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THE ACTIVITY, PRE-AND POST-EMERGENCE SELECTIVITY OF DIFLUFENICAN

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THE ACTIVITY, PRE- AND POST-EMERGENCE SELECTIVITY OF DIFLUFENICAN

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SUMMARY

In a series of pot experiments in the glasshouse and outdoors, diflufenican was examined for pre- and post-emergence selectivity on a wide range of temperate crop and weed species. Wheat, barley and maize were each treated with seed dressings of the safener 1,8 naphthalic anhydride (NA) to investigate possible protection from herbicide injury. The route of entry into plants was examined in a separate test on six selected species. Persistence of the herbicide in the soil was examined over a period of 52 weeks.

Diflufenican was more active pre- rather than post-emergence. Good selectivity was found pre-emergence with all cereals, carrot, and certain legume and brassica crops. The weed-spectrum, though consisting mainly of annual broad-leaved species, included A. myosuroides, Veronica persica and Viola arvensis. Potential selective control of Viola arvensis was achieved post-emergence in cereals but only at a high dose.

Persistence in the soil was moderate, relative to the standard cyanazine (short persistence) and simazine (long persistence).

INTRODUCTION

The pre- and post-emergence activities and selectivities of new herbicides are investigated at LARS, WRD on a number of pot-grown crop and weed species and at the same time experience of the type of effects produced by each compound is obtained. Persistence in the soil is also monitored and these data in conjunction with crop susceptibilities, are useful in considering subsequent cropping of treated land. The limitations of these investigations are that only one crop variety or source of weed species is used; they are grown in one particular soil type, at only one depth of sowing and 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 from those in the field.

This report gives pre- and post emergence selctivity data on diflufenican. Results of an activity experiment are also included to provide information on levels of phytotoxicity, type and route of action.

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* Herbicide Group

METHODS AND MATERIALS

Activity experiment (AE) This was carried out in the glasshouse on six selected species as described previously (Richardson and Dean, 1973). Four annual species were raised from seeds and two perennials from rhizome fragments. Herbicides were applied by four different methods.

i) a post-emergence spray to the foliage only, avoiding contact with the soil;

ii) post-emergence to the soil only, as a drench avoiding foliar contact;

iii) pre-emergence to the soil surface;

iv) pre-emergence with thorough incorporation to 5 cm depth before planting.

Pre-emergence selectivity experiment

Techniques for this experiment were as described by Richardson and Dean (1973), the herbicide being applied as a surface pre-emergence spray. Species were sown as detailed in Appendix I, each being replicated twice for every treatment.

Radish (Raphanus raphanistrum) was included for ease of propagation and may be regarded as a crop or weed. To improve establishment, seeds of Chenopodium album were kept in 0.1 M potassium nitrate for 48 hours in the light.

To protect from soil-borne pathogens, all seeds (except wheat, barley, oat, perennial ryegrass, C. segetum, G. aparine, Viola arvensis and most perennials) were pre-treated with one of the following:- thiram, captan, thiram + benlate (for onion only), bromophos + captan + thiabendazole (pea only). A. fatua seeds were dressed with 'Harvesan' organo-mercury. Maize seeds were purchased already treated with captan A + teraquinone. The seeds of kale, radish, swede and dwarf bean, were treated with thiram, a 6% gum arabic solution being used prior to dressing, to give better adhesion. In addition, 'Cheshunt Compound' (3 g litre^{-1}) fungicide solutions were applied to certain species as soil drenches or sprays to protect against fungal diseases. Root fragments of Cirsium arvense were washed in a 2 ml litre^{-1} colloidal copper solution.

A series of treatments were included for wheat, barley and maize in which seeds were treated with the safener (1,8-naphthalic anhydride) at 0.5% w/w a.i. of seeds.

Herbicides were applied using a laboratory sprayer embodying an 8002E Spraying Systems Tee Jet operated at a pressure of 207 kPa (30 lb/in^2) and moving at 0.54 m/s, 30 cm above the soil. Subsequent watering was from overhead. During the experiment, plants were raised in the glasshouse, normal daylight being supplemented by mercury vapour lighting to provide 14 hour photoperiods.

Table 1. Plant data for activity experiment

Species	Cultivar /source	No. per pot at spraying pre-	No. per pot at spraying post-	Depth of planting (cm)	Stage of growth Spraying pre-em	Stage of growth Assessment pre-em	Stage of growth Assessment post-em
Dwarf bean (Phaseolus vulgaris)	Master-piece	3	2	2.0	2 uni-foliate leaves	1.5 to 2.5 tri-foliate leaves	2 to 3 tri-foliate leaves
Kale (Brassica oleracea acephala)	Marrowstem	10	5	0.5	2 to 2.5 leaves	4 to 5 leaves	4 to 5 leaves
Polygonum amphibium	WRO Clone 1	6	4 to 5	1.0	4.5 to 5.5	6 to 8 leaves	9 to 10 leaves
Perennial ryegrass (Lolium perenne)	S23	12	10	0.5	2 to 3 leaves	4 to 5 leaves, tiller-ing	2 to 6 tillers
Avena fatua	WRO 1978	5 to 6	5	1.0	2.5 to 3 leaves	3.5 to 4.5 leaves, 0 to 2 tillers	2 tillers
Elymus repens	WRO Clone 31	6	4 to 5	1.0	2.5 to 3 leaves	3.5 to 5 leaves, 0 to 3 tillers	1 to 2 tillers

Table 2. Soil and environment conditions

Experiment type	Activity experiment	Pre-emergence selectivity test	Post-emergence selectivity test
Date of spraying	13.10.82	13.12.83	7&12.7.83
Main assessment completed	16.11.82	3.2.84	5.8.83
Organic matter (%)	2.2	2.2	1.3
Clay content (%)	15.0	15.0	16.0
pH (water; 1:2 soil/water)	7.5	7.5	7.5
Ammonium sulphate (g/kg)	-	0.4	-
Superphosphate (g/kg)	2.0	0.8	-
Potassium sulphate (g/kg)	-	0.4	-
Vitax QS fertilizer (g/kg)	2.5	-	2.5
Fritted trace elements (g/kg)	-	0.08	-
Hydrated Mg_2SO_4 (g/kg)	0.8	0.3	-
Temperature (^{o}C)	Glasshouse		Outdoors
Mean	19	15	19
Maximum	26	22	30
Minimum	12	6	9
Relative humidity (%)			
Mean	60	64	50
Maximum	85	88	86
Minimum	32	33	12

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 a soil/peat/sand medium (4:1:1 v/v) the soil being taken from a field near Begbroke Hill (Yarnton). Planting dates were staggered so that the majority of species would reach a pre-determined stage (2-4 leaves) by the time of spraying. However, as noted in Appendix II several species were at a more advanced stage of growth. All species were raised in the open.

