AGRICULTURAL RESEARCH COUNCIL

WEED RESEARCH ORGANIZATION

TECHNICAL REPORT No. 31

FACTORS AFFECTING THE SELECTIVITY OF SIX SOIL ACTING HERBICIDES AGAINST CYPERUS ROTUNDUS

M L Dean and C Parker

February 1974

Price

UK and overseas surface mail - £1.10

Overseas airmail - £1.35

BEGBROKE HILL, YARNTON, OXFORD

CONTENTS

FACTORS AFFECTING THE SELECTIVITY OF SIX SOIL ACTING HERBICIDES AGAINST *CYPERUS ROTUNDUS*

M L Dean and C Parker

ODA Tropical Weeds Group, ARC Weed Research Organization,
Begbroke Hill, Yarnton, Oxford OX5 1PF

SUMMARY

Six compounds were tested on up to three crop species, planted at 1 and 4 cm, plus *Cyperus rotundus* planted at 2 and 8 cm. Herbicides were applied at three rates as a surface film or incorporated to 2 or 8 cm.

Deeper incorporation of EPTC improved overall susceptibility of *C. rotundus* and although maize benefited from shallow (1 cm) planting selectivities were found at both depths of crop planting.

C. rotundus was susceptible to metflurazone from all applications of 1.14 kg/ha. Cotton planted at 4 cm was more resistant but deeper incorporation reduced tolerance.

Incorporation of ORGA 3045 reduced the control of *C. rotundus* at 1.14 kg/ha. Cotton benefited from shallow (1 cm) planting or herbicide incorporation to 8 cm.

Control of *C. rotundus* was achieved with all applications of metribuzin at 1.14 kg/ha. Maize was particularly sensitive and no selectivities were found.

All applications of MBR 4400 showed activity against *C. rotundus* with deeper incorporation increasing susceptibility. Cotton marginally benefited from deep (4 cm) planting while maize and soyabean improved with planting at 1 cm. Maize also benefited from deeper incorporation.

MBR 8251 showed a similar pattern of activity against *C. rotundus* to that of MBR 4400, but was more active. Cotton and soyabean benefited from shallow (1 cm) planting but maize was particularly sensitive to all treatments.

INTRODUCTION

The Tropical Weeds Group of the Weed Research Organization investigate the pre- and post-emergence selectivity of new herbicides on a range of tropical crop and weed species.

This present report summarises the results obtained with six compounds, in two separate experiments, conducted as a follow-up to the pre-emergence selectivity testing. (Richardson *et al.*, 1971, Richardson and Dean, 1972, Richardson and Dean, 1973). Each compound tested had shown some selectivity against *Cyperus rotundus* in at least one of the crops, but variable results had occurred in separate trials. Consequently different depths of crop and weed planting and methods of herbicide application were investigated in order to elucidate the reasons for these variations.

MATERIALS AND METHODS

EPTC, metflurazone, ORGA 3045 and metribuzin were included in experiment 1 and MBR 4400 plus MBR 8251 in experiment 2. The herbicides, as formulated by the manufacturer, were applied in 400 l/ha (35.6 gal/ac) to a sandy loam topsoil (detailed in table 1) from a field at Begbroke.

Table 1. Soil conditions

Organic matter	2.8%	John Innes Base Fertiliser	5.0 g/kg
Clay content	15.2%	DDT 5% dust	0.5 g/kg
pH	7.7	Fritted Trace Elements	0.25 g/kg

Soil for the incorporated treatments was sprayed in tins (19.0 x 13.5 x 7.5 cm) with a laboratory sprayer incorporating a Teejet fan nozzle (8002E) operating at a pressure of 30 p.s.i. and moving at a constant speed 30 cm above the smoothed soil surface. The soil was subsequently completely mixed and placed in black polythene pots, 12 cm deep and 12.5 cm in diameter. The soil used for 2 cm incorporation was sprayed at four times the dose stated so that the amount of herbicide incorporated in the 2 cm layer was identical to the corresponding 8 cm layer. Surface applications were made to the smoothed untreated soil surface following planting.

Crop species were planted at either 1 or 4 cm and dormant tubers of *C. rotundus* at either 2 or 8 cm. All treatments were replicated three times. Spraying and planting of experiment 1 took place on 22 October 1971 and on 2 February 1972 for experiment 2. Pots were subsequently watered individually from overhead and further nutrients were supplied during watering as required.

Table 2. Species data

Species	Cultivar	No. seeds/ tubers per pot	Expt. No.	Days after planting to assessment	Stage of growth at assessment
Cotton	26J	5	1	41	$4\frac{1}{2}$-5 leaves
			2	30	$5\frac{1}{2}$-$6\frac{1}{2}$ leaves
Maize	Inra 200	5	1	22	4-5 leaves
			2	57	4-5 leaves
Soyabean	Merit	6	1	Not included	
			2	43	2-3 trifoliate leaves
Cyperus rotundus	WRO Clone 1 (ex Rhodesia)	4	1	83	12-15 shoots
			2	64	20-23 shoots

Plants were grown at a mean temperature of 23°C (range 17-30°C for experiment 1 and 11-34°C for experiment 2). Normally the temperature did not drop below 18°C but this did occur occasionally for 1-2 hours, during experiment 2 due to electricity cuts. Supplementary fluorescent lighting was provided for both experiments producing a 12 hour photoperiod. This was reduced to 10 hours in experiment 2 from 1-10 February and ceased from 10-29 February. It was fully resumed on 1 March although some loss of plant vigour had occurred meantime.

At assessment survivors were counted and plants were scored on a 0-7 scale as previously described (Dean and Parker, 1971). Stages of growth (see table 2) and foliage fresh weights were recorded. Crop root systems were assessed for herbicide damage and special attention was subsequently paid to the foliage regrowth and rhizome system of C. rotundus.

Foliar fresh weights were found to be closely correlated with the degree of root or rhizome system injury, and hence were used as an index of herbicidal activity. Results were calculated as a percentage of the untreated plants, growing at the same depth, thus allowing for any differences due to depth of planting. In the following discussion on selectivities, crops have been regarded as tolerant where foliage fresh weight was at least 85% of control and C. rotundus as susceptible where reduced by 70% or more.

EPTC

Common name EPTC Trade name Eptam

Chemical name S-ethyl N,N-dipropyl (thiocarbamate)

Source Stauffer Chemical Company
Agricultural Research Centre
P O Box 760
Mountain View
California, USA

Formulation used 72% w/v a.i. emulsifiable concentrate

Doses 0.28, 1.14 and 4.55 kg a.i./ha
(0.15, 1.02 and 4.04 lb a.i./ac)

RESULTS

Pre-emergence surface application of EPTC at 1.14 kg/ha controlled shallow (2 cm)-planted C. rotundus tubers but this result is unlikely to be repeated under field conditions due to volatilisation and consequent loss of activity. Incorporation of the same dose produced adequate control of the weed planted at either 2 or 8 cm and no shoots emerged at higher doses. Deeper incorporation improved control at lower rates. The depth of herbicide incorporation appears to have little significant effect on weed control at higher doses but is a critical factor at lower rates of application.

