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THE ACTIVITY AND SELECTIVITY OF THE HERBICIDES: ETHOFUMESATE, RU 12709 AND ISOPROTURON

RU 12709 is 5-chloro-2-(2-tetrahydropyranyl)-6-methyluracil (Procida)

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THE ACTIVITY AND SELECTIVITY OF THE HERBICIDES ETHOFUMESATE, RU 12709 AND ISOPROTURON

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SUMMARY

Ethofumesate, RU 12709 and isoproturon were examined for their soil and foliar activity on six selected species and also for their pre and post-emergence selectivities on a wide range of temperate and tropical crop and weed species. Soil persistence was monitored in conjunction with the pre-emergence experiment.

Ethofumesate was more active through the soil, especially as a pre-emergence surface spray, but good weed control and several potential selectivities were found following incorporation. Post-emergence, it was less active on the weeds than pre-emergence but some useful selectivities were noted. Good tolerance of sugar beet was confirmed post-emergence but symptoms occurred pre-emergence under greenhouse conditions. Composite weeds were resistant both pre- and post-emergence. Soil persistence was considerable.

RU 12709 showed many features in common with other uracils. Annual broad-leaved weeds were more sensitive than annual grass weeds and were more susceptible to post-emergence than to pre-emergence treatments. Pea showed some tolerance pre- and post-emergence and a number of other potentially useful selectivities were noted. Soil persistence was of short duration, contrasting with other uracils.

Isoproturon was most active following soil application but the foliar spray damaged some broad-leaved species. Post-emergence soil drenches on annual species were more active than pre-emergence treatments. Some selectivities were found, notably in wheat and annual weeds were controlled pre- and post-emergence. These included Alopecurus myosuroides. Avena fatua was also susceptible pre-emergence, but not post-emergence. The resistance of certain weeds eg Galium aparine and perennial species was a notable disadvantage. A moderate period of soil persistence was observed.

INTRODUCTION

This report records the activity of ethofumesate, RU 12709 and isoproturon and summarises their potential pre- and post-emergence selectivities.

As the work was carried out on only one crop variety or source of weed species, in one particular soil type without intraspecific competition and at one specific growth stage, the results should be used only as a guide for further work. It should be borne in mind that plant responses in glasshouse experiments can be very different from those in the field.

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* Herbicide Group

** ODM Tropical Weeds Group

METHODS AND MATERIALS

Activity experiments. These were carried out in the manner standardised by Richardson and Dean (1973a). Herbicides were applied to six species as (i) a foliar spray without soil contact, (ii) a post-emergence soil drench avoiding the foliage, (iii) a pre-emergence surface application and (iv) a pre-planting spray with thorough incorporation. The four annual species were raised from seed and two perennials grown from rhizome fragments. Species data and environmental conditions are summarised in Tables 1 and 2.

Table 1. Plant data for activity experiments.

Species	Cultivar/ source	No. per pot at spraying		Depth of Planting (cm)	Stage of growth of post-emergence treatments	Stage of growth at assessment	
		pre-	post-			pre-	post-
Dwarf bean (Phaseolus vulgaris)	The Prince	3	2-3	1.8	2 unifoliate leaves	$1\frac{1}{2}$-2 trifoliate leaves	$1\frac{1}{2}$-2 trifoliate leaves
Kale (Brassica oleracea acephala)	Marrow stem	8-15	5-6	0.6	$\frac{1}{2}$-2 leaves	$2\frac{1}{2}$-$4\frac{1}{2}$ leaves	$3\frac{1}{2}$-$4\frac{1}{2}$ leaves
Polygonum amphibium	WRO Clone 1	6	4-5	1.2	$2\frac{1}{2}$-$5\frac{1}{2}$ leaves	7-$8\frac{1}{2}$ leaves	6-$9\frac{1}{2}$ leaves
Perennial ryegrass (Lolium perenne)	S 23	10-15	8-10	0.6	2-$2\frac{1}{2}$ leaves	5-6 leaves, tillering	5-7 leaves, tillering
Avena fatua	(Box- (worth (1967 (Hensing- (ton 1969	8-10	4-5	1.2	2-3 leaves	$4\frac{1}{2}$-6 leaves, tillering	5-7 leaves, tillering
Agropyron repens	WRO Clone 31	5-6	3-5	1.2	2-$3\frac{1}{2}$ leaves	5-6 leaves, tillering	5-7 leaves, tillering

Table 2. Soil and environmental conditions for activity experiments.

Experiment number and herbicide included	AE 1 ethofumesate	AE 2 RU 12709	AE 3 isoproturon
Date of spraying	15.5.70	7.6.72	21.6.73
Main assessment completed	15.6.70	15.7.72	20.7.73
Soil moisture at spraying	-	10.0	13.5
Organic matter (%)	1.8	2.8	2.8
Clay content	13.0	16.0	16.0
pH	7.3	7.7	7.0
John Innes Base ferilizer (g/kg)	4.0	4.0	4.0
5% DDT Dust (g/kg)	0.5	0.5	0.5
Fritted trace elements (g/kg)	-	0.25	0.25
Temperature (^{o}C)			
Mean	20	19	19
Maximum	32	29	30
Minimum	11	9	13
Relative humidity (%)			
Mean	60	60	60
Maximum	95	88	86
Minimum	34	30	32

Selectivity experiments. These also were of the standard form reported by Richardson and Dean (1973a, 1973b). Soil and environmental conditions are summarised in Table 3 and plant data and stages of growth in Appendices I and II.