In some cases plant material was pre-treated to improve establishment:- seeds of Chenopodium album were soaked in 0.1 M potassium nitrate solution and kept in the light for two days 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 leaves) transplanted into the potting medium.

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

A series of treatments was included to investigate possible uses for the safener NA (1,8-naphthalic anhydride). Maize, wheat and barley were treated with NA at 0.5% a.i. w/w of seeds. Before spraying, each species was thinned to constant number per pot.

Herbicides were applied using a laboratory sprayer operating at a pressure of 207 kPa (30 lb/in^{-2}) with a Spraying Systems 8002 TeeJet spray nozzle moving at 0.54 m sec^{-1}, 45 cm above the stationary plants and delivering a volume of 370 l/ha. There were two replicates for each treatment. Stages of growth at spraying and assessment are summarised in Apendix II. After spraying, the plants were protected from rainfall for 25 hours and then watered overhead to wash any residues off the foliage, using a rose at the end of a trigger hose attached to the mains water supply. The pots were then returned to their original position in the open. Watering throughout the experiment was 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.

Assessment and processing of results

Results were processed as described by Richardson and Dean (1973 and 1974). Survivors were counted and scored for vigour on a 0-7 scale where 0 = dead and 7 = as in untreated control. Certain species showed variable germination in the pre-emergence test and the results were ignored. However, vigour scores were taken for Polygonum lapathifolium and Phalaris paradoxa and these are included in the selectivity tables and referred to in the text where appropriate. Polygonum aviculare, Solanum nigrum and Holcus lanatus failed to germinate.

Pairs of histograms are presented for each treatment, the upper representing plant survival and the lower vigour score, both calculated at precentage of untreated controls. Each 'x' represents a 5% increment in the selectivity experiments but 7% in the activity experiment. A '+' indicates a value in excess of 100%; 'R' indicates a result based on one replicate only and 'M" represents a missing treatment.

A table of observed selectivities, using the criteria specified, is presented along with comments to highlight salient points.

Several species, notably the perennials, were kept for an extra period to observe later effects, or the degree of recovery from injury and these final observations are referred to in the text.

Persistence in the soil

This was monitored, by bioassay, in conjunction with the pre-emergence selectivity experiment. Pots (7.5 cm diameter) containing soil were sprayed directly with the herbicide. All pots were then transferred to the temperate glasshouse together with untreated controls and watered as necessary from overhead.

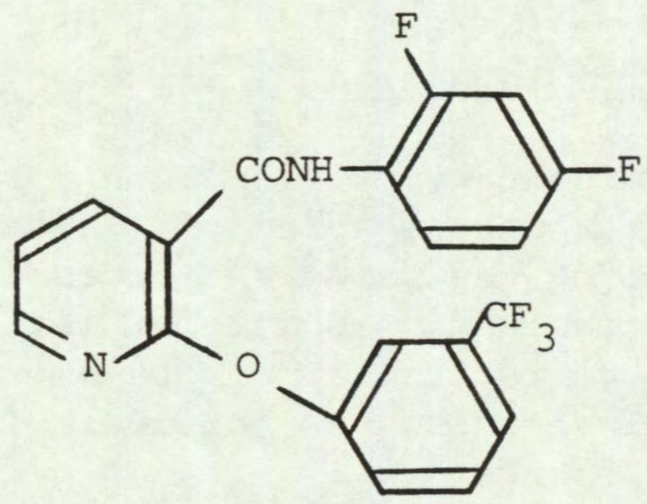
For each bioassay three replicate pots per treatment were selected and seeds of perennial ryegrass was sown 0.5 cm deep, disturbing the soil as little as possible. Plants were harvested three or four weeks after sowing at a pre-determined growth stage, the number and fresh weight of shoots being recorded. Bioassays were repeated at six to eight week intervals for 52 weeks, unless the herbicide had disappeared before then. The herbicide was considered to have disapeared when shoot fresh weights of the test plants were 80% or more as compared with the controls. Results are presented graphically and comments are made in the text. Standard treatments of cyanazine (short persistence) and simazine (moderate to long persistence) were included for comparison (see page 17). Average temperature during this period was 15^{o}C (minimum 2^{o}C, maximum 34^{o}C) and relative humidity 60% (minimum 25%, maximum 90%).

Diflufenican

Code number MB 38544

Chemical name 2',4'-difluoro-2-(α,α,α-trifluoro-m-tolyloxy)nicotinanilide

Structure



Source May and Baker Limited
Ongar Research Station
Fyfield Road
Ongar
Essex CN5 OHW

Information and available and suggested uses

Control of broad-leaved weeds (Galium, Veronica, Viola spp., Polygonum aviculare, Stellaria media), pre- and early post-emergence in wheat and barley at 0.125 to 0.25 kg a.i./ha. Also pre-emergence in maize for control of Setaria, Digitaria, Amaranthus, Chenopodium, Solanum spp.

Formulation used: Wettable power 50% w/w a.i.

Spray volume: 372 l/ha

RESULTS

Full results are given in the histograms on pages 21-23 and potential selectivities are summarised in the tables.

Comments on results

Activity experiment (see histogram on page 10)

Phytotoxicity was greatest with the smaller seeded species (kale and perennial ryegrass) treated pre-emergence, the surface treatments being much more effective than when incorporated into the soil. Only minor effects were found post-emergence. The perennials (Polygonum amphibium and Elymus repens) showed a high degree of resistance, as did the larger seeded dwarf bean and Avena fatua.

Symptoms on susceptible species

The most prominent symptom, common to all four application methods and seen in many species was albinism of leaves and petioles. This albinism was often strongest along the veins but occasionally, the whole shoot system was affected. Growth inhibition developed later followed by necrosis. Many species were able to recover from post-emergence treatments however, even though the initial albinism was considerable. Germination was not affected in pre-emergence treatments.

Persistence in the soil (see graphs on pages 16 an 17)

Perennial ryegrass was not as sensitive a test species as had been expected, the two lower doses having no effect on shoot fresh weight, although symptoms (albinism) were seen at 0.25 kg/ha. It is therefore difficult to make any conclusions regarding soil persistence at these doses. Curiously the highest dose of 1.0 kg/ha, was causing a similar depression of shoot fresh weight (c. 50%) after 52 weeks, to that found initially, while even greater effects were observed at intermediate bioassay time.