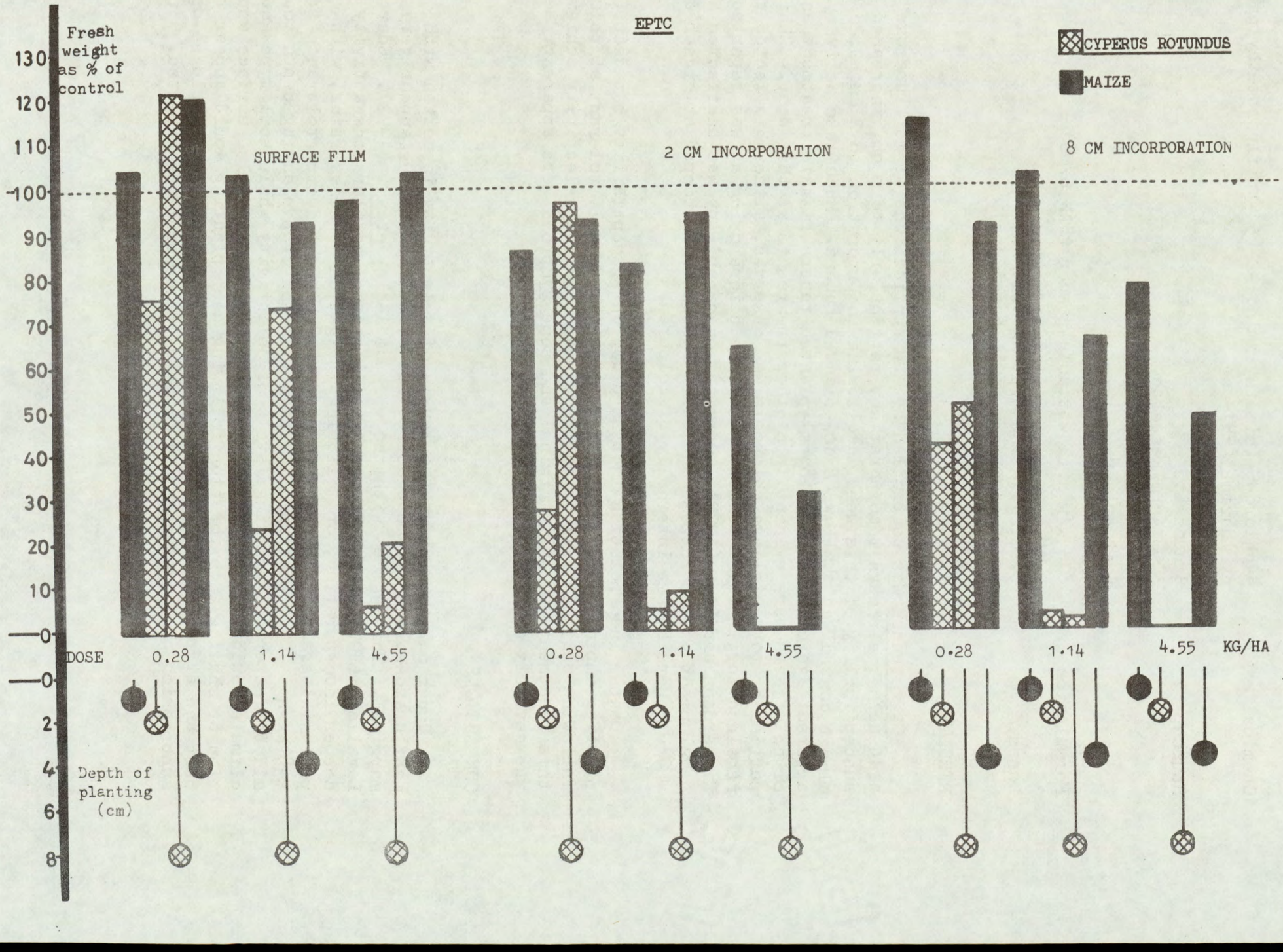
Variations in the depth of maize planting caused no large differences in crop response to EPTC. Deep (8 cm) incorporation before shallow (1 cm) planting resulted in greater tolerance.

The best practical result was 1.14 kg/ha of EPTC incorporated to 2 cm following maize planting at 4 cm. A number of other treatments also showed good selective control of C. rotundus (1.14 kg/ha of EPTC incorporated to 8 cm with maize planted at 1 cm; 4.55 kg/ha surface applied when the crop was planted at 1 or 4 cm) under glasshouse conditions but these would be impractical under field conditions.

CONCLUSIONS

These results confirm that the use of EPTC in maize may involve a certain degree of risk to the crop. Kasasian and Seeyave (1968) do suggest, however, that the danger can be reduced by incorporation 3-7 days before maize planting. It is also evident that deep incorporation is not necessary to control tubers from greater depths, particularly at higher doses. The Herbicide Research Unit, University of West Indies (1965) reported better control of C. rotundus following 3 in. incorporation as opposed to 6 in. incorporation. Our results would also agree with those of Waldrep and Thomas (1964) who reported that deeper incorporation of EPTC increased maize injury.

A scheme of shallow incorporation following deep crop sowing is probably the safest method for controlling C. rotundus in maize providing that the incorporation is uniform. It may be, however, that local soil and climatic conditions could alter these responses. One further possibility for improving the levels of selectivity in maize is the use of antidotes or protectants as seed dressings or tank mixes (Chang et al., 1973).


EPTC
CYPERUS ROTUNDUS
MAIZE
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
0.28
1.14
4.55
KG/HA
0
2
4
6
8
Depth of planting (cm)

METFLURAZONE

Common name	metflurazone	Trade name -
Chemical name	4-chloro-5-(dimethylamino)-2-(3 -trifluoromethylphenyl) pyridazin-3(2H)-one	
Source	Sandoz Ltd 3090 Agro Research CH-4002 Basle Switzerland	
Formulation used	80% w/w a.i. wettable powder (SAN 6706)	
Doses	0.28, 1.14 and 4.55 kg a.i./ha (0.15, 1.02 and 4.04 lb a.i./ac)	

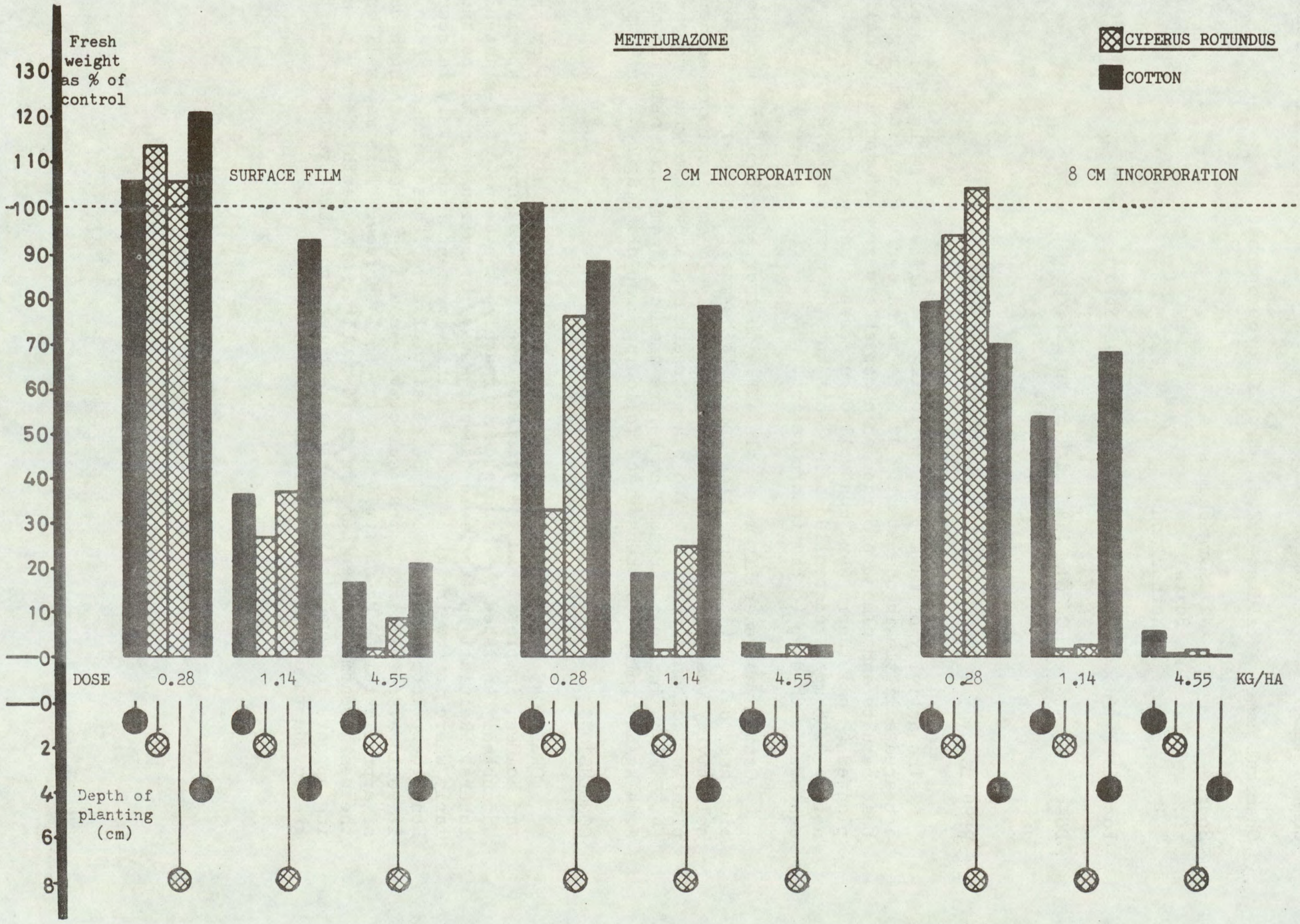
RESULTS

C. rotundus was controlled by most applications of metflurazone at 1.14 kg/ha, although incorporation, particularly to 8 cm, increased the susceptibility of this weed. Following incorporation to 2 cm, 0.28 kg/ha almost controlled shallow (2 cm)-planted tubers. Much less activity was apparent against the deep (8 cm)-planted tubers in this treatment and little or no effects were evident from other treatments at this dose. Characteristic partial or total foliage chlorosis was observed, although affected tissue remained turgid for a considerable time before dying, as was reported by Richardson and Dean (1972). Germination capability was unaffected but development of the rhizome and tuber systems was stopped at higher doses where tubers became internally discoloured.