In the pre-emergence experiments, soil from a field at Begbroke was sprayed with ethofumesate or RU 12709, thoroughly mixed and individual species sown at measured depths. Isoproturon was applied as a surface spray after planting the various species in pots containing untreated soil. Pots were kept in the glasshouse and watered from overhead.

For the post-emergence experiment, plants were grown in soil from the field and treated at one stage of growth, following thinning to a constant number. Temperate species were raised throughout in the open on a paved area and tropical species in a glasshouse.

Radish (Raphanus raphanistrum) was included because of its ease of propagation and may be regarded as a crop or weed. To improve establishment, the following treatments were applied:-

Chenopodium album — Seeds soaked in 0.1 M KNO_3 and kept in the light for 3 days before planting.

Cyperus esculentus — Tubers stored moist at 4^{o}C for 23 days.

Oxalis latifolia	Freshly harvested bulbils stored at 20°C for 4 weeks followed by treating at 45°C for 4 hours.
Rumex crispus	Husks of seeds removed.
Polygonum aviculare	Kept moist for 6 weeks at 2°C before sowing.
Veronica persica	Kept moist for 6 weeks at 2°C before sowing. Sown in steam-sterilized soil to avoid damping-off in post-emergence experiment.

Table 3. Soil and environmental conditions for selectivity experiments

Experiment type and number	Pre-emergence selectivity			post-emergence selectivity experiment
Herbicide(s) included	experiment 1 ethofumesate	experiment 2 RU 12709	experiment 3 isoproturon	ethofumesate RU 12709 isoproturon
Date of spraying	20.1.70	31.10.72	30.1.74	26.7.73
Main assessment completed	10.3.70	8.12.72	5.3.74	9.8.73
Soil moisture (%)	14.0	13.0	13.5	-
Organic matter (%)	1.8	2.8	2.8	2.8
Clay content (%)	13.0	16.0	16.0	16.0
pH	7.3	7.7	7.7	7.0
John Innes Base fertilizer (g/kg)	1.5	1.0	2.5	2.0
5% DDT dust (g/kg)	0.5	0.5	0.5	0.5
Fritted trace elements	-	0.25	-	0.25
Magnesium sulphate	-	-	1.0	-

	Temperate	Tropical	Temperate	Tropical	Temperate	Tropical	Temperate	Tropical
Temperature (°C)								
Mean	17	22	17	23	18	22	18	27
Maximum	25	26	25	29	30	30	27	39
Minimum	14	18	12	12	5	9	7	19
Relative humidity (%)								
Mean	60	55	60	60	60	60	55	70
Maximum	90	90	86	88	87	86	78	100
Minimum	40	40	38	44	30	34	34	34

Herbicide treatment. Herbicides were applied by a laboratory sprayer which embodied a moving Teejet fan nozzle operating at a pressure of 2.11 bars (30 lb/in^2) moving at constant speed 30 cm above the soil/plants. All doses are in terms of active ingredient (a.i.) unless otherwise specified.

Assessment and processing of results

In all experiments surviving plants were counted and their vigour was scored on a 0-7 scale as defined by Richardson and Dean (1973a) where 0 = dead and 7 = control. A computer was used to process the selectivity experiment data as before. A table of the results is presented for each herbicide which includes a pair of figures; the first figure represents mean plant survival and the second, mean vigour score, both calculated as a percentage of untreated controls. Thus 100/100 = as control; 0/0 = complete kill. In the activity experiment a histogram is presented for each treatment, the upper row of 'x's' representing mean plant survival and the lower, mean vigour score. Each 'x' represents a 7% increment and a '+' indicates a value in excess of 100%.

Herbicide persistence in the soil.

Soil treated with ethofumesate or RU 12709 from the pre-emergence experiments was stored in glass jars at 23°C in the dark and sub-sampled at intervals. In the experiment with ethofumesate the soil moisture level fell from 14% at the start of the experiment to 8% after one year. Soil sprayed with isoproturon was kept under temperate glasshouse conditions, moistened with overhead watering and was sown periodically with minimum disturbance of the soil, a different area being used for each test. Untreated soil was stored and sown in a similar manner in each type of experiment. Sensitive species were planted and assessments made at the 2-4 leaf stage (Richardson and Dean 1973a).