Pre-emergence selectivity (see histograms on pages 11 to 15)

RATE (kg a.i./ha)	CROPS: vigour reduced by less than 15%	WEEDS: number or vigour reduced by 70% or more
1.0	wheat±safener (NA) barley±safener (NA) maize±safener (NA) oat dwarf bean field bean carrot	Alopecurus myosuroides Poa annua Matricaria perforata Chenopodium album Rumex obtusifolius Phalaris minor Polygonum lapathifolium+ + species below
0.25	as above + pea lucerne rape kale fenugreek	Poa trivialis Stellaria media Veronica persica Viola arvensis Phalaris paradoxa+
0.0625	None listed as no weeds	None

+ not in histograms

Five annual weeds were susceptible to 0.25 kg/ha, most interestingly Veronica persica and Viola arvensis. Others were Stellaria media and two grasses, Poa trivialis and Phalaris paradoxa. At the high dose of 1.0 kg/ha a further seven annual weeds were controlled, including three grasses, Alopecurus myosuroides, Poa trivialis and Phalaris minor and four broad-leaved species, Matricaria perforata, Chenopodium album, Polygonum lapathifolium and Rumex obtusifolius. Perennial weeds were resistant as were large-seeded grasses (Avena fatua, Bromus sterilis), crucifers (Sinapis arvensis, Raphanus raphanistrum) and Chrysanthemum segetum. Galium aparine showed pronounced symptoms of albinism and was reduced in vigour by 36 and 43% at 0.25 and 1.0 kg/ha respectively.

All four cereals (wheat, barley, maize, oats) showed outstanding tolerance. Carrot and large-seeded legumes (dwarf bean, field bean) also withstood the high dose of 1.0 kg/ha. Three other legumes, pea, lucerne and fenugreek tolerated 0.25 kg/ha as did two of the brassicas, rape and kale. Onion was very sensitive.

The potential control of V. persica and V. arvensis, as well as A. myosuroides in wheat and barley is the most impressive feature of this herbicide. In addition, a wide range of broad-leaved crops such as carrots, legumes and certain brassicas, tolerate doses which achieve control of several important annual weeds.

Post-emergence selectivity (see histograms on pages 18 to 22)

RATE (kg a.i./ha)	CROPS: vigour reduced by less than 15%	WEEDS: number or vigour reduced by 70% or more
1.0	wheat±safener (NA) barley±safener (NA) maize±safener (NA) oat perennial ryegrass onion carrot parsnip fenugreek	Viola arvensis Raphanus raphanistrum Solanum nigrum
0.25 and 0.0625	None listed as no weeds controlled	None

Only three broad-leaved weeds (Viola arvensis, Raphanus raphanistrum and Solanum nigrum) were controlled and then only at the highest dose of 1.0 kg/ha. Effects were seen on Galium aparine and Veronica persica at lower doses but did not result in control. Certain species, notably grasses and composites were resistant, while some such as Stellaria media recovered well from earlier symptoms.

Temperate cereals (wheat, barley, oat), perennial ryegrass, onion, carrot, parsnip and fenugreek tolerated the highest dose. A moderate safening of maize by NA was observed.

Post-emergence selectivity would appear to be rather limited from these results, the activity experiment suggesting that pre- and perhaps very early post-emergence is the preferred time of application.

ACTIVITY EXPERIMENT

DIFLUFENICAN

		0.0625 kg/ha	0.25 kg/ha	1.0 kg/ha
DWARF BEAN	F	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx
	S	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx
	P	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxx xxxxxxxxxx
	I	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx
KALE	F	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx
	S	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx
	P	xxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxx xxxxxxxxx	xxxx xxxxxxx
	I	xxxxxxxxxxxxx+ xxxxxxxxxxxx	xxxxxxxxxxxxx+ xxxxxxxxxxxx	xxxxxxxxxxxxx+ xxxxxxxxx
POLYGONUM AMPHIBIUM	F	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	S	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	P	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	I	xxxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxxx
PERENNIAL RYEGRASS	F	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	S	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	P	xxxxxxxxxxxxx+ xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxx	x xx
	I	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxx
AVENA FATUA	F	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	S	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	P	xxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxx
	I	xxxxxxxxxxxxx+ xxxxxxxxxxxx	xxxxxxxxxxxxx+ xxxxxxxxxxxx	xxxxxxxxxxxxx+ xxxxxxxxxxxx
ELYMUS REPENS	F	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	S	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx
	P	xxxxxxxxxxxxx+ xxxxxxxxxxx	xxxxxxxxxxxxx+ xxxxxxxxxxx	xxxxxxxxxxxxx+ xxxxxxxxxxx
	I	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxx

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

DIFLUFENICAN

SPECIES		0.0625 KG/HA		0.25 KG/HA		1.0 KG/HA
WHEAT	83	XXXXXXXXXXXXXXXX	102	XXXXXXXXXXXXXXXXXXXX	96	XXXXXXXXXXXXXXXXXXX
(1)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	93	XXXXXXXXXXXXXXXXXX
WHEAT+S	94	XXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	94	XXXXXXXXXXXXXXXXXX
(2)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX
BARLEY	102	XXXXXXXXXXXXXXXXXXX	102	XXXXXXXXXXXXXXXXXXX	102	XXXXXXXXXXXXXXXXXXX
(3)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX
BARLEY+S	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX
(4)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX
OAT	98	XXXXXXXXXXXXXXXXXXX	104	XXXXXXXXXXXXXXXXXXX+	104	XXXXXXXXXXXXXXXXXXX+
(5)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	93	XXXXXXXXXXXXXXXXXX
PER RYGR	109	XXXXXXXXXXXXXXXXXXX+	89	XXXXXXXXXXXXXXXXX	41	XXXXXXXX
(6)	100	XXXXXXXXXXXXXXXXXXX	79	XXXXXXXXXXXXXXX	50	XXXXXXXXX
ONION	57	XXXXXXXXXX	4	X	0	
(8)	57	XXXXXXXXXX	14	XXX	0	
DWF BEAN	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX
(9)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX
FLD BEAN	111	XXXXXXXXXXXXXXXXXXX+	126	XXXXXXXXXXXXXXXXXXX+	95	XXXXXXXXXXXXXXXXXX
(10)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXXX
PEA	106	XXXXXXXXXXXXXXXXXXX+	124	XXXXXXXXXXXXXXXXXXX+	71	XXXXXXXXXXXXX
(11)	100	XXXXXXXXXXXXXXXXXXX	93	XXXXXXXXXXXXXXXXXX	79	XXXXXXXXXXXXXXX