Deeper incorporation increased cotton susceptibility but deep (4 cm) planting improved crop resistance. Cotton was only tolerant at this depth following surface application of 1.14 kg/ha. The selectivity achieved in this treatment was only marginal and some symptoms were apparent. 4.55 kg/ha was severely damaging in all treatments.

CONCLUSIONS

Under our conditions the levels of selectivity in cotton with metflurazone, and the more active but related SAN 9789, appear very marginal. This agrees with the work of Keeley et al. (1972). Eder and Lavalleye (1970) have also reported increased metflurazone activity from deeper incorporation, or following irrigation or heavy rains, with perennial grass and sedge control at 4-8 kg/ha and crop tolerance from 2-8 kg/ha. Dose, methods of application and crop planting depth could all be factors determining levels of selectivity while soil type and climate could also alter the response. From our results surface application or shallow incorporation following deep planting would appear to be best and at rates of about 1.0 kg/ha, where annual weeds would be controlled, suppression of C. rotundus and crop tolerance could be expected.


METFLURAZONE
CYPERUS ROTUNDUS
COTTON
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
0.28
1.14
4.55
0.28
1.14
4.55
0.28
1.14
4.55
KG/HA
0
2
4
6
8
Depth of planting (cm)

ORGA 3045

Common name	tetrapion (proposed)	Trade name	Frenock
Chemical name	sodium-2,2,3,3-tetrafluoropropionate		
Source	N.V. Orgachemia Boxtel Netherlands		
Formulation used	93% w/v a.i. aqueous concentrate		
Doses	0.28, 1.14 and 4.55 kg a.i./ha (0.15, 1.02 and 4.04 lb a.i./ac)		

RESULTS

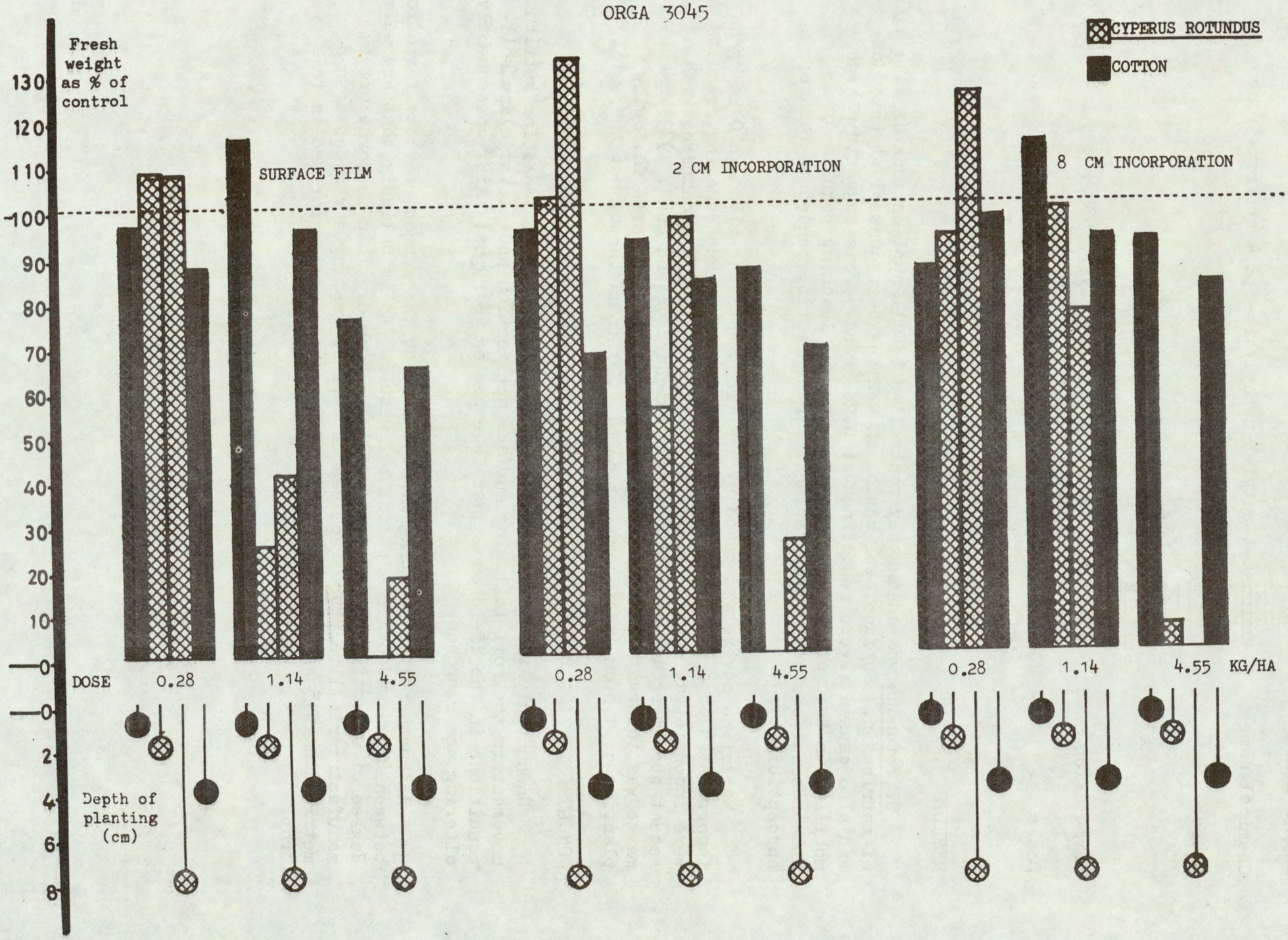
The activity of ORGA 3045, following the different methods of application, appeared a little inconsistent. At 1.14 kg/ha surface application gave best results and almost provided an acceptable degree of control (shallow-planted (2 cm) tubers were controlled but deep-planted (8 cm) ones were not). 4.55 kg/ha controlled all plants but the most complete control was achieved with deep (8 cm) incorporation.

Cotton was generally more tolerant with increased depth of incorporation and shallow (1 cm) planting proved to be marginally safer. The best selectivity was achieved with 4.55 kg/ha deeply (8 cm)-incorporated before planting cotton 1 cm deep. Two other treatments showed marginal selectivities; (4.55 kg/ha incorporated to 2 cm before shallow (1 cm) crop planting and 1.14 kg/ha applied to the surface following crop planting at 1 or 4 cm).

CONCLUSIONS

ORGA 3045 is a highly mobile compound (Aelbers et al. 1969, Taylor and Holden, in press) and the overhead watering throughout the experiment undoubtedly assisted the herbicide in reaching the deep (8 cm)-planted tubers. Rainfall in the field can not always be relied upon and particularly where furrow-irrigation is used this movement is unlikely to occur. Hence deep incorporation would be beneficial under these circumstances. It would also seem likely that selectivity could be achieved using a dose of approximately 2 kg/ha applied to the soil surface. This may well be the best treatment under certain field conditions as depth of crop planting appears to have little effect on response from this treatment and the greater depth of sowing (4 cm) would be more practical.

ORGA 3045


CYPERUS ROTUNDUS
COTTON
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
0.28
1.14
4.55
0.28
1.14
4.55
0.28
1.14
4.55
KG/HA
Depth of planting (cm)

METRIBUZIN

Common name	metribuzin — Trade name Sencor, Sencorex
Chemical name	4-amino-6-t-butyl-3-methylthio-1,2,4-triazin-5-one
Source	Bayer Agrochemicals Ltd Eastern Way Bury St Edmunds Suffolk
Formulation used	70% w/w a.i. wettable powder (Bayer 94337)
Doses	0.28, 1.14 and 4.55 kg a.i./ha (0.15, 1.02 and 4.04 lb a.i./ac)