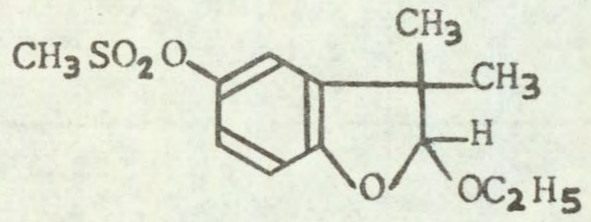
ETHOFUMESATE

Code number NC 8438

Trade name Nortron (previously Nortran)

Chemical name 2-ethoxy-2,3-dihydro-3,3-dimethylbenzofuran-5-yl methylsulphonate

Structure



Source

Fisons Ltd
Agrochemical Division
Chesterford Park Research Station
Nr Saffron Walden
Essex CB10 1XO

Information available and suggested uses

Approved for control of germinating annual broad-leaved and grass weeds pre-emergence of sugar beet when used with lenacil or pyrazone. The dose of ethofumesate is 1-0 to 2.0 kg ai/ha depending on soil type. The manufacturers also recommend it post-emergence at 1.0 kg ai/ha plus phenmedipham. It is also approved for control of weed grasses and some broad-leaved weeds in ryegrass seed crops. Dosage is 1.4 kg ai/ha pre-emergence and 2.0 kg ai/ha post-emergence.

Selectivity is also reported in other Beta spp., sunflower, tobacco, pastures (for barley grass control) and certain cruciferous crops. Agropyron repens and Agrostis stolonifera have been controlled at 4 kg/ha. Cyperus rotundus and Cyperus esculentus were well controlled in the glasshouse. (Fisons Technical Bulletin 1973).

Formulation used 20% w/w a.i. wettable powder for activity and pre-emergence experiment.

200 g a.i./l emulsifiable concentrate for post-emergence experiment.

Spray volume 338 l/ha (30.1 gal/ac) for activity and pre-emergence experiment.

305 l/ha (27.1 gal/ac) for post-emergence experiment.

RESULTS

Full results are presented on pages 11-13 and potential selectivities are summarised in the following tables.

Table 4. Potential pre-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
4.48	None	None listed as no crops tolerant
1.12	perennial ryegrass onion dwarf bean carrot groundnut	Avena fatua Alopecurus myosuroides Galium aparine Chenopodium album Agropyron repens Rumex acetosella Eleusine indica Echinochloa crus-galli Cyperus rotundus + species below
0.28	species above + oat pea kale swede sugar beet maize sorghum cotton kenaf	Poa annua Stellaria media Digitaria sanguinalis

Table 5. Potential post-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
6.0	onion	Poa trivialis Sinapis arvensis Spergula arvensis Eleusine indica Echinochloa crus-galli Amaranthus retroflexus + species below
2.0	species above + lettuce sugar beet rice	Polygonum aviculare Digitaria sanguinalis + species below
0.67	species above + perennial ryegrass kale carrot maize groundnut tobacco	Galium aparine Chenopodium album Stellaria media Solanum nigrum Portulaca oleracea

Comments on results

Activity experiment (see page 11)

Most activity was found following soil treatments. The foliar spray caused some damage, particularly on broad-leaved species, using the wettable powder formulation. (Had the emulsifiable concentrate been used, as it was in the post-emergence selectivity experiment, more foliar activity might have been expected). Pre-emergence surface application was more active than incorporation, particularly with the annual grasses. Pfeiffer (1969) has shown that much of the activity on grasses is due to uptake from the soil through the emerging shoot but clarification on the site of entry is needed for the broad-leaved species. Post-emergence soil drenches were also very active; kale and dwarf bean were more susceptible to these treatments than to pre-emergence surface applications.

Symptoms

Foliar sprays initially caused necrosis of treated leaves (mild in the activity experiment, more severe in the post-emergence selectivity experiment).

Subsequently the main shoots of grasses and buds of broad-leaves species were severely inhibited. New leaves were often deformed and tended to stick together, possibly due to loss of wax from the leaf surfaces which were frequently shiny in appearance. Older foliage usually became darker green before eventual dieback. A feature in broad-leaved species, notably Galium aparine, was the complete inhibition of the main bud, but cotyledons were virtually unaffected. Post-emergence soil drenches stopped growth within a few days of treatment. Some leaves became darker green while others showed a mild chlorosis, before dying back. Increased tillering was sometimes observed in certain grasses following the post-emergence foliar spray or soil drench. These tillers were generally stunted and dark green, however.

Similar symptoms were caused by pre-emergence treatments. At high doses grasses failed to emerge from the coleoptile while at lower doses leaves were darker green and frequently stuck together. Effects were observed mainly on the growing points of broad-leaved species. The symptoms described are reminiscent of those caused by amide, carbamate and halogenated aliphatic acid herbicides.

Soil persistence

A long period of soil persistence was found using Poa annua as the test species. Foliage fresh weight was only 50% of control 52 weeks after applying 0.28 kg/ha and at 1.12 kg/ha it was only 16% of control. At 4.48 kg/ha all plants were killed. However P. annua is particularly sensitive to ethofumesate; other species which germinate and emerge more quickly may not show this extreme susceptibility.

Selectivity among temperate species

Pre-emergence

Noteworthy features of the pre-emergence experiment were the kill of Rumex acetosella and Agropyron repens at 1.12 kg/ha and the tolerance of Senecio vulgaris and Tussilago farfara. Onion, carrot and, to a lesser extent, sugar beet showed variable responses. Certain plants were severely affected or even killed at lower rates while at higher doses some developed normally. Hence with all these crops moderate/severe reductions in plant number were noted. Although sugar beet showed some resistance at 1.12 kg/ha it can only be considered fully tolerant at 0.28 kg/ha. The pre-emergence experiment did not completely confirm the tolerance of sugar beet to ethofumesate. Symptoms were present at assessment but this has also been reported by the manufacturer (Technical data, 1973). They report however that there is no evidence to suggest that the final yield is depressed, unless effects are very severe. The growing environment evidently plays an important role in determining the presence or absence of these symptoms. The potential selective pre-emergence control of certain annual grasses in perennial ryegrass has already been reported by Pfeiffer (1969), and Blair (1972 and 1973).

