WEED CONTROL IN UMBELLIFEROUS CROPS

G. W. MASON

Ivon Watkins Ltd., New Plymouth

Summary

The tolerance of carrots and parsnips to pre-emergence applications of propazine 1 to 2 lb a.i. per acre has been confirmed in further yield data trials in New Zealand. Additional umbelliferous crops tolerating propazine at 1 to 2 lb a.i. per acre have included celery and parsley. The related triazine herbicide, ipazine, has been shown to be well tolerated by carrots and parsnips and also by celery with a greater initial margin of safety than with propazine. However, the residual weed control activity of ipazine is lower than that given by equivalent dosage rates of propazine. Therefore higher rates of application up to 3 lb a.i. per acre are necessary for comparable weed control with ipazine.

INTRODUCTION

Most umbelliferous crops are quite sensitive to weed competition, particularly in the early stages of seedling development. Furthermore, crops like parsnips are rather slow in germination, taking up to four weeks even under ideal conditions. The seedling parsnip, therefore, may begin growth with a severe handicap from already established weeds and consequently is readily suppressed in its early development.

The use of light petroleum distillates "carrot oils" has been discussed previously by Smith and Mason (1961). For carrots the potential advantages of a pre-emergence application of the weedkiller were compared with the widely used post-em. applications of "carrot oil". These workers evaluated a range of triazines in comparison with the chlorpropham and amiben in pre-em. applications and with post-germination treatments of "carrot oil" and certain newer anilide herbicides. In their work the most effective pre-em. herbicide showing satisfactory selectivity towards carrots was propazine at 1 to 2 lb. (References to quantities of chemicals used are expressed in terms of active ingredient per acre.) These tests were made under a wide range of soil and environmental conditions. It was shown by Thompson (1961) that propazine gave excellent control of broadleaf weeds in carrots for the duration of the crop. However, a subsequent infestation of summer grass (*Digitaria sanguinalis*) and witch grass (*Panicum capillare*) smothered the crop. It has been reported by Gregory (1961) that propazine poorly controls such members of the grass tribe Paniceae. However, other grasses, such as annual bluegrass (*Poa annua*), prairie grass (*Bromus catharticus*) and cocksfoot (*Dactylis glomerata*) have been well controlled by up to 2 lb propazine as in Smith and Mason's trials.

In the present trials the tolerance by both carrots and parsnips of up to 3 lb propazine and ipazine has been confirmed and adequate weed control has been obtained at 2 lb of both compounds under the existing soil and weather conditions.

Previously, satisfactory control of weeds in celery in New Zealand has been achieved by post-planting applications of CDEC at 6 lb under rather specific conditions. For reliable results the soil moisture prior and subsequent to the application of CDEC must be well controlled by overhead irrigation practices. Normally, 6 lb of CDEC is sufficient under these soil moisture conditions to give control of a range of weeds till the celery leaves over. The herbicide treatment is usually supplemented by limited inter-row cultivation.

The desire of the celery grower has been for a pre- or post-plant treatment of a herbicide to give extended weed control which is less critically dependent on soil moisture conditions by irrigation round planting time. The selectivity of propazine and ipazine towards carrots suggested their evaluation for weed control in celery. Post-planting treatments of propazine at 1 to 2 lb were compared with CDEC at 8 lb by Mason (1961). Some leaf chlorosis was reported in plants treated with propazine at 1.5 and 2 lb in the initial growth of the celery, but residual weed control was clearly superior to that of CDEC at 8 lb. At the time of harvesting, the celery in the propazine-treated plots appeared to be equal to those from hand-weeded controls in height, flavour and tenderness. In the present trials a real selectivity of ipazine up to 3 lb has been indicated, although the use of lower rates of propazine at 1 lb may be more economical as regards treatment costs.

An observational test indicates that propazine at 1 to 2 lb is well tolerated by established plantings of a further umbelliferous crop — parsley.

MATERIALS AND METHODS

The trials in carrots and parsnips were conducted on adjacent sites on an Ohakune silt loam soil of volcanic ash origin. Applications were made using an Oxford precision sprayer to 1/200th-acre plots (31ft × 7ft) covering three crop rows sown 24 in. apart, at the rate of 2 lb of seed per acre. The equivalent of 46 gal of water per acre was applied at 3 m.p.h. using 37 solid cone nozzles at 40 lb/sq. in. Treatments were replicated four times in randomized blocks. Pre-emergence treatments were made one day after sowing, and the single post-em. application of "carrot oil" at 60 gal per acre five weeks after sowing when the first hand-weeding was carried out. At this stage the weeds were already up to 4 in. high while the carrots and parsnips were only 3 in. in height. The weed cover was estimated as follows: Shepherd's purse (*Capsella bursa-pastoris*) 40%; fathen (*Chenopodium album*) 10%; spurrey (*Spergula arvensis*) 15%; twincress (*Coronopus didymus*) 10%; rocket (*Diplotaxis muralis*) 10%; sorrel (*Rumex acetosella*) 5%; broadleaf dock (*Rumex obtusifolius*) 5%, and dead nettle (*Lamium purpureum*) 5%.

