1XL, UK

Information available and suggested uses

For control of grass weeds in broad-leaved crops.

Formulation used Emulsifiable concentrate 10% a.i.

Spray volume For activity experiment 373 l/ha.
For post-emergence selectivity experiment 371 /ha.

RESULTS

Full results are presented in the histograms on pages 8 to 13 and potential selectivities are summarised in the following table.

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
0.8	onion dwarf bean field bean pea white clover kale cabbage carrot parsnip lettuce fenugreek sugar beet radish	Phalaris paradoxa Phalaris minor + species below

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
0.2	species above	Bromus sterilis Avena fatua Agrostis stolonifera + species below
0.05	species above + rape	Alopecurus myosuroides Poa trivialis Agropyron repens

Comments on results

Activity experiment

Toxicity was high on the grasses with all four application methods, but broad-leaved species were generally tolerant, except for minor effects at the high dose. On grasses the foliar spray was the most effective of all the application methods, and was much more effective than the soil drench, post-emergence. Agropyron repens was the most sensitive species. Pre-emergence, the herbicide was more active on the surface than when incorporated for perennial ryegrass but the reverse was true for A. repens. In the case of Avena fatua, incorporated treatments were more active than surface applications at the two lower doses, but not at the higher dose.

Symptoms

These were generally very similar to those caused by the three previous herbicides, with a severe inhibition of growth accompanied by chlorosis and necrosis. Grasses often failed to emerge at the high dose pre-emergence. Avena fatua exhibited a weakened root system with soil treatments. Effects on broad-leaved species were usually minor and temporary, such as lack of vigour, chlorosis and necrosis. Some slight deformities of leaves (e.g. crinkling) developed after spraying in some species e.g. certain brassica crops (kale and rape). On two of the leguminous species (dwarf bean and fenugreek) a pronounced, patchy chlorosis or bleaching of trifoliates was observed.

Post-emergence selectivities

All but two of the grass weed species were controlled. Agropyron repens was highly sensitive (as in the activity experiment) being controlled at the lowest dose of 0.05 kg/ha. Poa trivialis and Alopecurus myosuroides were also either killed or controlled at this dose. At 0.2 kg/ha Avena fatua, Bromus sterilis and Agrostis stolonifera were susceptible. Both Phalaris minor and P. paradoxa were either killed or controlled at 0.8 kg/ha. Poa annua, although not controlled, was reduced by about 50% at the higher doses. Festuca rubra was reduced, but not adequately controlled at 0.8 kg/ha. All broad-leaved weeds were resistant.

Onion and broad-leaved crops were tolerant. However rape only satisfied the tolerance criteria at the lowest dose of 0.05 kg/ha. Although reduced in vigour by only 20 to 30% at higher doses, slight deformities were observed as decribed earlier. All four cereals and perennial ryegrass were very sensitive. The safener, NA, failed to alleviate effects on maize, wheat and barley, in fact it increased activity slightly on the two latter species.

FBC 32197 shows high potential for control of most grasses, notably perennials but also volunteer cereals, in onion and most broad-leaved crops. Some further pot work is worthwhile to see if control of Poa annua (treated here at a late growth stage) can be achieved, possibly with the use of additives or other herbicides.

ACTIVITY EXPERIMENT

FBC 32197

		0.05 kg/ha	0.25 kg/ha	1.25 kg/ha
DWARF BEAN	F	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxx
	S	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx
	P	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx
	I	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx
KALE	F	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxx
	S	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx
	P	xxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx+ xxxxxxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	I	xxxxxxxxxxxxxxx+ xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx
POLYGONUM AMPHIBIUM	F	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxx
	S	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx
	P	xxxxxxxxxxxxx xxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxxxx
	I	xxxxxxxxxxxxx xxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx+ xxxxxxxxxxxxxxx
PERENNIAL RYEGRASS	F	xxxxxxxxxxxxxxx xxxxxxxx	x xx	o o
	S	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	x xxxx
	P	xxxxxxxxxx xxxxxxxxxxxxx	x xxxx	o o
	I	xxxxxxxxxxxxxxx+ xxxxxxxxxx	xxxxxxxxxxxxxxx xxxxx	xxxxx xxx
AVENA FATUA	F	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	o o	o o
	S	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxx xxxxxxxxx	o o
	P	xxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxxxx	xxx x
	I	xxxxxxxxxxxxxxx+ xxxxxxxxx	xxxxxxxxxxxxxxx+ xxxxxxx	xxxxxxxxxx xxxxx
AGROPYRON REPENS	F	xxxxx xxxxxx	o o	o o
	S	xxxxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxx	o o
	P	xxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxx xxxxxxxxx	o o
	I	xxxxxxxxxxxxxxx+ xxxxxxxx	xxxxxxxxxxxxxx xxx	o o