RESULTS

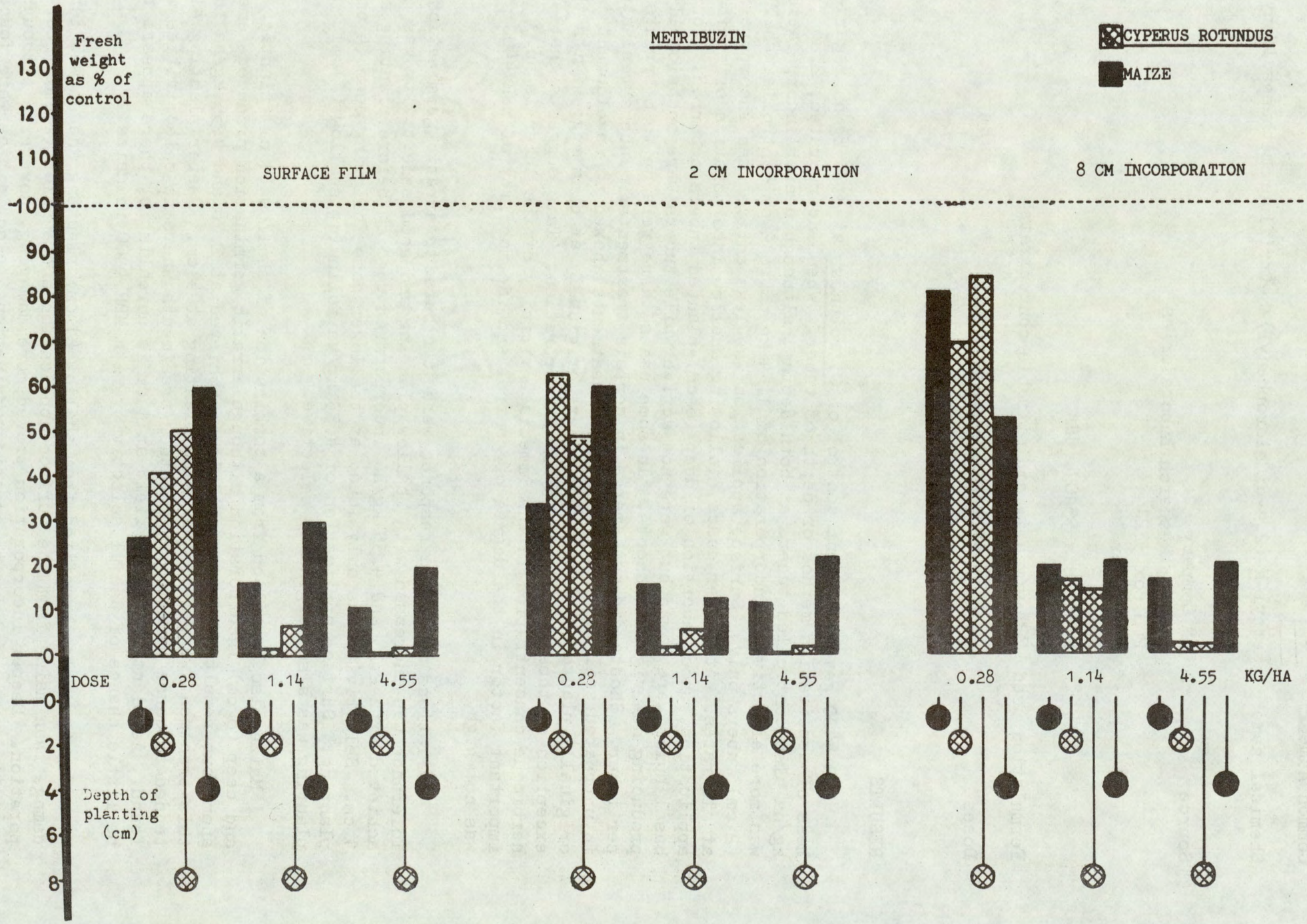
C. rotundus was adequately controlled by all applications of 1.14 kg/ha of metribuzin. Surface application showed the best control at this dose and also caused severe reductions at 0.28 kg/ha. This suggests a high mobility in the soil and would agree with the leaching results of Richardson (personal communication). Incorporation tended to reduce susceptibility.

Maize was severely damaged by all treatments and although 0.28 kg/ha incorporated to 8 cm before planting at 1 cm was least damaging, results were inconsistent and no selectivities achieved. [This compares with a recent pre-emergence selectivity test (Richardson and Dean, 1973) where maize was tolerant at 0.30 kg/ha and C. rotundus recovered following planting at 1.8 cm and incorporation of 1.20 kg/ha throughout the soil.]

CONCLUSIONS

Undoubtedly the conditions of this experiment were ideal for metribuzin movement in the soil following surface application and climatic and soil conditions in the field could not be expected to repeat this, consequently altering the response.

Although further testing might elucidate the reasons for the variations between these and other experimental results, it is unlikely that any safe degree of selectivity in maize could be achieved. This is borne out by manufacturer's literature received in 1972 suggesting a reduced dose of metribuzin (0.5 kg product/ha) plus 1.5 kg/ha atrazine for use in this crop.


METRIBUZIN
CYPERUS ROTUNDUS
MAIZE
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
0.28
1.14
4.55
0.28
1.14
4.55
0.28
1.14
4.55
KG/HA
Depth of planting (cm)

MBR 4400

Common name	- Trade name -
Chemical name	ethyl-N-(2,4-dichlorophenyl)-N-(trifluoromethanesulfonyl) carbamate
Source	3M Company Central Research Laboratories P O Box 3221 3M Center Saint Paul Minnesota 55101, USA
Formulation used	72% w/v a.i. emulsifiable concentrate
Doses	1.14, 2.28 and 4.55 kg a.i./ha (1.02, 2.03 and 4.04 lb a.i./ac)

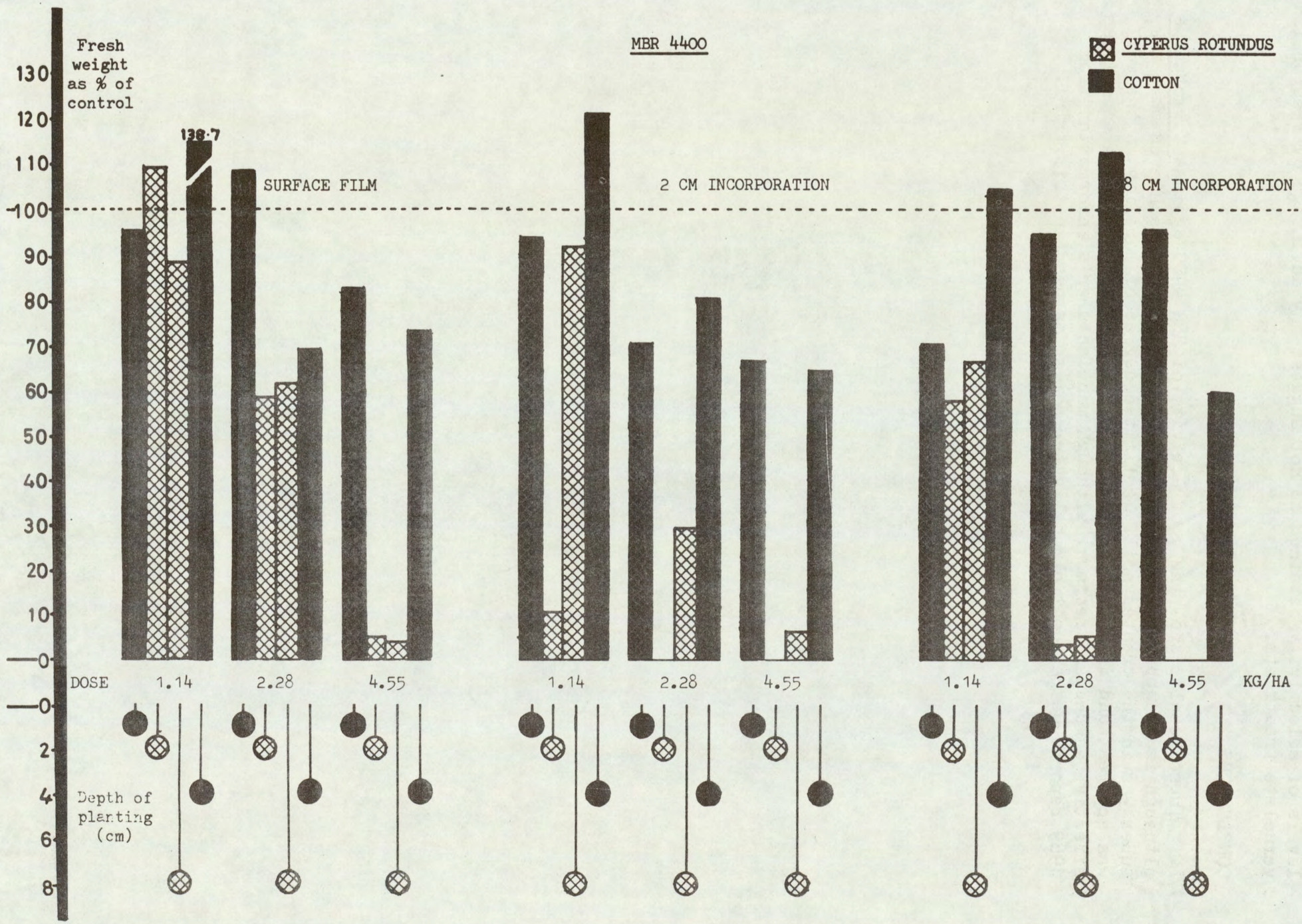
RESULTS

MBR 4400 gave excellent control of C. rotundus at 4.55 kg/ha regardless of application method or depth of tuber. When incorporated, 2.28 kg/ha also controlled tubers at both depths, although deeper incorporation was more effective. Incorporation of 1.14 kg/ha to 2 cm controlled shallow (2 cm) tubers only. Surface application was less active than incorporation at all rates. At higher doses, following shallow incorporation or surface application, shoot abortion of deep (8 cm)-planted tubers occurred. Sound basal bulbs were found but were not active while tubers were occasionally producing new vigorous shoots. In some cases there were up to 6 sprouts per tuber. Shoots did not emerge in certain treatments. Tubers replanted in untreated soil from the 4.55 kg/ha treatments showed no development if originally planted at 2 cm while tubers originally at 8 cm regrew with the exception of those from deep (8 cm) incorporation. This suggests that herbicide concentration in the immediate vicinity of the tuber is an important factor in the degree of control and the mobility of MBR 4400 was not high.