DIFLUFENICAN

SPECIES		0.0625 KG/HA		0.25 KG/HA		1.0 KG/HA
W CLOVER	68	XXXXXXXXXXXXXX	27	XXXXX	0	
(12)	86	XXXXXXXXXXXXXXXX	21	XXXX	0	
LUCERNE	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	58	XXXXXXXXXXXX
(13)	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX	64	XXXXXXXXXXXX
RAPE	103	XXXXXXXXXXXXXXXXXXX+	103	XXXXXXXXXXXXXXXXXXX+	97	XXXXXXXXXXXXXXXXXX
(14)	93	XXXXXXXXXXXXXXXXXX	93	XXXXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXX
KALE	95	XXXXXXXXXXXXXXXXXX	95	XXXXXXXXXXXXXXXXXX	99	XXXXXXXXXXXXXXXXXX
(15)	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX	64	XXXXXXXXXXXX
SWEDE	103	XXXXXXXXXXXXXXXXXXX+	99	XXXXXXXXXXXXXXXXXX	56	XXXXXXXXXX
(17)	93	XXXXXXXXXXXXXXXXXX	79	XXXXXXXXXXXXXXX	50	XXXXXXXXX
CARROT	92	XXXXXXXXXXXXXXXXX	75	XXXXXXXXXXXXXXX	83	XXXXXXXXXXXXXXXX
(18)	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX
LETTUCE	101	XXXXXXXXXXXXXXXXXXX	89	XXXXXXXXXXXXXXXXX	72	XXXXXXXXXXXXX
(20)	100	XXXXXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXX	43	XXXXXXXXX
FENUGREK	82	XXXXXXXXXXXXXXXX	98	XXXXXXXXXXXXXXXXXXX	104	XXXXXXXXXXXXXXXXXXX+
(21)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXX
SUG BEET	103	XXXXXXXXXXXXXXXXXXX+	81	XXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX
(22)	100	XXXXXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXX	50	XXXXXXXXX
BETA VUL	87	XXXXXXXXXXXXXXXXX	94	XXXXXXXXXXXXXXXXXX	82	XXXXXXXXXXXXXXX
(23)	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXX

DIFLUFENICAN

SPECIES	0.0625 KG/HA		0.25 KG/HA		1.0 KG/HA	
BROM STE	105	XXXXXXXXXXXXXXXXXXXX+	109	XXXXXXXXXXXXXXXXXXXX+	105	XXXXXXXXXXXXXXXXXXX+
(24)	100	XXXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX
FEST RUB	81	XXXXXXXXXXXXXXXX	73	XXXXXXXXXXXXXXX	49	XXXXXXXXXX
(25)	86	XXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXXX	50	XXXXXXXXXX
AVE FATU	121	XXXXXXXXXXXXXXXXXXX+	93	XXXXXXXXXXXXXXXXXXX	114	XXXXXXXXXXXXXXXXXXX+
(26)	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXXX	79	XXXXXXXXXXXXXXX
ALO MYOS	104	XXXXXXXXXXXXXXXXXXX+	75	XXXXXXXXXXXXXXX	17	XXX
(27)	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXXX	43	XXXXXXXXX
POA ANN	75	XXXXXXXXXXXXXXX	62	XXXXXXXXXXXX	0	
(28)	79	XXXXXXXXXXXXXXXX	57	XXXXXXXXXXX	0	
POA TRIV	89	XXXXXXXXXXXXXXXXXX	0		0	
(29)	71	XXXXXXXXXXXXXX	0		0	
SIN ARV	83	XXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	47	XXXXXXXXX
(30)	86	XXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXXX	57	XXXXXXXXXX
RAPH RAP	102	XXXXXXXXXXXXXXXXXXX	112	XXXXXXXXXXXXXXXXXXX+	107	XXXXXXXXXXXXXXXXXXX+
(31)	93	XXXXXXXXXXXXXXXXXX	79	XXXXXXXXXXXXXXXX	79	XXXXXXXXXXXXXXXX
CHRY SEG	97	XXXXXXXXXXXXXXXXXX	131	XXXXXXXXXXXXXXXXXXX+	101	XXXXXXXXXXXXXXXXXXX
(32)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXXX
MAT PERF	78	XXXXXXXXXXXXXXXX	63	XXXXXXXXXXXX	13	XXX
(33)	79	XXXXXXXXXXXXXXXX	57	XXXXXXXXXX	43	XXXXXXXXX