Post-emergence

In the post-emergence experiment, Avena fatua was eventually controlled at 6.0 kg/ha and although Agropyron repens and Agrostis stolonifera were not considered controlled by 2.0 kg/ha at the intial assessment, their shoot fresh weights were reduced by 81% and 89% respectively, six weeks after spraying. Two problem weeds, Galium aparine and Polygonum aviculare were

controlled at 2 kg/ha but P. lapathifolium, V. persica and Compositae were resistant. Although all the tolerant crops showed initial symptoms, there was no reduction in the shoot fresh weights of sugar beet, lettuce and carrot 3 months after treatment, even at 6 kg/ha, and post-emergence selective control of a range of temperature weeds should be feasible in these crops and in onion. As with pre-emergence treatments, gaps in the post-emergence weed control spectrum were evident, but could possibly be closed by mixtures with other herbicides selective in these crops. The residual activity of ethofumesate, following post-emergence application, could also have the advantage of controlling later germinating weeds.

Post-emergence weed control generally required slightly higher rates in spite of the more foliar active emulsifiable formulation in this experiment. Crop tolerance in the two experiments was comparable but dwarf bean was more susceptible to post-emergence application and lettuce, sugar beet and onion more susceptible pre-emergence.

Selectivity among tropical species

Pre-emergence

Although not appearing in Table 6 because of erratic germination Amaranthus retroflexus/ appeared to be susceptible to 0.28 kg/ha. Severe effects on Cyperus rotundus at 1.12 kg/ha were still apparent 11 weeks after treatment. C. esculentus/ was also severely damaged at this dose but later recovered. Neither species emerged at 4.48 kg/ha but C. rotundus tubers grew normally after transfer to untreated soil. The reduced plant numbers in cotton were caused by erratic germination. There appears to be a potential for selective control of Cyperus spp and annual weeds (particularly Digitaria but not Rottboellia/) in groundnut and possibly in maize, kenaf and cotton.

Post-emergence

C. rotundus was the most resistant of the perennials and eventually recovered from the highest dose. C. esculentus/ was more sensitive, but even though the foliage was killed, the tubers appeared to be still sound. Cynodon dactylon was eventually suppressed by 6 kg/ha; new shoots were deformed and some proliferation of distorted shoots was also observed.

In this post-emergence experiment considerably higher rates were required than in the pre-emergence test and relatively little selectivity was demonstrated, except possibly in rice.

/ Species marked in this way do not appear in the histograms because of erratic germination. Their behaviour was, however, noted.

ACTIVITY EXPERIMENT

ETHOFUMESATE

		0.8 kg/ha	2.5 kg/ha	7.5 kg/ha
DWARF BEAN	F	xxxxxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxx
	S	xxxxxxxxxxxxxx xxxxxxx	xxxxxxxxxxxxxx xxxx	xxxxxx xx
	P	xxxxxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxxxxxx + xxxxxxxxx	xxxxxxxxxxxxxx + xxxxxx
	I	xxxxxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxxx xxxxxx x
KALE	F	xxxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxx	xxxxxxxxxxxxxx xxxxxxx
	S	xxxxxxxx xx	o o	o o
	P	xxxxxxxxxxxxxx + xxxxxxxxxx	xxxxxxxxxx xxxxx	xx xxxx
	I	xxxxxxxxxxxxxx + xxxxxxxxxx	xxxxxxxxxxxxxx + xxxxxxx	xxxxxxxxxx xxxxx
POLYGONUM AMPHIBIUM	F	xxxxxxxxxxxxxx xxxxxxxxx	xxxxxxxxxxxxxx xxxxxx	xxxxxxxxxxxxxx xxxxxxx
	S	xxxxxxxxxxxxxx xxxxxx	xxxxxxxxxx xxxx	xxxxxxxxxx xxxx
	P	o o	o o	o o
	I	xxxxxxxxxxxxxx xxxxx	xxxx xx	o o
PERENNIAL RYEGRASS	F	xxxxxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxxxxx
	S	xxxxxx xxxx	x xx	o o
	P	xxxx xxxxxxxxxx	o o	o o
	I	xxxxxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxxxx xxxxxxx	x xxx
AVENA FATUA	F	xxxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxx
	S	xxxxxxxxx xxx	xx xx	o o
	P	o o	o o	o o
	I	xxxxxxxxxx xxxxxxx	o o	o o
AGROPYRON REPENS	F	xxxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxxx xxxxxxxxx	xxxxxxxxxxxxxx xxxxxxx
	S	xxxxxx xxxx	xx x	xx x
	P	o o	o o	o o
	I	o o	o o	o o