Variations in cotton response were attributed to erratic germination. Tolerance was increased with shallow planting and good selectivity was achieved with 2.28 and 4.55 kg/ha incorporated to 8 cm before planting at 1 cm. Selectivity was only found at the lower dose following deep (4 cm) planting. Surface application of 4.55 kg/ha following shallow (1 cm) planting was also marginally selective.

Maize also benefited from a combination of shallow (1 cm) planting and deep (8 cm) incorporation although erratic germination produced some anomalous results. The selectivities achieved at 2.28 and 4.55 kg/ha in this treatment were lost following planting at 4 cm. Deeper planting also tended to cause more injury in other treatments where no selectivities were found. As planting in the field at 1 cm is unrealistic, there appears to be little chance of useful selectivity with MBR 4400 in maize.

Soyabean also benefited from shallow (1 cm) planting and showed less damage than maize from the surface application and shallow (2 cm) incorporation. Deeper incorporation proved more damaging, however. Although variations occurred due to erratic germination, selectivities were found

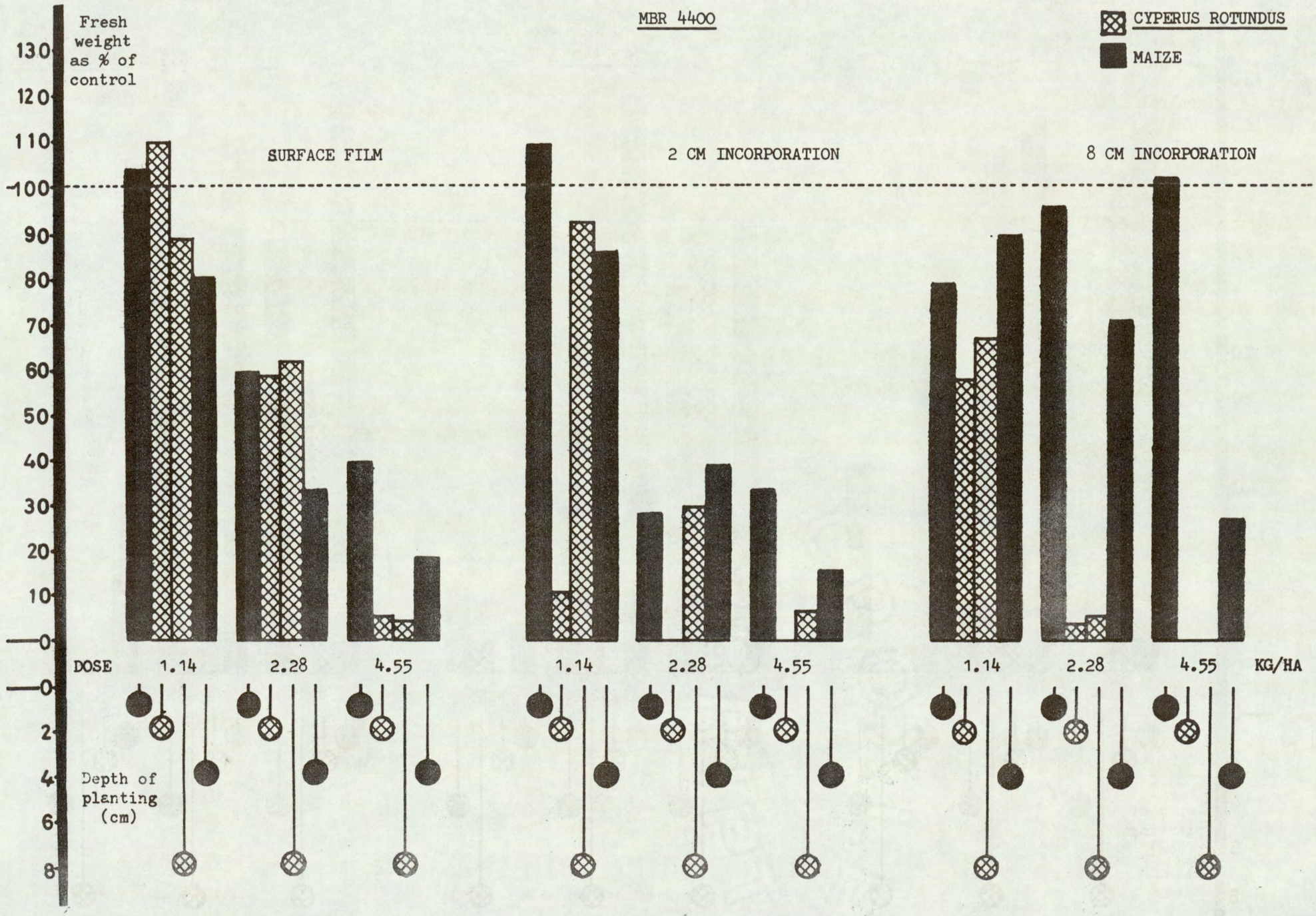

MBR 4400
CYPERUS ROTUNDUS
COTTON
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
138·7
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
1.14
2.28
4.55
1.14
2.28
4.55
1.14
2.28
4.55
KG/HA
0
2
4
6
8
Depth of planting (cm)

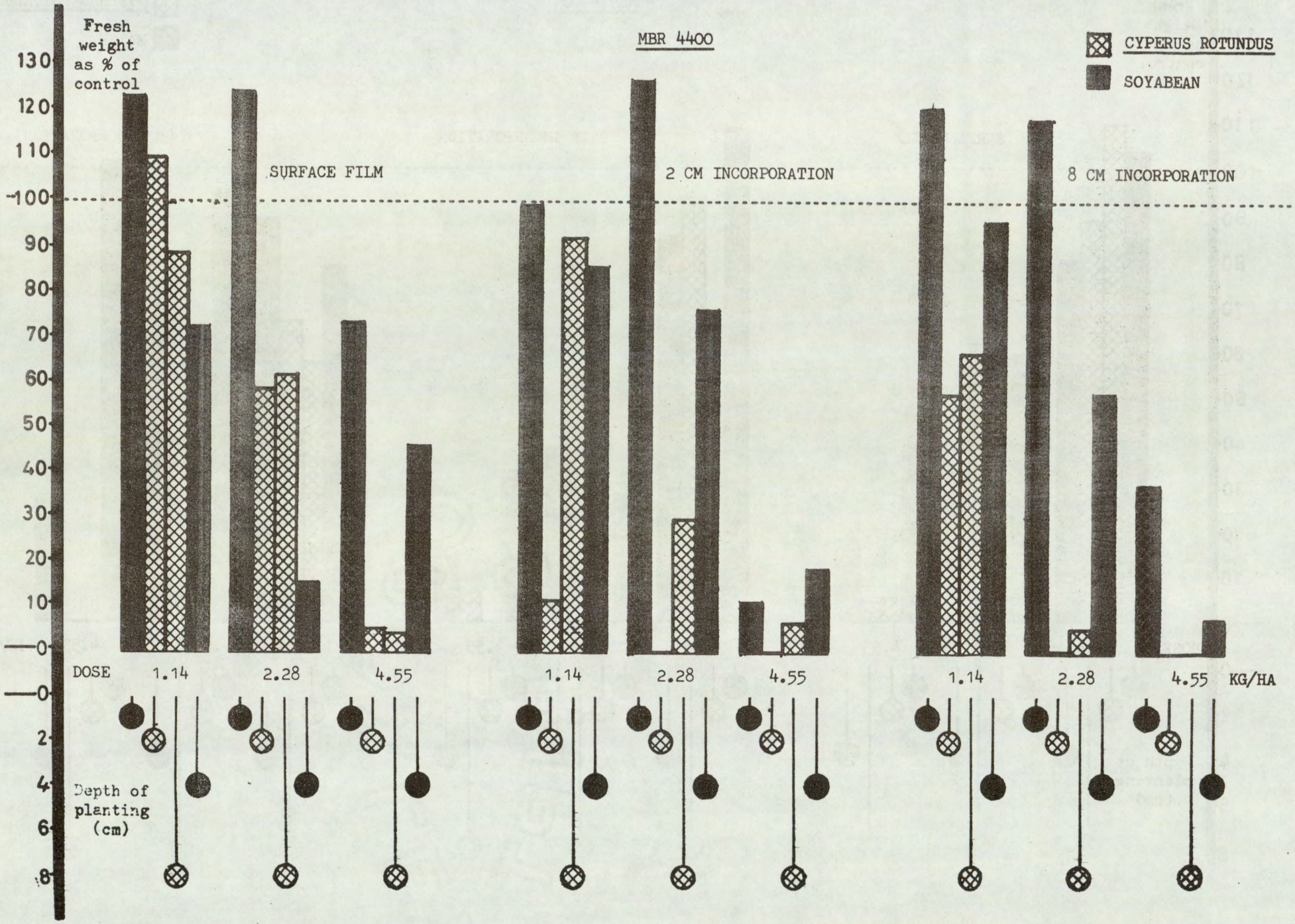
at 2.28 kg/ha with incorporation before planting at 1 cm. As with maize, planting at this depth would be unrealistic under field conditions and the levels of selectivity obtained do not suggest any advantage over established vernolate treatments.