DIFLUFENICAN

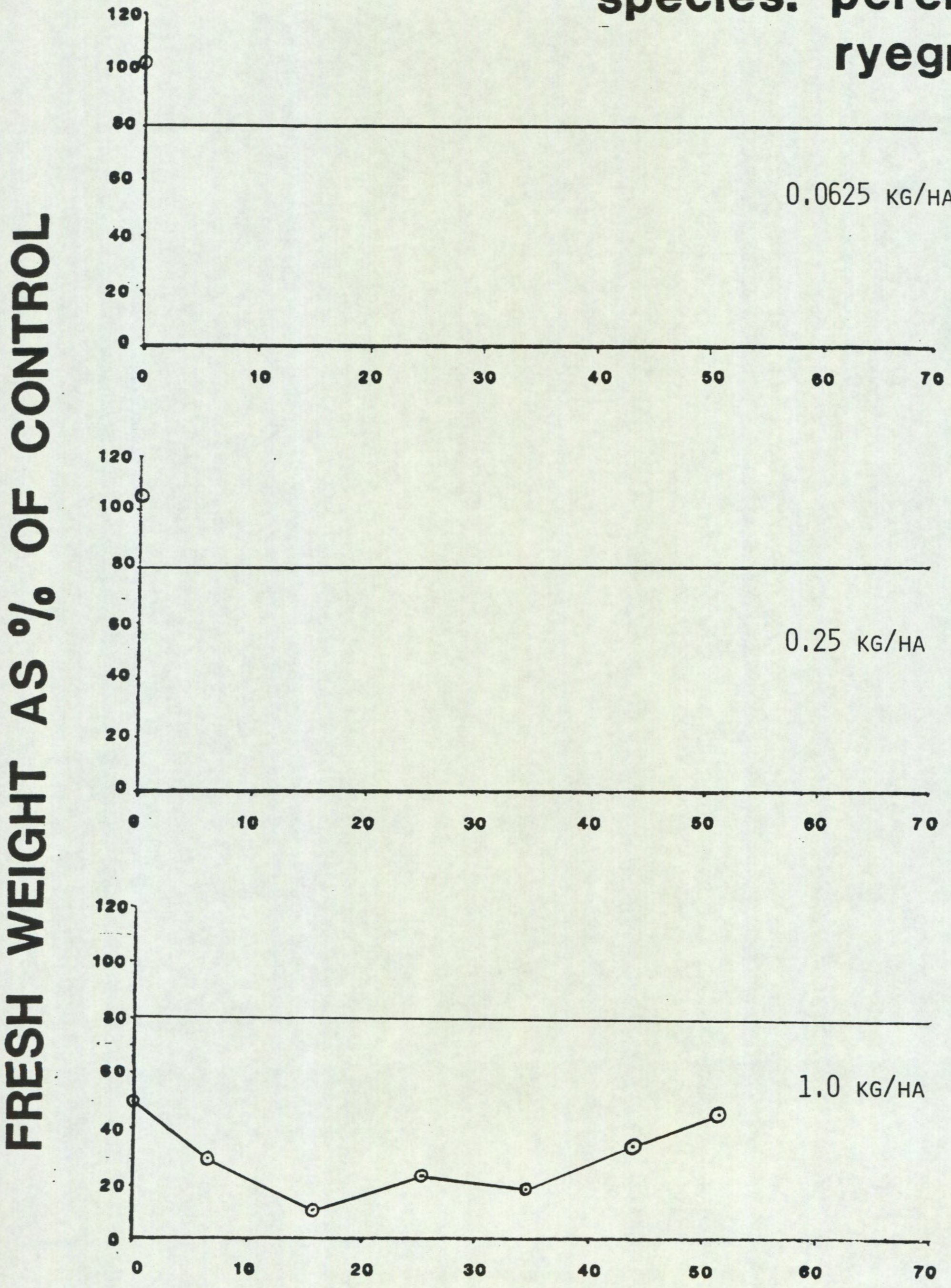
SPECIES		0.0625 KG/HA		0.25 KG/HA		1.0 KG/HA
SEN VULG	90	XXXXXXXXXXXXXXXXXX	94	XXXXXXXXXXXXXXXXXXX	36	XXXXXXX
(34)	93	XXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXXX	50	XXXXXXXXXX
GAL APAR	92	XXXXXXXXXXXXXXXXX	87	XXXXXXXXXXXXXXXXX	179	XXXXXXXXXXXXXXXXXXX+
(38)	86	XXXXXXXXXXXXXXXX	64	XXXXXXXXXXXX	57	XXXXXXXXXX
CHEN ALB	119	XXXXXXXXXXXXXXXXXXX+	107	XXXXXXXXXXXXXXXXXXX+	20	XXXX
(39)	100	XXXXXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXX	29	XXXXX
STEL MED	91	XXXXXXXXXXXXXXXXX	9	XX	0	
(40)	86	XXXXXXXXXXXXXXXX	21	XXXX	0	
VER PERS	75	XXXXXXXXXXXXXX	0		0	
(42)	93	XXXXXXXXXXXXXXXXXX	0		0	
VI ARVE	103	XXXXXXXXXXXXXXXXXXX+	0		0	
(43)	50	XXXXXXXXX	0		0	
RUM OBTU	44	XXXXXXXX	33	XXXXXX	0	
(44)	64	XXXXXXXXXXXX	50	XXXXXXXXX	0	
EL REPEN	94	XXXXXXXXXXXXXXXXXX	94	XXXXXXXXXXXXXXXXXX	103	XXXXXXXXXXXXXXXXXXX+
(47)	100	XXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXX
ALL VIN	109	XXXXXXXXXXXXXXXXXX+	96	XXXXXXXXXXXXXXXXX	83	XXXXXXXXXXXXXXXX
(49)	93	XXXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXX	57	XXXXXXXXXX
CIRS ARV	67	XXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXX	133	XXXXXXXXXXXXXXXXXX+
(50)	100	XXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX

DIFLUFENICAN

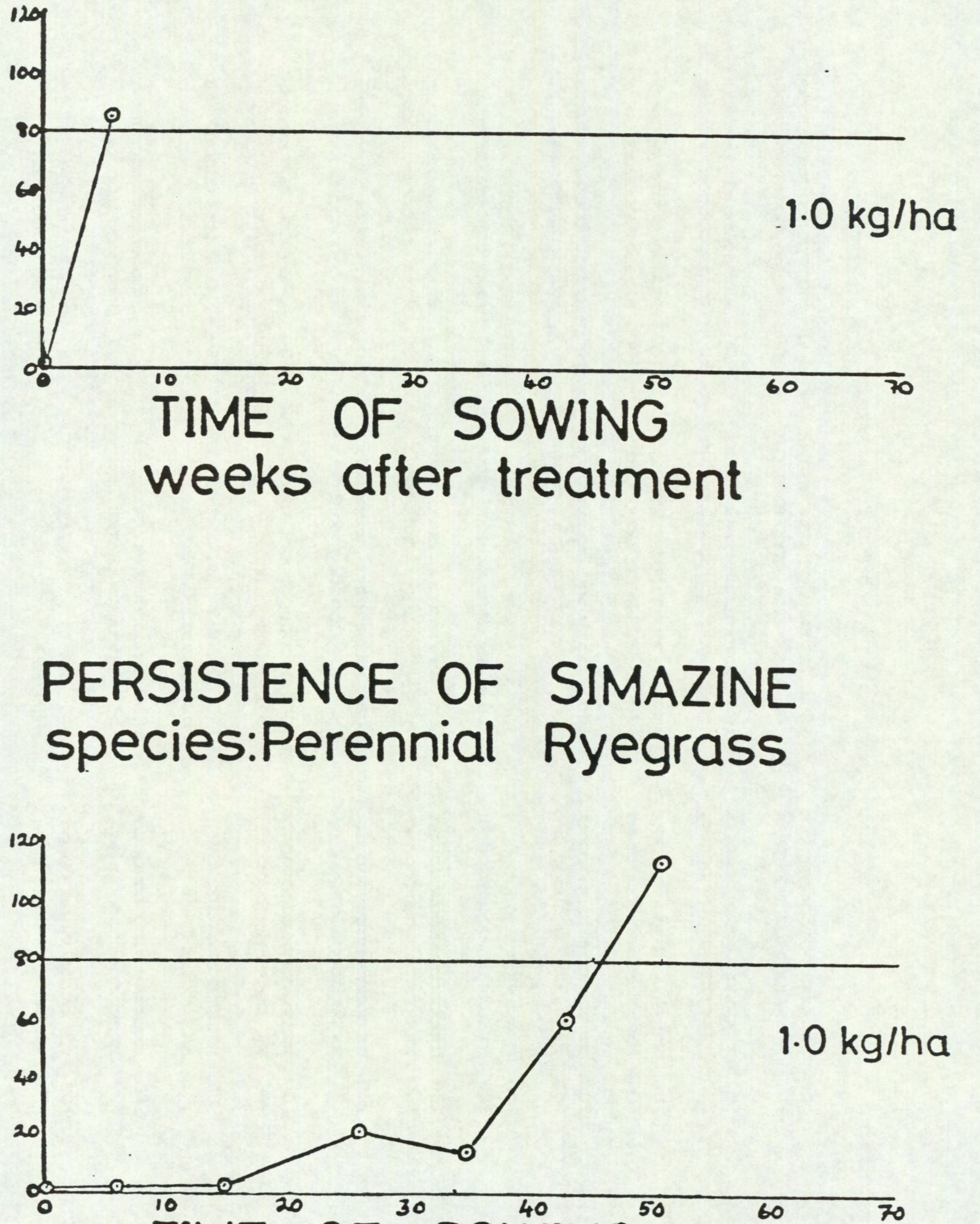
SPECIES		0.0625 KG/HA		0.25 KG/HA		1.0 KG/HA
TUS FARF	87	XXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXXX
(51)	100	XXXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXXX
CONV ARV	53	XXXXXXXXXX	71	XXXXXXXXXXXXX	176	XXXXXXXXXXXXXXXXXXXX+
(52)	93	XXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX	71	XXXXXXXXXXXXX
MAIZE+S	100	XXXXXXXXXXXXXXXXXXX	90	XXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX
(56)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX
MAIZE	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX
(57)	100	XXXXXXXXXXXXXXXXXXX	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX
PHAL MIN	105	XXXXXXXXXXXXXXXXXXX+	101	XXXXXXXXXXXXXXXXXXX	4	X
(84)	100	XXXXXXXXXXXXXXXXXXX	86	XXXXXXXXXXXXXXXX	21	XXXX