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

Table 6. ETHOFUMESATE

SPECIES	SPECIES NO.	PRE-EMERGENCE 0.28	1.12	4.48	POST-EMERGENCE 0.67	2.00	6.00
		kg a.i./ha			kg a.i./ha		
WHEAT	1	63/43	0/0	0/0	100/50	100/43	100/43
BARLEY	2	96/71	0/0	0/0	100/57	100/43	100/36
OAT	3	100/100	6/29	0/0	100/71	100/43	100/29
PER RYGR	4	97/100	93/93	14/43	100/93	100/64	94/50
ONION	8	150/93	83/86	38/50	100/86	100/86	100/86
DWF BEAN	9	100/100	100/93	100/64	100/71	100/79	100/71
FLD BEAN	10	16/50	32/21	63/29	100/43	100/43	100/43
PEA	11	141/100	106/64	71/29	100/71	100/79	100/43
W CLOVER	12	79/43	10/21	0/0	100/29	100/29	100/29
BRD BEAN	13	-	-	-	100/71	100/50	100/43
RAPE	14	-	-	-	100/57	100/43	100/43
KALE	15	120/86	113/50	73/36	100/86	100/50	100/36
CABBAGE	16	-	-	-	87/64	100/57	100/43
SWEDE	17	113/86	107/50	7/14	-	-	-
CARROT	18	111/100	39/93	24/79	100/93	100/71	100/71
LETTUCE	20	108/79	31/36	0/0	100/86	100/86	100/79
SUG BEET	21	75/100	66/71	115/43	100/100	100/86	100/71
AVE FATU	26	111/86	22/21	0/0	100/100	100/57	100/43
ALO MYOS	27	47/50	0/0	0/0	100/43	100/36	100/43
POA ANN	28	14/43	0/0	0/0	100/50	100/36	100/36
POA TRIV	29	-	-	-	100/79	100/36	100/29
SIN ARV	30	-	-	-	100/57	100/43	75/29
RAPH RAP	31	-	-	-	90/64	100/43	60/43
CHRY SEG	32	-	-	-	100/86	100/86	100/57
TRIP MAR	33	-	-	-	100/100	100/64	83/36
SEN VULG	34	140/100	50/100	120/93	100/100	100/100	100/100
POL LAPA	35	98/93	87/57	35/36	100/79	100/79	100/57
POL AVIC	36	-	-	-	100/64	100/29	100/29
RUM CRIS	37	-	-	-	100/71	100/50	100/43
GAL APAR	38	73/43	47/29	27/21	100/29	100/29	100/29
CHEN ALB	39	74/86	17/14	0/0	100/29	100/29	0/0
STEL MED	40	66/29	0/0	0/0	44/7	100/29	100/29
SPER ARV	41	-	-	-	92/43	100/43	100/29
VER PERS	42	-	-	-	100/86	100/86	100/71

KEY = No/Vigour (survivors as % of control)

Untreated = 100/100

Table 6 (cont...) ETHOFUMESATE

SPECIES	SPECIES NO.	PRE-EMERGENCE 0.28	1.12	4.48	POST-EMERGENCE 0.67	2.00	6.00
		kg a.i./ha			kg a.i./ha		
SOL NIG	43	-	-	-	25/21	100/29	100/29
AG REPEN	47	82/43	0/0	0/0	100/50	100/43	100/43
AG STOLO	48	-	-	-	100/71	100/71	100/50
ALL VIN	49	118/86	75/71	32/14	-	-	-
CIRS ARV	50	82/100	55/86	0/0	-	-	-
TUS FARF	51	100/100	100/100	88/100	-	-	-
RUM ACET	53	-/78 *	0/0	0/0	-	-	-
MAIZE	58	100/100	100/71	100/29	100/86	100/64	100/50
SORGHUM	59	88/93	0/0	0/0	100/64	100/29	100/29
RICE	60	-	-	-	100/100	100/93	100/50
GRNDNUT	64	104/100	91/86	91/64	100/86	100/71	100/50
SOYABEAN	65	69/79	92/43	23/21	100/43	100/36	100/29
COTTON	66	63/100	47/79	0/0	100/36	100/29	100/29
JUTE	67	-	-	-	100/50	100/36	83/21
KENAF	68	127/100	73/71	36/29	100/36	100/29	100/29
TOBACCO	69	-	-	-	100/93	100/64	100/50
SESAMUM	70	-	-	-	100/57	92/43	92/36
TOMATO	71	-	-	-	100/43	100/29	100/29
OR PUNCT	73	-	-	-	100/93	100/93	100/43
ELEU IND	74	42/71	0/0	0/0	100/43	100/36	100/29
ECH CRUS	75	70/86	23/50	0/0	100/79	100/36	100/29
ROT EXAL	76	-	-	-	100/100	100/71	100/36
DIG SANG	77	0/0	0/0	0/0	100/50	100/29	100/29
ANAR RET	78	-	-	-	100/79	100/57	100/29
PORT OLE	79	-	-	-	67/29	33/14	17/7
CYN DACT	82	-	-	-	105/71	114/43	105/36
CYP ESCU	85	-	-	-	86/100	114/93	57/36
CYP ROTU	86	131/71	16/21	0/0	91/100	86/79	74/64