CONCLUSIONS

-

These results show the good activity of MBR 4400 against C. rotundus although it is apparent that the best control was only achieved when the tuber was in the treated soil. A limited degree of mobility in the soil was apparent and it may be that incorporation to 4-6 cm may be equally as effective as deeper treatment although manufacturer's information from 1969 reports better control on lighter soils, as used in this trial.


MBR 4400
CYPERUS ROTUNDUS
MAIZE
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
1.14
2.28
4.55
1.14
2.28
4.55
1.14
2.28
4.55
KG/HA
0
2
4
6
8
Depth of planting (cm)


Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
Depth of planting (cm)
MBR 4400
CYPERUS ROTUNDUS
SOYABEAN
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
1.14
2.28
4.55
1.14
2.28
4.55
1.14
2.28
4.55
KG/HA

MBR 8251

Common name - Trade name Destun

Chemical name (2-methyl-4-phenylsulfonyl)-trifluoromethanesulfono phenyl-acetamide

Source 3M Company
Central Research Laboratories
P O Box 3221
3M Center
Saint Paul
Minnesota 55101, USA

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

Doses 1.14, 2.28 and 4.55 kg a.i./ha
(1.02, 2.03 and 4.04 lb a.i./ac)

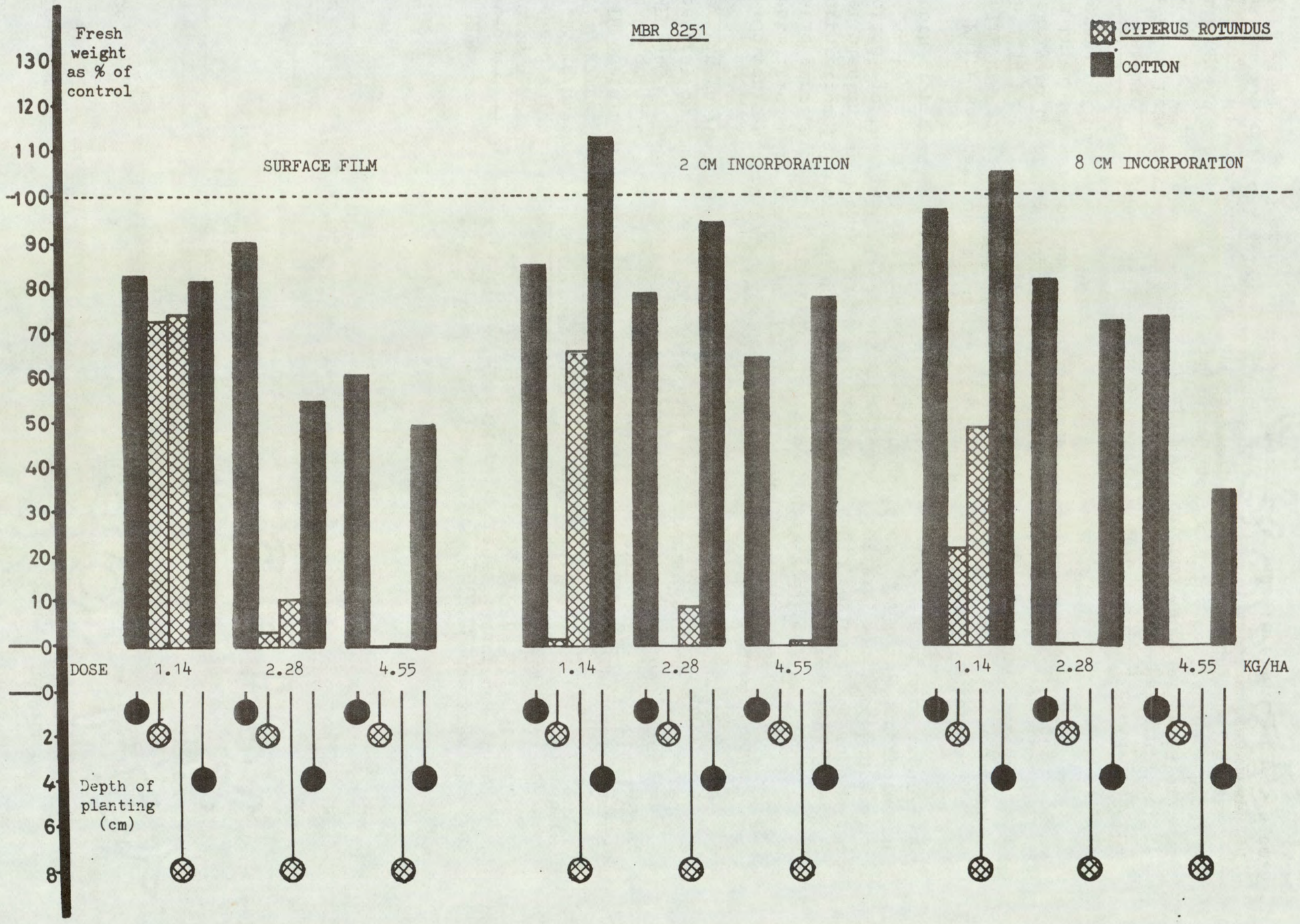
RESULTS

MBR 8251 was considerably more active against C. rotundus than the related MBR 4400, particularly when applied to the soil surface. This suggests a greater mobility of MBR 8251 which is in accord with its increased solubility. C. rotundus was well controlled by all applications of 2.28 kg/ha and both incorporations also controlled shallow (2 cm) tubers at 1.14 kg/ha. Deeper incorporation marginally improved overall control and in certain treatments there was no shoot emergence. Symptoms following deep (8 cm) planting and shallow applications of high doses were similar to MBR 4400. Development of new shoots suggested that the herbicide concentration was not sufficient to kill the tuber. Regrowth of treated tubers in untreated soil also produced similar results to MBR 4400.

Cotton sensitivity to MBR 8251 was greater than to MBR 4400 and selectivities were not markedly superior. Again results varied due to erratic germination but selectivities were found at 2.28 kg/ha with 2 cm incorporation following deep (4 cm) planting and with surface application after planting at 1 cm. The former treatment would obviously be more practical in the field situation. Marginal selectivity was also achieved at 1.14 kg/ha against shallow (2 cm)-planted tubers following incorporation at both crop planting depths. Overall deep planting caused more injury.

Maize was particularly sensitive to MBR 8251 but the pattern of results was similar to MBR 4400. Although marginal selectivity was found with 1.14 kg/ha incorporated to 8 cm at both planting depths, this is unlikely to be of any practical significance. The response of maize in this trial may well be due to soil type according to manufacturer's literature from 1971 and 1972.