KEY: F = post-emergence, foliar application
S = post-emergence, soil drench
P = pre-emergence, surface film
I = pre-planting, incorporated

POST-EMERGENCE SELECTIVITY TEST

FBC 32197

SPECIES		0.05 kg/ha		0.20 kg/ha		0.80 kg/ha
WHEAT	37	xxxxxxx	12	xx	0	
(1)	7	x	7	x	0	
WHEAT + S	0		0		0	
(2)	0		0		0	
BARLEY	62	xxxxxxxxxxxx	0		0	
(3)	21	xxxx	0		0	
BARLEY + S	0		0		0	
(4)	0		0		0	
OAT	100	xxxxxxxxxxxxxxxxxxxx	0		0	
(5)	64	xxxxxxxxxxxxx	0		0	
PER PYGR	20	xxxx	0		0	
(6)	29	xxxxxx	0		0	
ONION	87	xxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(8)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx
DWF BEAN	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(9)	100	xxxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx
FLD BEAN	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(10)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
PEA	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(11)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxxx
W CLOVER	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(12)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx

POST-EMERGENCE SELECTIVITY TEST

FBC 32197

SPECIES		0.05 kg/ha		0.20 kg/ha		0.80 kg/ha
RAPE	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(14)	86	xxxxxxxxxxxxxxxx	79	xxxxxxxxxxxxxxx	71	xxxxxxxxxxxxx
KALE	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(15)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx
CABBAGE	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(16)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx
CARROT	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	90	xxxxxxxxxxxxxxxxx
(18)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
PARSNIP	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(19)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
LETTUCE	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(20)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx
FENUGREEK	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(21)	100	xxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx
SUG BEET	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(22)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
BETA VULG	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(23)	93	xxxxxxxxxxxxxxxxxx	79	xxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx
BROM STE	100	xxxxxxxxxxxxxxxxxxx	0		0	
(24)	57	xxxxxxxxxxx	0		0	
FEST RUB	94	xxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	69	xxxxxxxxxxxxx
(25)	93	xxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	57	xxxxxxxxxxx

FBC 32197

SPECIES		0.05 kg/ha		0.20 kg/ha		0.80 kg/ha
AVE FATU	100	xxxxxxxxxxxxxxxxxxx	37	xxxxxxx	0	
(26)	50	xxxxxxxxxx	29	xxxxxx	0	
ALO MYOS	20	xxxx	0		0	
(27)	21	xxxx	0		0	
POA ANN	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	92	xxxxxxxxxxxxxxxxx
(28)	100	xxxxxxxxxxxxxxxxxxx	57	xxxxxxxxxx	50	xxxxxxxxxx
POA TRIV	0		0		0	
(29)	0		0		0	
SIN ARV	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(30)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
RAPH RAP	125	xxxxxxxxxxxxxxxxxxx+	125	xxxxxxxxxxxxxxxxxxx+	87	xxxxxxxxxxxxxxxx
(31)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx
CHRY SEG	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(32)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx
TRIP MAR	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(33)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx
SEN VULG	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(34)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
POL LAPA	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(35)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
GAL APAR	89	xxxxxxxxxxxxxxxxx	111	xxxxxxxxxxxxxxxxxxx+	67	xxxxxxxxxxxxx
(38)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx

FBC 32197

SPECIES			0.05 kg/ha			0.20 kg/ha			0.80 kg/ha
CHEN ALB	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx
(39)	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx
STEL MED	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx
(40)	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx
SPER ARV	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx
(41)	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx
VER PERS	71		xxxxxxxxxxxxx	71		xxxxxxxxxxxxx	71		xxxxxxxxxxxxx
(42)	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx	100		xxxxxxxxxxxxxxxxxxx
RUM OBTU	100	R	xxxxxxxxxxxxxxxxxxx	100	R	xxxxxxxxxxxxxxxxxxx	100	R	xxxxxxxxxxxxxxxxxxx
(44)	100	R	xxxxxxxxxxxxxxxxxxx	100	R	xxxxxxxxxxxxxxxxxxx	100	R	xxxxxxxxxxxxxxxxxxx
AG REPEN	87		xxxxxxxxxxxxxxxxx	62		xxxxxxxxxxx	50		xxxxxxxxxx
(47)	29		xxxxxx	21		xxxx	14		xxx
AG STOLO	67		xxxxxxxxxxxxx	17		xxx	0		
(48)	36		xxxxxxx	7		x	0		
CIRS ARV	100	R	xxxxxxxxxxxxxxxxxxx	100	R	xxxxxxxxxxxxxxxxxxx	100	R	xxxxxxxxxxxxxxxxxxx
(50)	100	R	xxxxxxxxxxxxxxxxxxx	100	R	xxxxxxxxxxxxxxxxxxx	100	R	xxxxxxxxxxxxxxxxxxx
PHAL PAR	100		xxxxxxxxxxxxxxxxxxx	80		xxxxxxxxxxxxxxxx	50		xxxxxxxxxx
(54)	93		xxxxxxxxxxxxxxxxxx	50		xxxxxxxxxx	21		xxxx
MAIZE + S	0			0			0		
(56)	0			0			0		
MAIZE	0			0			0		
(57)	0			0			0		

FBC 32197

SPECIES		0.05 kg/ha		0.20 kg/ha		0.80 kg/ha
SOL NIG	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(81)	93	xxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx	57	xxxxxxxxxx
PHAL MIN	100	xxxxxxxxxxxxxxxxxxx	50	xxxxxxxxxx	0	
(84)	86	xxxxxxxxxxxxxxxx	36	xxxxxxx	0	
OXAL LAT	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(87)	86	xxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx	64	xxxxxxxxxxxx

ACKNOWLEDGEMENTS

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Appendix 1. Species, abbreviations, varieties and stages of growth at spraying and assessment for post-emergence selectivity test

	Designation and computer serial number	Cultivar or source	Stage of growth at spraying	Stage of growth at assessment (untreated controls, leaf numbers exclusive of cotyledons)
Temperate species				
Wheat (Triticum aestivum)	WHEAT (1)	Mardler	2 tillers	Numerous leaves, tillering
Wheat + safener	WHEAT + S (2)	Mardler	2 tillers	Numerous leaves, tillering
Barley (Hordeum vulgare)	BARLEY (3)	Sonja	1-2 tillers	Numerous leaves, 2-4 tillers
Barley + safener	BARLEY + S (4)	Sonja	1-2 tillers	Numerous leaves, 2-4 tillers
Oat (Avena sativa)	OAT (5)	Pennal	1 tiller	Numerous leaves, up to 6 tillers
Perennial ryegrass (Lolium perenne)	PER RYGR (6)	S 23	2 tillers	Up to 12 tillers
Onion (Allium cepa)	ONION (8)	Robusta	2-2½ leaves	3-3½ leaves; bulbs ≏ 1 cm diameter
Dwarf bean (Phaseolus vulgaris)	DWF BEAN (9)	Masterpiece	2 trifoliate leaves	3 trifoliate leaves, flowering
Field bean (Vicia faba)	FLD BEAN (10)	Maris Bead	5-5½ leaves	10 leaves, flowering
Pea (Pisum sativum)	PEA (11)	Dark Skinned Perfection	5 leaves	Up to 10 leaves
White Clover (Trifolium repens)	W CLOVER (12)	Kent Wild	4-7 trifoliate leaves	Up to 20 trifoliate leaves
Rape (Brassica napus oleifera)	RAPE (14)	Jet Neuf	2½-3½ leaves	6 leaves
Kale (Brassica oleracea acephala)	KALE (15)	Maris Kestrel	3 leaves	6 leaves
Cabbage (Brassica oleracea capitata)	CABBAGE (16)	Primata Derby Day	3½-4 leaves	Up to 8 leaves
Carrot (Daucus carota)	CARROT (18)	Chantenay Red Core	3-4 leaves	7 leaves