KEY = No/Vigour (survivors as % of control)

Untreated = 100/100

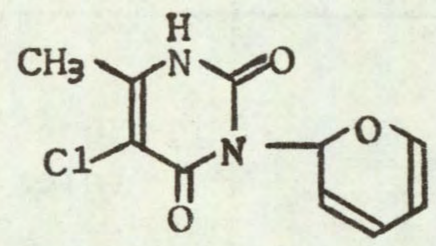
* vigour score only, as some plant kill due to natural die-back

RU 12709

Code number RU 12709, HP 412 Trade name -

Chemical name 5-chloro-3-(2-tetrahydropyranyl)-6-methyl uracil

Structure



Source Procida
Department de Biologie Appliquée
5 rue Bellini
99 Puteaux
France

Information available and suggested uses

Procida Technical leaflet, 1973 reports selective pre- and post-emergence control of a range of grass and broad-leaved weeds in winter cereals, cotton, established lucerne, maize, pineapple, potatoes, rice, sugar cane, vines and fruit trees. Rates of application range from 0.10 to 4.0 kg/ha. Non-selective control can be achieved at higher doses, although perennials are not susceptible. Bertin et al (1972) reported a broad spectrum of herbicidal activity with good tolerance of wheat, cotton, sugar cane, orchard trees and pineapple.

Formulation used 50% w/w a.i. wettable powder

Spray volume 352 l/ha (31.3 gal/ac) for activity experiment.
413 l/ha (36.8 gal/ac) for pre-emergence experiment.
305 l/ha (27.1 gal/ac) for post-emergence experiment.

RESULTS

Full results are presented on pages 19-21 and potential selectivities are summarised in the following tables.

Table 7. Potential pre-emergence selectivities

RATE (kg/a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
0.9	None	None listed as no crops tolerant
0.3	pea groundnut cotton	Avena fatua Alopecurus myosuroides Poa annua Raphanus raphanistrum Tripleurospermum maritimum Senecio vulgaris Chenopodium album Eleusine indica Echinochloa crus-galli Digitaria sanguinalis + species below
0.1	species above + wheat oat onion dwarf bean field bean white clover carrot maize sorghum soyabean kenaf tomato	Polygonum lapathifolium Stellaria media

Table 8 Potential post-emergence selectivities

RATE (kg a.i./ha)	CROPS: vigour reduced by 15% or less	WEEDS: number or vigour reduced by 70% or more
2.50	None	None listed as no crops tolerant
0.50	pea	Alopecurus myosuroides Poa annua Poa trivialis Raphanus raphanistrum Chrysanthemum segetum Rumex crispus Galium aparine Chenopodium album Spergula arvensis Veronica persica Oryza punctata Eleusine indica Echinochloa crus-galli Digitaria sanguinalis + species below
0.1	species above + wheat barley oat perennial ryegrass white clover broad bean kale cabbage carrot maize sorghum groundnut cotton	Sinapis arvensis Tripleurospermum maritimum Senecio vulgaris Polygonum lapathifolium Stellaria media Solanum nigrum Portulaca oleracea

Comments on results

Activity experiment (see page 19)

The level and type of activity of RU 12709 was very similar to other uracils. Only broad-leaved species showed any susceptibility to the foliar

spray and symptoms were generally limited to the treated leaves. No great difference in activity was noted between soil treatments, all of which caused much greater damage than the foliar application.

Symptoms

Symptoms were similar to those caused by other photosynthetic inhibitors. The foliar spray produced scorch, sometimes accompanied by chlorosis. Post-emergence soil drenches caused severe chlorosis followed by wilting and death at higher rates. Pre-emergence application did not affect germination but at higher rates resulted in death at an early stage preceded by severe chlorosis.

Soil persistence

A very short period of soil persistence was found for RU 12709, using turnip as the test species. This contrasts with the long persistence of other uracils eg lenacil and RU 12068 (Richardson and Dean, 1973a). Doses of 0.1 and 0.3 kg/ha were not detected 7 weeks after treatment. At this time 0.9 kg/ha caused a 90% reduction in shoot fresh weight but no effects were observed 14 weeks after application of this dose.

Selectivity among temperate species

Pre-emergence

All annual weeds, with the exception of Galium aparine were controlled pre-emergence at 0.3 kg/ha but all perennial weeds were resistant. Pea was tolerant at 0.3 kg/ha. (In a subsequent experiment Polygonum aviculare and Veronica persica were well controlled at 0.1 kg/ha while sugar beet was particularly sensitive).

Post-emergence

Broad-leaved weeds were somewhat more susceptible than grasses and several were controlled at 0.1 kg/ha. At 0.5 kg/ha a further 10 weeds were controlled including three annual grasses. Avena fatua, Polygonum aviculare and the perennial weeds, however, were not controlled at 0.5 kg/ha. Pea was again the most tolerant crop and it was also interesting to note that Sinapis arvensis was more sensitive than either kale or cabbage.

Crop tolerance was similar pre- and post-emergence. Pea was the most tolerant temperate crop in both trials. Margins of selectivity in other temperate crops were not outstanding. The sensitivity of V. persica to RU 12709 is interesting in view of the resistance of this species to other uracils, eg lenacil and RU 12068 (Richardson and Dean, 1973a).