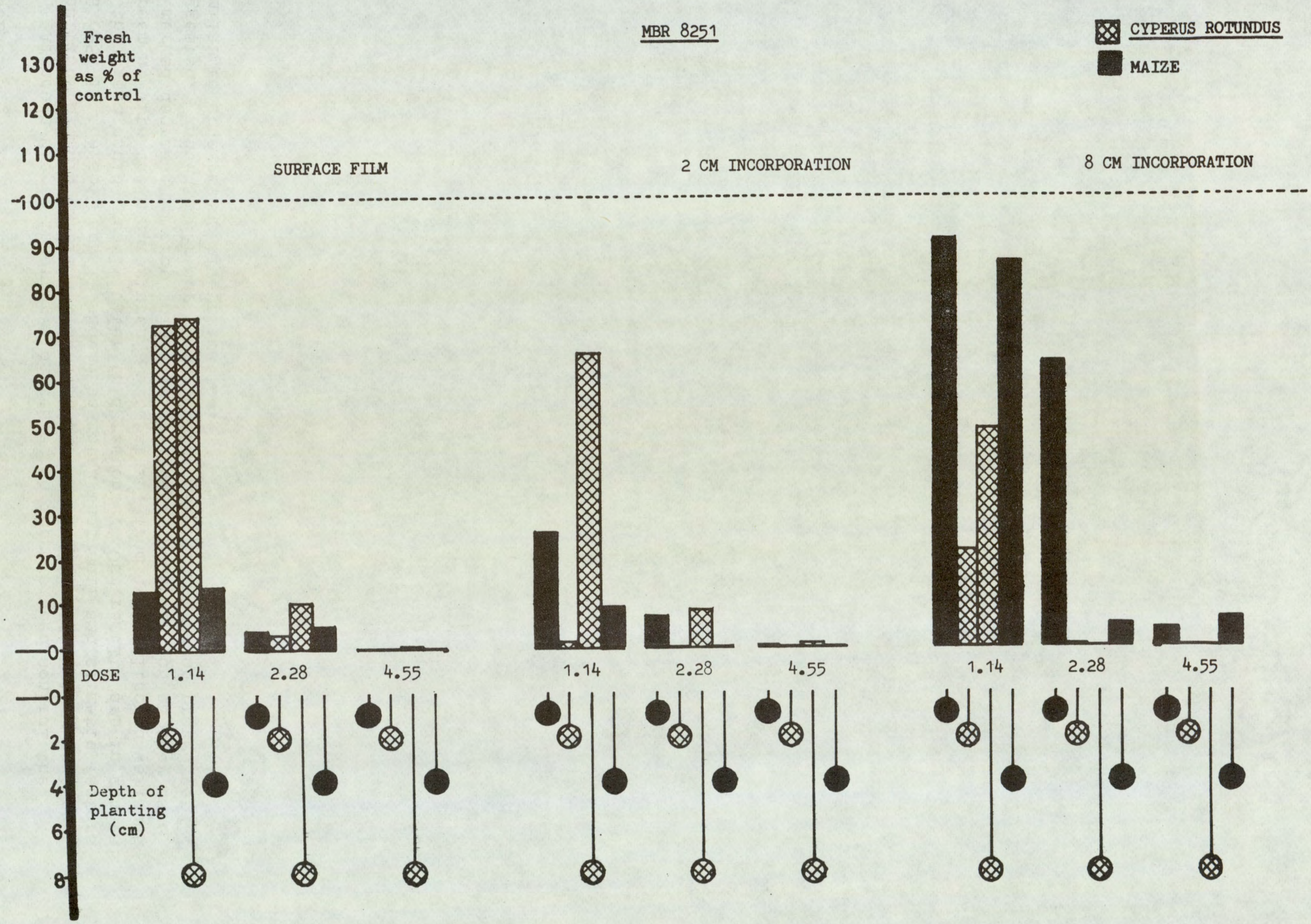
Results with soyabean and MBR 8251 were somewhat variable and comparison with those from MBR 4400 does not produce any definite pattern. Selectivity was found at 2.28 kg/ha with all applications and shallow (1 cm) planting, and also at this dose with 8 cm incorporation before deep (4 cm) planting. However, minor symptoms were evident on the crop in all these treatments. Marginal selectivity was also found at 1.14 kg/ha incorporated before planting at 1 cm and with deep incorporation before planting at 4 cm.

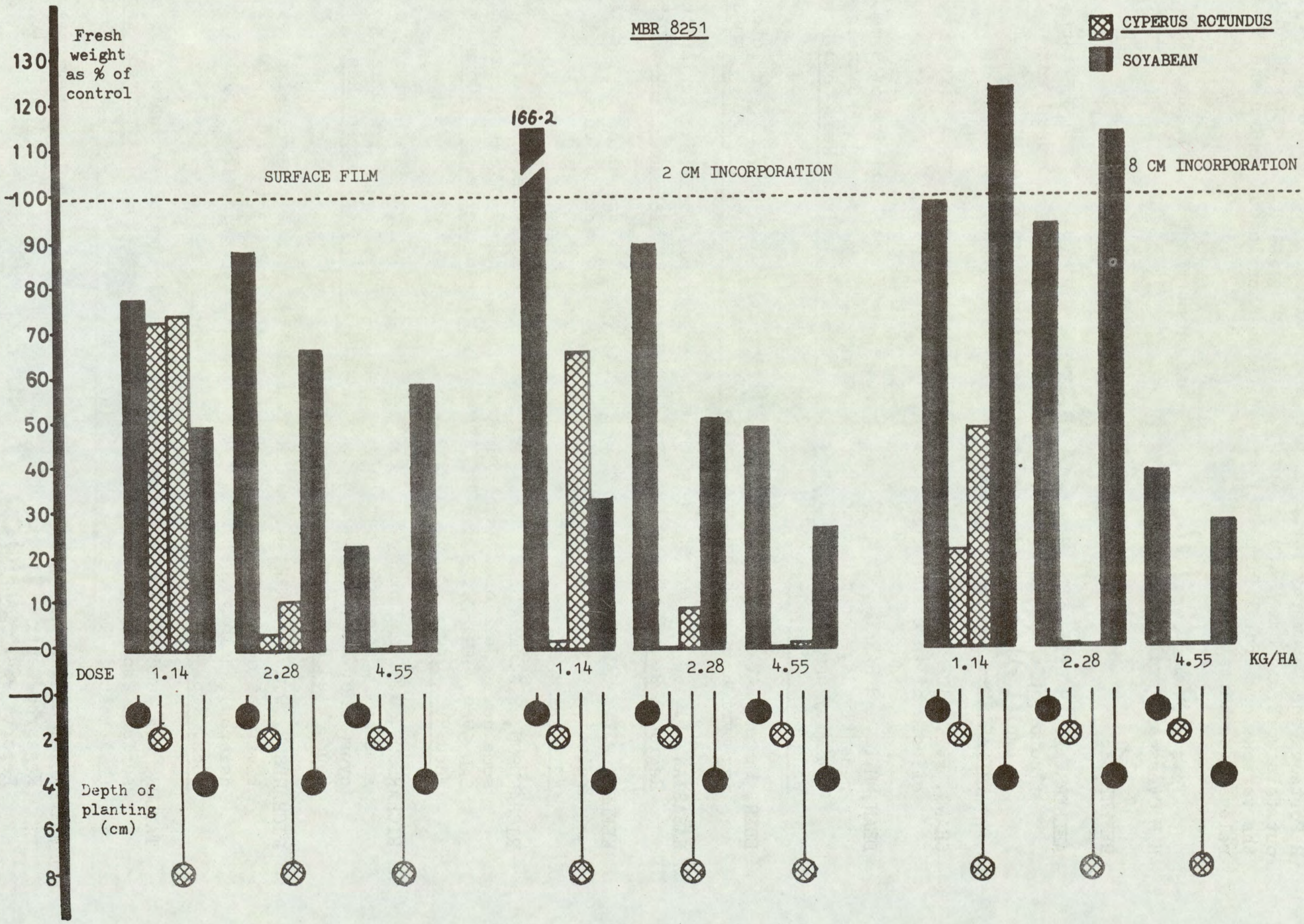

MBR 8251
CYPERUS ROTUNDUS
COTTON
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
1.14
2.28
4.55
1.14
2.28
4.55
1.14
2.28
4.55
KG/HA
Depth of planting (cm)

Levels of selectivity, although not outstanding, were better than with MBR 4400 and further investigation in this crop may be worthwhile.

CONCLUSIONS

Although deeper incorporation tended to improve weed control the conditions of this experiment were ideal for movement of shallow applied MBR 8251 in the soil and it should be noted that soil and climatic factors in the field could greatly alter this response. Our results are in general agreement with the manufacturer's literature, from 1972, although we found no marked decrease in crop tolerance following incorporation as they have suggested. Indeed under our conditions deeper incorporation proved very similar to other means of application.


MBR 8251
CYPERUS ROTUNDUS
MAIZE
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
SURFACE FILM
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
1.14
2.28
4.55
Depth of planting (cm)


MBR 8251
CYPERUS ROTUNDUS
SOYABEAN
Fresh weight as % of control
130
120
110
100
90
80
70
60
50
40
30
20
10
0
SURFACE FILM
166·2
2 CM INCORPORATION
8 CM INCORPORATION
DOSE
1.14
2.28
4.55
1.14
2.28
4.55
1.14
2.28
4.55
KG/HA
0
2
4
6
8
Depth of planting (cm)

ACKNOWLEDGEMENTS

We are most grateful to Miss A-M Hitchcock and Mesrs R H Webster, R Porteous and D Cambray for technical and practical assistance in carrying out this work; to Mrs M Weedon for preparing and typing this report and to the various commercial firms for providing the herbicide samples and relevant technical information.

This work was carried out under Research Scheme R 2119 financed by H M Overseas Development Administration.