Appendix 1, Cont'd

	Designation and computer serial number	Cultivar or source	Stage of growth at spraying	Stage of growth at assessment (untreated controls, leaf numbers exclusive of cotyledons)
Galium aparine	GAL APAR (38)	WRO 1980	2 whorls	Numerous whorls
Chenopodium album	CHEN ALB (39)	WRO 1979	6-10 leaves	10 leaves, flowering
Stellaria media	STEL MED (40)	B & S Supplies, 1979	Up to 14 leaves	Numerous leaves, flowering
Spergula arvensis	SPER ARV (41)	B & S Supplies, 1977	3-4 whorls	Numerous whorls, flowering
Veronica persica	VER PERS (42)	WRO 1975	4-10 leaves	Numerous leaves, flowering
Rumex obtusifolius	RUM OBTU (44)	WRO 1981	2-3 leaves	6 leaves
Agropyron repens	AG REPEN (47)	WRO Clone 31*	1 tiller	Up to 15 leaves, 2 tillers
Agrostis stolonifera	AG STOLO (48)	B & S Supplies, 1981	5 leaves	Up to 25 stolons
Cirsium arvense	CIRS ARV (50)	WRO Clone 1**	8 leaves	Up to 14 leaves
Phalaris paradoxa	PHAL PAR (54)	Ethiopia, 1979	2 tillers	Up to 9 tillers, flowering
Maize + safener (Zea mays)	MAIZE + S (56)	Caldera 535	4-5 leaves	7 leaves
Maize (Zea mays)	MAIZE (57)	Caldera 535	4-5 leaves	7 leaves
Solanum nigrum	SOL NIG (81)	WRO 1980	4 leaves	7 leaves, flowering
Phalaris minor	PHAL MIN (84)	Delhi 1977	5 leaves, some tillering	6 leaves, flowering
Oxalis latifolia	OXAL LAT (87)	WRO Clone 2⸗ (ex Cornwall)	3-4 trifoliate leaves	4-15 trifoliate leaves, flowering

* one node rhizome pieces ** root fragments ⸗ bulbs

Appendix 1. Cont'd

	Designation and computer serial number	Cultivar or source	Stage of growth at spraying	Stage of growth at assessment (untreated controls, leaf numbers exclusive of cotyledons)
Parsnip (Pastinaca sativa)	PARSNIP (19)	Unicorn	1½-3 leaves	4-5 leaves
Lettuce (Lactuca sativa)	LETTUCE (20)	Reskia	6 leaves	10 leaves
Fenugreek (Trigonella foenumgraecum)	FENUGREEK (21)	Paul	3-4 trifoliate leaves	7 trifoliate leaves
Sugar beet (Beta vulgaris)	SUG BEET (22)	Monotri	4 leaves	6-10 leaves
Beta vulgaris	BETA VUL (23)	WRO 1981 ex Attleborough	4 leaves	6-10 leaves
Bromus sterilis	BROM STE (24)	WRO 1981	4 tillers	Up to 8 tillers
Festuca rubra	FEST RUB (25)	Boreal	0-1 tiller	Up to 15 tillers
Avena fatua	AVE FATU (26)	WRO 1978	2 tillers	12-14 leaves, 2 tillers
Alopecurus myosuroides	ALO MYOS (27)	WRO 1980	2-3 tillers	Up to 15 tillers
Poa annua	POA ANN (28)	B & S Supplies, 1980	2-3 tillers	Up to 15 tillers
Poa trivialis	POA TRIV (29)	B & S Supplies, 1981	0-1 tiller	Up to 15 tillers
Sinapis arvensis	SIN ARV (30)	WRO 1978	6 leaves	Numerous leaves, podded
Raphanus raphanistrum	RAPH RAP (31)	Long Black Spanish	3 leaves	Up to 7 leaves
Chrysanthemum segetum	CHRYS SEG (32)	WRO 1981	8-12 leaves	Up to 22 leaves
Tripleurospermum maritimum	TRIP MAR (33)	WRO 1978	6-8 leaves	Up to 10 leaves, flowers developing
Senecio vulgaris	SEN VULG (34)	B & S Supplies, 1979.	Up to 7 leaves	17 leaves, flowering
Polygonum lapathifolium	POL LAPA (35)	WRO 1981	3-6 leaves	8 leaves, flowering

ABBREVIATIONS

ångström	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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