Selectivity among tropical species

Pre-emergence

Cyperus esculentus was eventually controlled at 0.9 kg/ha while other perennials recovered. Groundnut and cotton tolerated 0.3 kg/ha but only the small-seeded annual grasses were controlled at this dose. There would not appear to be particular advantages for this compound over existing pre-emergence herbicides.

Post-emergence

At 0.5 kg/ha Rottboellia exaltata recovered after initial reduction as did the perennials. At 2.5 kg/ha Cyperus esculentus was eventually killed.

Only four crops were tolerant at the lowest dose and only small broad-leaved species were susceptible. The control of Portulaca oleracea could possibly be of some interest but the plants were very small when sprayed.

ACTIVITY EXPERIMENT

RU 12709

		0.125 kg/ha	0.50 kg/ha	2.00 kg/ha
DWARF BEAN	F	xxxxxxxxxxxxxxx xxxxxxxxx	xxxxxxxxxxxxxxx xxxxxx	xxxxxxxxxxxx xxxx
	S	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	o o	o o
	P	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	o o	o o
	I	xxxxxxxxxxxxxxx xxxxxxxxxxxxxx	o o	o o
KALE	F	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxx
	S	xxxxxxxxxxxxxxx xxxxxxxx	o o	o o
	P	xxx xxxxxxx	o o	o o
	I	xxxxxxxx xxxxxxxx	o o	o o
POLYGONUM AMPHIBIUM	F	xxxxxxxxxxxxxxx xxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxx
	S	xxxxxxxxxxxxxxx + xxxxxxxxxx	xxxxxxxxxxxx xxxx	xxxxxxxxx xxx
	P	xxxxxxxxxxx xxxxxxxxxxxx	xxxxxxxx xxx	xxxxx xxxx
	I	xxxxxxxxxxxxxxx xxxxxxxxxxxxx	xxxxx xx	o o
PERENNIAL RYEGRASS	F	xxxxxxxxxxxxxxx xxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxx
	S	xxxxxxxxx xxxxxxxxxxxx	o o	o o
	P	xxxxxxxxx xxxxxxxxx	o o	o o
	I	xxxxxxxxxx xxxxxxxxxx	o o	o o
AVENA FATUA	F	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxx
	S	xxxxxxxxxxxxxxx + xxxxxxxxxxxxxx	xx xx	o o
	P	xxxxxxxxxxxxxx xxxxxxxxxxxxx	o o	o o
	I	xxxxxxxxxxxxxx xxxxxxxxxxxxxxx	x xx	o o
AGROPYRON REPENS	F	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx
	S	xxxxxxxxxxxxxxx + xxxxxxxxxxxxxxx	xxxxxxxxx xxx	o o
	P	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	xxxx xx	x x
	I	xxxxxxxxxxxxxxx + xxxxxxxxxxxxxx	x x	o o

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

Table 9. RU 12709

SPECIES	SPECIES NO.	PRE-EMERGENCE 0.10	0.30	0.90	POST-EMERGENCE 0.10	0.50	2.50
		kg a.i./ha			kg a.i./ha		
WHEAT	1	107/86	0/0	0/0	100/86	12/7	0/0
BARLEY	2	100/50	0/0	0/0	100/93	25/21	0/0
OAT	3	100/100	7/14	0/0	100/93	50/21	0/0
PER RYGR	4	98/79	0/0	0/0	100/86	0/0	0/0
ONION	8	141/93	24/43	0/0	100/79	33/43	0/0
DWF BEAN	9	82/93	0/0	0/0	100/50	100/29	100/14
FLD BEAN	10	104/100	26/14	13/7	100/57	0/0	0/0
PEA	11	71/100	100/93	14/21	100/100	100/100	50/29
W CLOVER	12	100/100	0/0	0/0	100/86	12/14	0/0
BRD BEAN	13	-	-	-	100/100	100/79	100/36
RAPE	14	-	-	-	100/79	42/21	42/7
KALE	15	75/71	0/0	0/0	100/86	10/7	0/0
CABBAGE	16	-	-	-	100/86	12/14	0/0
SWEDE	17	37/50	0/0	0/0	-	-	-
CARROT	18	106/100	0/0	0/0	100/86	17/14	50/43
LETTUCE	20	25/36	0/0	0/0	0/0	0/0	0/0
SUG. BEET	21	-	-	-	100/71	8/21	0/0
AVE FATU	26	64/86	16/29	0/0	100/93	100/50	0/0
ALO MYOS	27	160/79	7/14	0/0	100/86	0/0	0/0
POA ANN	28	84/71	15/36	0/0	75/50	0/0	0/0
POA TRIV	29	-	-	-	83/43	0/0	0/0
SIN ARV	30	-	-	-	0/0	0/0	0/0
RAPH RAP	31	65/57	0/0	0/0	40/43	0/0	0/0
CHRY SEG	32	-	-	-	50/100	0/0	0/0
TRIP MAR	33	85/57	0/0	6/14	25/29	0/0	0/0
SEN VULG	34	127/71	0/0	0/0	0/0	0/0	0/0
POL LADA	35	24/21	0/0	0/0	31/29	0/0	0/0
POL AVIC	36	-	-	-	100/93	31/50	0/0
RUM CRIS	37	-	-	-	100/71	0/0	0/0
GAL APAR	38	102/100	48/36	55/14	62/36	0/0	0/0
CHEN ALB	39	73/86	5/14	0/0	90/86	0/0	0/0
STEL MED	40	14/50	0/0	0/0	0/0	0/0	0/0
SPER ARV	41	-	-	-	42/36	0/0	0/0
VER PERS	42	-	-	-	100/71	0/0	0/0
SOL NIG	43	-	-	-	0/0	0/0	0/0
AG REPEN	47	103/100	103/71	77/36	100/100	100/64	37/7