PERSISTENCE OF DIFLUFENICAN

species: perennial ryegrass



PERSISTENCE OF CYANAZINE
species: Perennial Ryegrass



PERSISTENCE OF SIMAZINE
species: Perennial Ryegrass

DIFLUFENICAN

Species	0.0625 kg/ha		0.25 kg/ha		1.0 kg/ha	
WHEAT	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(1)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
WHEAT+S	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(2)	100	xxxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
BARLEY	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(3)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
BARLEY+S	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(4)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
OAT	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(5)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
PER RYGR	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(6)	100	xxxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx
ONION	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(8)	86	xxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx
DWF BEAN	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(9)	86	xxxxxxxxxxxxxxxx	57	xxxxxxxxxx	50	xxxxxxxxx
FLD BEAN	80	xxxxxxxxxxxxxxx	120	xxxxxxxxxxxxxxxxxxx+	107	xxxxxxxxxxxxxxxxxxx+
(10)	71	xxxxxxxxxxxxx	50	xxxxxxxxx	43	xxxxxxxx
PEA	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(11)	79	xxxxxxxxxxxxxxx	71	xxxxxxxxxxxxx	71	xxxxxxxxxxxxx
W CLOVER	100	xxxxxxxxxxxxxxxxxxxx	90	xxxxxxxxxxxxxxxxxx	50	xxxxxxxxxx
(12)	79	xxxxxxxxxxxxxxx	79	xxxxxxxxxxxxxxx	64	xxxxxxxxxxxx

DIFLUFENICAN

Species	0.0625 kg/ha		0.25 kg/ha		1.0 kg/ha	
RAPE	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(14)	86	xxxxxxxxxxxxxxxxx	71	xxxxxxxxxxxxxx	64	xxxxxxxxxxxx
KALE	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(15)	64	xxxxxxxxxxxx	57	xxxxxxxxxx	43	xxxxxxxx
CABBAGE	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	60	xxxxxxxxxx
(16)	79	xxxxxxxxxxxxxxx	57	xxxxxxxxxx	36	xxxxxx
CARROT	114	xxxxxxxxxxxxxxxxxxxx+	114	xxxxxxxxxxxxxxxxxxxx+	114	xxxxxxxxxxxxxxxxxxxx+
(18)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
PARSNIP	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	83	xxxxxxxxxxxxxxxx
(19)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxxx
LETTUCE	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	75	xxxxxxxxxxxxxx
(20)	100	xxxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx	57	xxxxxxxxxx
FENUGREK	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(21)	100	xxxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx
SUG BEET	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	92	xxxxxxxxxxxxxxxxx
(22)	86	xxxxxxxxxxxxxxxx	64	xxxxxxxxxxxx	43	xxxxxxxx
BETA VUL	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	58	xxxxxxxxxx
(23)	79	xxxxxxxxxxxxxxx	71	xxxxxxxxxxxxx	50	xxxxxxxxx
BROM STE	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(24)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
FEST RUB	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(25)	93	xxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxx	71	xxxxxxxxxxxxx

DIFLUFENICAN

Species	0.0625 kg/ha		0.25 kg/ha		1.0 kg/ha	
AVE FATU	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(26)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
ALO MYOS	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	90	xxxxxxxxxxxxxxxxxx
(27)	86	xxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxxx	71	xxxxxxxxxxxxxx
POA ANN	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(28)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxxx
POA TRIV	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(29)	100	xxxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxxx	64	xxxxxxxxxxxx
SIN ARV	91	xxxxxxxxxxxxxxxxx	91	xxxxxxxxxxxxxxxxx	91	xxxxxxxxxxxxxxxxx
(30)	57	xxxxxxxxxx	50	xxxxxxxxx	36	xxxxxx
RAPH RAP	100	xxxxxxxxxxxxxxxxxxxx	50	xxxxxxxxx	0	
(31)	43	xxxxxxxx	43	xxxxxxxx	0	
CRY SEG	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(32)	93	xxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxxx
MAT PERF	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(33)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
GAL APAR	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(38)	57	xxxxxxxxxx	57	xxxxxxxxxx	43	xxxxxxxx
CHEN ALB	92	xxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	92	xxxxxxxxxxxxxxxxx
(39)	86	xxxxxxxxxxxxxxxxx	71	xxxxxxxxxxxxx	71	xxxxxxxxxxxxx
STEL MED	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(40)	86	xxxxxxxxxxxxxxxxx	64	xxxxxxxxxxxx	43	xxxxxxxx