REFERENCES

AELBERS, E., BASTIAANSEN, M.G. and GRIJSEELS, A.J. (1969) 2,2,3,3-tetrafluoropropionate, a new herbicide for the control of annual and perennial grasses in different crops. Proc. 3rd Symp. on New Herbicides, Versailles, 17-33.

CHANG, F.Y., STEPHENSON, G.R. and BANDEEN, J.D. (1973) Comparative effects of three EPTC antidotes. Weed Sci., 21, (4), 292-295.

DEAN, M.L. and PARKER, C. (1971) The pre-emergence selectivity of some recently developed herbicides in jute, kenaf and sesamum and their activity against Oxalis latifolia. Tech. Rep. agric. Res. Coun. Weed Res. Orgn, 19, pp.24.

EDER, F. and LAVALLEYE, M.P. (1970) Metflurazone (San H 6706), an interesting pyridazinone herbicide. 7th int. Congr. Pl. Prot., Paris, 308-309.

KASASIAN, L. and SEEYAVE, J. (1968) Weedkillers for Caribbean Agriculture. Regional Res. Centre, Univ. West Indies, Jamaica and Trinidad, pp.44.

KEELEY, P.E., CARTER, C.H. and MILLER, J.H. (1972) Evaluation of the relative phytotoxicity of herbicides to cotton and nutsedge. Weed Sci., 20, (1), 71-74.

RICHARDSON, W.G. and DEAN, M.L. (1972) The pre-emergence selectivity of some newly developed herbicides: bentazon, BAS 3730H, metflurazone, SAN 9789, HER 52.123 and U 27,267. Tech. Rep. agric. Res. Coun. Weed Res. Orgn, 22, pp.51.

RICHARDSON, W.G. and DEAN, M.L. (1973) The pre-emergence selectivity of some newly developed herbicides: lenacil, RU 12068, metribuzin, cyprazine, EMD-IT 5914 and benthiocarb. Tech. Rep. agric. Res. Coun. Weed Res. Orgn, 25, pp.57.

RICHARDSON, W.G., PARKER, C. and HOLLY, K. (1971) The pre-emergence selectivity of some newly developed herbicides: ORGA 3045 (in comparison with dalapon), haloxydine (PP 493), HZ.52.112, pronamide (RH 315) and R 12001. Tech. Rep. agric. Res. Coun. Weed Res. Orgn, 17, pp.39.

TAYLOR, W.A. and HOLDEN, M.R. (in press) The biological evaluation of subsurface applications of herbicides for the control of Agropyron repens (L.) Beauv. Tech. Rep. agric. Res. Coun. Weed Res. Orgn.

UNIVERSITY OF THE WEST INDIES (1965) Herbicide Research Unit, Regional Research Centre, University of the West Indies, Trinidad, Annual Report 1964. PANS(C), 11, (4), 417-429.

WALDREP, T.W. and FREEMAN, J.F. (1964) EPTC injury to corn as affected by depth of incorporation in the soil. Weeds, 12, (4), 315-316.

AGRICULTURAL RESEARCH COUNCIL

WEED RESEARCH ORGANIZATION

Technical reports available

5. A survey of the problem of aquatic weed control in England and Wales. October, 1967. T.O. Robson. Price - £0.25.

6. The botany, ecology, agronomy and control of Poa trivialis L. rough-stalked meadow-grass. November 1966. G.P. Allen. Price - £0.25.

7. Flame cultivation experiments 1965. October, 1966. G.W. Ivens. Price - £0.25.

8. The development of selective herbicides for kale in the United Kingdom. 2. The methylthiotriazines. Price - £0.25.

9. The post-emergence selectivity of some newly developed herbicides (NC 6627, NC 4780, NC 4762, BH 584, BH 1455). December, 1967. K. Holly and Mrs. A.K. Wilson. Price - U.K. and overseas surface mail - £0.25; overseas airmail - £0.50.

10. The liverwort, Marchantia polymorpha L. as a weed problem in horticulture; its extent and control. July, 1968. I.E. Henson. Price - £0.25.

11. Raising plants for herbicide evaluation; a comparison of compost types. July, 1968. I.E. Henson. Price - £0.25.

12. Studies on the regeneration of perennial weeds in the glasshouse; I. Temperate species. May, 1969. I.E. Henson. Price - £0.25.

13. Changes in the germination capacity of three Polygonum species following low temperature moist storage. June, 1969. I.E. Henson. Price - £0.25.

14. Studies on the regeneration of perennial weeds in the glasshouse. II. Tropical species. May, 1970. I.E. Henson. Price - U.K. and overseas surface mail - £0.25; overseas airmail - £0.50.

15. Methods of analysis for herbicide residues in use at the Weed Research Organization. December, 1970. R.J. Hance and C.E. McKone. Price - U.K. and overseas surface mail - £0.25; overseas airmail - £0.50.

16. Report on a joint survey of the presence of wild oat seeds in cereal seed drills in the United Kingdom during Spring 1970. November, 1970. J.G. Elliott and P.J. Attwood. Price - £0.25.

17. The pre-emergence selectivity of some newly developed herbicides, Orga 3045 (in comparison with dalapon), haloxydine (PP 493), HZ 52.112, pronamide (RH 315) and R 12001. January, 1971. W.G. Richardson, C. Parker and K. Holly. Price - U.K. and overseas surface mail - £0.25; overseas airmail - £0.50.

18. A survey from the roadside of the state of post-harvest operations in Oxfordshire in 1971. November, 1971. A. Phillipson. Price - U.K. and overseas surface mail - £0.12; overseas airmail - £0.34.

19. The pre-emergence selectivity of some recently developed herbicides in jute, kenaf and sesamum, and their activity against Oxalis latifolia. December 1971. M.L. Dean and C. Parker. Price - U.K. and overseas surface mail - £0.25; overseas airmail - £0.45.

20. A survey of cereal husbandry and weed control in three regions of England. July 1972. A. Phillipson, T.W. Cox and J.G. Elliott. Price - U.K. and overseas surface mail - £0.35; overseas airmail - £0.75.

21. An automatic punching counter. November 1972. R.C. Simmons. Price - U.K. and overseas surface mail - £0.30; overseas airmail - £0.50.

22. The pre-emergence selectivity of some newly developed herbicides: bentazon, BAS 3730H, metflurazone, SAN 9789, HER 52.123, U 27,267. December 1972. W.G. Richardson and M.L. Dean. Price - U.K. and overseas surface mail - £0.25; overseas airmail - £0.45.

23. A survey of the presence of wild oats and blackgrass in parts of the United Kingdom during summer 1972. A. Phillipson. Price - U.K. and overseas surface mail - £0.25; overseas airmail - £0.45.

24. The conduct of field experiments at the Weed Research Organization. February 1973. J.G. Elliott, J. Holroyd and T.O. Robson. Price - U.K. and overseas surface mail - £1.25; overseas airmail - £1.47.

25. The pre-emergence selectivity of some recently developed herbicides: lenacil, RU 12068, metribuzin, cyprazine, EMD-IT 5914 and benthiocarb. August 1973. W.G. Richardson and M.L. Dean. Price - U.K. and overseas surface mail - £1.75; overseas airmail - £2.20.

26. The post-emergence selectivity of some recently developed herbicides: bentazon, EMD-IT 6412, cyprazine, metribuzin, chlornitrofen, glyphosate, MC 4379, chlorfenprop-methyl. October 1973. W.G. Richardson and M.L. Dean. Price - U.K. and overseas surface mail - £3.31; overseas airmail - £3.56.

27. Selectivity of benzene sulphonyl carbamate herbicides between various pasture grasses and clover. October 1973. A.M. Blair. Price - U.K. and overseas surface mail - £1.05; overseas airmail - £1.30.

28. The post-emergence selectivity of eight herbicides between pasture grasses: RP 17623, HOE 701, BAS 3790, metoxuron, RU 12068, cyprazine, MC 4379, metribuzin. October 1973. A.M. Blair. Price - U.K. and overseas surface mail - £1.00; overseas airmail - £1.25.

29. The pre-emergence selectivity between pasture grasses of twelve herbicides: haloxydine, pronamide, NC 8438, Orga 3045, chlortoluron, metoxuron, dicamba, isopropalin, carbetamide, MC 4379, MBR 8251 and EMD-IT 5914. November 1973. A.M. Blair. Price - U.K. and overseas surface mail - £1.30; overseas airmail - £1.50.

30. Herbicides for the control of the broad-leaved dock (Rumex obtusifolius L.). November 1973. A.M. Blair and J. Holroyd. Price - U.K. and overseas surface mail - £1.06; overseas airmail - £1.30.

31. Factors affecting the selectivity of six soil acting herbicides against Cyperus rotundus. February 1974. M.L. Dean and C. Parker. Price - U.K. and overseas surface mail - £1.10; overseas airmail - £1.35.