KEY = No / Vigour (survivors, as % of control)

Untreated = 100/100

Table 9 (cont...) RU 12709

SPECIES	SPECIES NO.	PRE-EMERGENCE 1.10	0.30 kg a.i./ha	0.90	POST-EMERGENCE 0.10	0.50 kg a.i./ha	2.50
AG STOL	48	-	-	-	100/64	75/36	50/7
ALL VIN	49	145/93	103/79	93/29	-	-	-
TUS FARF	51	60/100	75/93	105/50	-	-	-
MAIZE	58	108/93	108/71	84/50	100/86	100/57	0/0
SORGHUM	59	96/93	83/71	0/0	100/100	67/50	0/0
RICE	60	90/64	60/21	36/21	87/71	100/43	12/7
GRNDNUT	64	100/100	100/100	100/79	100/93	100/79	100/43
SOYABEAN	65	107/100	75/21	21/14	100/79	100/57	100/14
COTTON	66	97/100	89/93	57/43	100/86	100/71	100/29
JUTE	67	0/0	0/0	0/0	67/29	0/0	0/0
KENAF	68	104/100	38/21	0/0	87/50	50/14	75/14
TOBACCO	69	-	-	-	10/29	0/0	0/0
SESAMUM	70	208/79	0/0	0/0	17/21	0/0	0/0
TOMATO	71	91/86	0/0	0/0	100/50	50/14	20/7
OR PUNCT	73	-	-	-	100/79	40/14	0/0
ELEU IND	74	122/93	14/43	0/0	100/43	6/7	0/0
ECH CRUS	75	98/79	3/14	0/0	100/100	25/21	0/0
ROT EXALT	76	140/93	87/79	6/29	100/100	65/36	0/0
DIG SANG	77	99/86	0/0	0/0	100/100	33/14	0/0
AMAR RET	78	130/93	109/86	20/29	95/86	95/71	0/0
PORT OLE	79	-	-	-	17/29	8/7	0/0
CYN DACT	82	-	-	-	114/100	105/93	76/21
CYP ESCU	85	82/100	136/64	82/50	100/100	86/36	86/29
CYP ROTU	86	87/100	87/100	95/71	97/100	63/86	74/50
OXAL LAT	87	107/100	75/100	118/57	-	-	-

KEY = No/Vigour (survivors, as % of control)

Untreated = 100/100

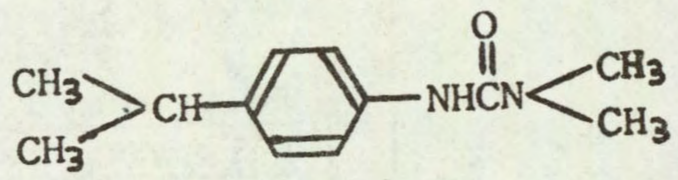
ISOPROTURON

Code number: LS 69-1299
Also HOE 16410, CGA 18731, DPX 6674

Trade names: Tolkan, Arelon Hytane, Melsan

Chemical name: N'-(4-isopropylphenyl)-N,N-dimethylurea

Structure:



Source:
Pepro
Quartier de la Dargoire
69-Lyon
9RC Lyon 54 B 339
France

This compound has also been referred to as ipuron and IPU.

Information available and suggested uses

Approved for control of Alopecurus myosuroides, some other grasses and broad-leaved weeds when applied pre- or post-emergence in winter barley and winter wheat.

Pepro Technical Bulletin, 1973 reported selectivity pre- and post-emergence in maize, soyabeans, rice, groundnuts, sorghum, cotton and potatoes at rates of 1.0 - 4.0 kg/ha pre-emergence and 1.0 - 2.5 kg/ha post-emergence. Avena fatua, Lolium spp. and weed grasses in general are susceptible at 3.0 - 4.0 kg/ha pre-emergence and 1.75 - 2.5 kg/ha post-emergence when applied at tillering. Rognon et al (1972) state that the post-emergence susceptibility of wild oats depends on their stage of growth at spraying.

Formulation used: 50% w/w a.i. wettable powder

Spray volume:
305 l/ha (27.1 gal/ac) for activity experiment
413 l/ha (36.8 gal/ac) for pre-emergence experiment
305 l/ha (27.1 gal/ac) for post-emergence experiment

RESULTS

Full results are presented on pages 26-28 and potential selectivities are summarised in the following tables.

Click here to continue