DIFLUFENICAN

Species	0.0625 kg/ha		0.25 kg/ha		1.0 kg/ha	
SPER ARV	93	xxxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxxxx	64	xxxxxxxxxxxxx
(41)	79	xxxxxxxxxxxxxxxx	57	xxxxxxxxxxx	43	xxxxxxxxx
VER PERS	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	70	xxxxxxxxxxxxxx
(42)	86	xxxxxxxxxxxxxxxxxx	57	xxxxxxxxxxx	43	xxxxxxxxx
VI ARVE	60	xxxxxxxxxxxx	80	xxxxxxxxxxxxxxxx	0	
(43)	43	xxxxxxxxx	43	xxxxxxxxx	0	
RUM OBTU	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(44)	93	xxxxxxxxxxxxxxxxxxx	57	xxxxxxxxxxx	43	xxxxxxxxx
EL REPEN	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(47)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
AG STOLO	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(48)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxxx
PHAL PAR	80	xxxxxxxxxxxxxxxx	80	xxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(54)	100	xxxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
MAIZE+S	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(56)	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
MAIZE	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(57)	86	xxxxxxxxxxxxxxxxx	86	xxxxxxxxxxxxxxxxx	71	xxxxxxxxxxxxx
SOYABEAN	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx
(65)	71	xxxxxxxxxxxxx	57	xxxxxxxxxxx	57	xxxxxxxxxxx
SOL NIG	100	xxxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxxx	58	xxxxxxxxxxx
(81)	57	xxxxxxxxxx	36	xxxxxx	29	xxxxx

POST-EMERGENCE SELECTIVITY TEST

DIFLUFENICAN

Species	0.0625 kg/ha		0.25 kg/ha		1.0 kg/ha	
PHAL MIN	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx
(84)	100	xxxxxxxxxxxxxxxxxxx	100	xxxxxxxxxxxxxxxxxxx	93	xxxxxxxxxxxxxxxxxx

ACKNOWLEDGEMENTS

We are grateful to the joint Letcombe/WRO Statistics Section for processing the experimental data; to Miss J M Heritage and Messrs G P White, R H Webster, R M Porteous and S Burbank for technical and practical assistance; to Mrs J Wallsworth for the preparation and typing of this report; to Miss N Kiley for the persistence graphs; to Mrs S Cox and her staff for its duplication and to the commercial firms who provided the herbicides and relevant data.

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

	Designation and computer serial number	Cultivar or source	No per pot	Depth of planting (cm)	Stages of growth at assessment (untreated controls, leaf numbers excl. of cotyledons)
Temperate species					
Wheat (Triticum aestivum)	WHEAT (1)	Armada	8	1.0	3.5-4 leaves 0-1 tiller
Wheat+safener (Triticum aestivum)	WHEAT+S (2)	Armada	8	1.0	7 leaves, tillering
Barley (Hordeum vulgare)	BARLEY (3)	Sonja	8	1.0	4 leaves, 0-1 tiller
Barley+safener (Hordeum vulgare)	BARLEY+S (4)	Sonja	8	1.0	7.5-8.5 leaves, tillering
Oat (Avena sativa)	OAT (5)	Pennal	8	1.0	4-5 leaves
Perennial ryegrass (Lolium perenne)	PER RYGR (6)	S 23	15	0.5	5-6 leaves, 0-1 tiller
Onion (Allium cepa)	ONION (8)	Robusta	15	0.5	3-4 leaves
Dwarf bean (Phaseolus vulgaris)	DWF BEAN (9)	Masterpiece	4	1.5	1.5 trifoliate leaves
Field bean (Vicia faba)	FLD BEAN (10)	Maris Bead	4	2.0	5 leaves
Pea (Pisum sativum)	PEA (11)	Dark Skinned Perfection	4	1.5	7 leaves
White Clover (Trifolium repens)	W CLOVER (12)	Kent Wild White	20	0.5	3 trifoliate leaves
Lucerne (Medicago sativa)	LUCERNE (13)	Europe	12	0.5	3 trifoliate leaves
Rape (Brassica napus oleifera)	RAPE (14)	Jet Neuf	20	0.5	4 leaves
Kale (Brassica oleracea acephala)	KALE (15)	Green Marrow Stem	15	0.5	2.5-3 leaves
Swede (Brassica napus)	SWEDE (17)	Acme	12	0.5	3.5 leaves

	Designation and computer serial number	Cultivar or source	No per pot	Depth of planting (cm)	Stages of growth at assessment (untreated controls, leaf numbers excl. of cotyledons)
Carrot (Daucus carota)	CARROT (18)	Chantenay Red Core	12	0.5	3.5-4 leaves
Lettuce (Lactuca sativa)	LETTUCE (20)	Reskia	15	0.5	6 leaves
Fenugreek (Trigonella foenumgraecum)	FENUGREEK (21)	Paul	10	0.5	2-3 trifoliate leaves
Sugar beet (Beta vulgaris)	SUG BEET (22)	Nomo monogerm	15	1.0	2-4 leaves
Beta vulgaris	BETA VUL (23)	Attleborough 1979	20	0.5	4.5 leaves
Bromus sterilis	BROM STE (24)	WRO 1982	12	0.5	6-8 leaves, 2 tillering
Festuca rubra	FEST RUB (25)	BOREAL CDN 86-0192	25	0.25	1-3 tillers
Avena fatua	AVE FATU (26)	WRO 1980	10	1.0	4.5-5 leaves
Alopecurus myosuroides	ALO MYOS (27)	B and S Supplies 1982	25	0.25	2-3 tillers
Poa annua	POA ANN (28)	B and S Supplies 1980	25	0.5	4-5 leaves, 0-1 tiller
Poa trivialis	POA TRIV (29)	B and S Supplies 1981	25	0.25	Up to 10 cm
Sinapis arvensis	SIN ARV (30)	WRO 1981	20	0.5	4-5 leaves
Raphanus raphanistrum	RAPH RAP (31)	Long Black Spanish	12	0.5	4 leaves
Chrysanthemum segetum	CHRY SEG (32)	WRO 1982	20	surface	5-6 leaves
Matricaria perforata	MAT PERF (33)	WRO 1981	25	surface	6-7 leaves

	Designation and computer serial number	Cultivar or source	No per pot	Depth of planting (cm)	Stages of growth at assessment (untreated controls, leaf numbers excl. of cotyledons)
Senecio vulgaris	SEN VULG (34)	B and S Supplies 1981	40	surface	6-7 leaves
Polygonum lapathifolium	POL LAPA (35)	WRO 1981	20	0.5	1-4 leaves
Galium aparine	GAL APAR (38)	WRO 1981	12	1.0	8-15 whorls
Chenopodium album	CHEN ALB (39)	WRO 1979	40	0.5	4 leaves
Stellaria media	STEL MED (40)	B and S Supplies 1981	40	0.5	Numerous leaves
Veronica persica	VER PERS (42)	WRO 1981	15	0.5	Several leaves
Viola arvensis	VI ARVE (43)	B and S Supplies 1982	30	0.5	6 leaves
Rumex obtusifolius	RUM OBTU (44)	B and S Supplies 1981	25	0.25	2-3 leaves
Elymus repens	EL REPEN (47)	WRO Clone 31	6*	1.5	4-5 leaves
Allium vineale	ALL VIN (49)	WRO 1982	12***	1.0	2-3.5 leaves
Cirsium arvense	CIRS ARV (50)	WRO Clone 1	4**	1.5	4-7 leaves
Tussilago farfara	TUS FARF (51)	WRO Clone 1	4*	1.5	2-4 leaves
Convolvulus arvensis	CONV ARV (52)	B and S Supplies 1979	15	0.5	7-8 leaves
Phalaris paradoxa	PHAL PAR (54)	ADAS 1981	20	0.5	-

	Designation and computer serial number	Cultivar or source	No per pot	Depth of planting (cm)	Stages of growth at assessment (untreated controls, leaf numbers excl. of cotyledons) at assessment
Maize+safener (Zea mays)	MAIZE+S (56)	LG11	5	1.5	4.5 leaves
Maize (Zea mays)	MAIZE (57)	LG11	5	1.5	4.5 leaves
Phalaris minor	PHAL MIN (84)	Delhi 1978	15	0.25	4–5 leaves

* = one node rhizome fragments
** = 4 cm root fragments
*** = aerial bulbils

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

Species	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)
Wheat (Triticum aestivum)	WHEAT (1)	Timmo	3.5–4.5 leaves, 1 tiller	3–5 tillers
Wheat + safener	WHEAT + S (2)	Timmo	3 leaves	4 tillers
Barley (Hordeum vulgare)	BARLEY (3)	Triumph	3–5 leaves, 1 tiller	4–5 tillers
Barley + safener	BARLEY + S (4)	Triumph	2–2.5 leaves	4–5 tillers
Oat (Avena sativa)	OAT (5)	Pennal	2.5–3 leaves	4–6 tillers
Perennial ryegrass (Lolium perenne)	PER RYGR (6)	S 23	1 tiller	7–9 tillers
Onion (Allium cepa)	ONION (8)	Robusta	2–2.5 leaves	4.5 leaves
Dwarf bean (Phaseolus vulgaris)	DWF BEAN (9)	Masterpiece	2 unifoliate leaves	5 trifoliate leaves, flowering
Field bean (Vicia faba)	FLD BEAN (10)	Maris Bead	3 leaves	10–12 leaves, flowering
Pea (Pisum sativum)	PEA (11)	Dark Skinned Perfection	3.5 leaves	Up to 10 leaves
White Clover (Trifolium repens)	W CLOVER (12)	S 100	4 trifoliate leaves	Numerous trifoliate leaves
Rape (Brassica napus oleifera)	RAPE (14)	Jet Neuf	2.5–3.5 leaves	7–7.5 leaves
Kale (Brassica oleracea acephala)	KALE (15)	Marrowstem	2–2.5 leaves	3.5–4.5 leaves
Cabbage (Brassica oleracea capitata)	CABBAGE (16)	Derby Day	2–2.5 leaves	8–8.5 leaves

Species	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)
Carrot (Daucus carota)	CARROT (18)	Chantenay Red Core	3-3.5 leaves	7-8 leaves
Parsnip (Pastinaca sativa)	PARSNIP (19)	Evesham	2.5 leaves	4.5-5 leaves
Lettuce (Lactuca sativa)	LETTUCE (20)	Reskia	3.5 leaves	6-10 leaves
Fenugreek (Trigonella foenumgraecum)	FENUGREK (21)	Paul	3-4 trifoliate leaves	7.5-8.5 trifoliate leaves
Sugar beet (Beta vulgaris)	SUG BEET (22)	Nomo	4-5 leaves	10 leaves
Beta vulgaris	BETA VUL (23)	WRO 1981 ex Attleborough	3-4 leaves	14 leaves
Bromus sterilis	BROM STE (24)	WRO 1982	2-3 tillers	Up to 10 tillers
Festuca rubra	FEST RUB (25)	Boreal	3-3.5 leaves	7-20 tillers
Avena fatua	AVE FATU (26)	WRO 1980	2-3 tillers	3-4 tillers
Alopecurus myosuroides	ALO MYOS (27)	WRO 1982	1-2 tillers	Up to 14 tillers
Poa annua	POA ANN (28)	B & S Supplies,1978	2-3 tillers	8-10 tillers
Poa trivialis	POA TRIV (29)	B & S Supplies,1981	1-3 tillers	8-10 tillers
Sinapis arvensis	SIN ARV (30)	WRO 1981	5 leaves	Numerous leaves, podded
Raphanus raphanistrum	RAPH RAP (31)	Long Black Spanish	2.5-4 leaves	4.5-6 leaves
Chrysanthemum segetum	CHRY SEG (32)	WRO 1982	8 leaves	Up to 11 leaves
Matricaria perforata	MAT PERF (33)	WRO 1981	7-9 leaves	Numerous leaves, flowering
Galium aparine	GAL APAR (38)	WRO 1981	3-3.5 whorls	Numerous whorls

Species	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)
Chenopodium album	CHEN ALB (39)	WRO 1979	Up to 14 leaves	Numerous leaves, flowering
Stellaria media	STEL MED (40)	B & S Supplies,1982	Up to 18 leaves	Numerous leaves, flowering
Spergula arvensis	SPER ARV (41)	WRO, 1981	3-4 whorls	Numerous whorls, flowering
Veronica persica	VER PERS (42)	WRO, 1980	9-11 leaves	Numerous leaves, flowering
Viola arvensis	VI ARVE (43)	B & S Supplies,1982	3-7 leaves	Numerous leaves, flowering
Rumex obtusifolius	RUM OBTU (44)	WRO, 1981	3-4.5 leaves	5.5 leaves
Elymus repens	EL REPEN (47)	WRO Clone 31*	2.5-3 leaves	4-5 tillers
Agrostis stolonifera	AG STOLO (48)	B & S Supplies,1981	4-6 stolons	18-25 stolons
Cirsium arvense	CIRS ARV (50)	WRO Clone 1**	10-10.5 leaves	Numerous leaves
Phalaris paradoxa	PHAL PAR (54)	Ethiopia, 1979	Up to 2 tillers	5-7 tillers, flowering
Maize + safener (Zea mays)	MAIZE + S (56)	LG 11	4.5 leaves	6-6.5 leaves
Maize (Zea mays)	MAIZE (57)	LG 11	3.5 leaves	5.5-6.5 leaves
Soybean (Glycine max)	SOYABEAN (65)	Anoko	2 unifoliates	3.5 trifoliate leaves
Solanum nigrum	SOL NIG (81)	WRO, 1980	3.5-4 leaves	5-6 leaves, flowering
Phalaris minor	PHAL MIN (84)	WRO, 1979	2 tillers	5 tillers

* one node rhizome pieces ** root fragments