The centre row only was used for yield assessment, two 10 ft sections being harvested. The mean fresh weight of roots free of tops was taken for analysis of yield. The weeds were hoed off at ground level from a 1 ft strip on either side of the 10 ft row of harvested crop, the mean fresh weight of weed tops being recorded.

Because of the limited area available, the trial on celery was restricted to 1/400th-acre plots (15 ft 6 in. × 7 ft) replicated three times. Pre-plant (6 days) and post-plant (1 day) treatments were made using the same application equipment as for the carrots and parsnips. A 1 in. overhead irrigation was applied one day after the post-plant treatment, and a further 1 in. after the pre-plant covering the whole trial block. Hand-weeding was carried out in the control plots after each assessment of weed control and crop vigour four and nine weeks after planting. No yield data were obtainable from the pre-plant trials because the celery developed heart rot and was therefore not harvested. The celery in the post-plant treatments were all harvested from the plots and the number and total weight of sticks per bed were recorded. The mean yield of celery per acre was established, but no statistical analysis was possible on the data.

RESULTS AND DISCUSSION

(Student's *t* used for significance test)

CARROTS AND PARSNIPS

Tables 1 and 2 list the results obtained for the assessment of weed control and crop vigour, and also the weed weights and crop yield at harvest time.

TABLE 1: WEED CONTROL AND YIELD OF CARROTS
(Carrots var. Manchester Table)

Treatment (lb)	Weed Control* Weeks			Crop Vigour† Weeks		Weed Tops (tons per acre)	Crop Yield (tons per acre)
	5	9	25	9	25		
Propazine 2.0	9.0	8.0	3.3	9.8	9.8	5.4	42.4
Propazine 3.0	9.1	8.8	4.9	9.1	9.6	8.2	37.4
Ipazine 2.0	9.0	6.5	4.9	9.4	9.3	10.8	37.2
Propazine 1.0	8.9	6.0	2.8	9.3	9.1	8.7	36.6
Ipazine 1.0	8.3	4.0	2.3	9.1	8.5	10.6	33.4
HWC	10.0	6.6	6.8	6.7	8.9	4.7	26.5
"Carrot oil" 60 gal	—	1.8	1.6	4.9	6.8	17.0	13.0
Control	0	0.3	0	5.8	6.3	14.6	11.8
L.S.D. 5%						5.8	7.0
L.S.D. 1%						7.8	9.5

* Weed control: 0 = no control, 10 = complete control.

† Crop vigour: 0 = crop eliminated, 10 = no crop reduction.

TABLE 2: WEED CONTROL AND YIELD OF PARSNIPS
(Parsnips var. Hollow Crown)

Treatment (lb)	Weed Control* Weeks			Crop Vigour† Weeks		Weed Tops (tons per acre)	Crop Yield (tons per acre)
	5	9	25	9	25		
Propazine 3.0	9.0	8.6	4.1	9.4	9.6	5.4	11.4
Propazine 2.0	9.3	7.8	3.8	9.3	9.7	7.3	11.2
Ipazine 2.0	8.5	5.4	1.4	9.4	9.3	13.1	9.7
Propazine 1.0	8.1	6.2	1.6	9.4	9.2	8.4	9.4
HWC	10	6.4	1.3	6.9	9.0	8.8	9.0
Ipazine 1.0	7.4	4.4	1.1	8.7	9.1	10.6	6.9
"Carrot oil" 60 gal	—	0.8	0	4.4	7.0	16.5	1.9
Control	0	0.6	0.1	4.1	6.8	14.4	1.1
L.S.D. 5%						5.9	2.8
L.S.D. 1%						8.1	3.8

An assessment of weed control from a visual rating was made at the time of hand-weedings (five and nine weeks after sowing) and finally just prior to harvest (25 weeks after sowing). A visual estimation of crop vigour was also made at the time of the second hand-weeding and just prior to harvest (9 and 25 weeks after sowing).

The "carrot oil" application was made five weeks after sowing. Already the weeds were in the 2 to 4 true leaf stage, 4 in. high and "hardening off" due to the dry conditions. The weather at the time of the oil application was fine, sunny and warm. An ineffective kill of the weeds in both the carrots and parsnips was achieved, as evident from the assessment made four weeks later. Clearly the competition from the young weeds, even in the first month under these growth conditions of lower soil moisture, has been the critical factor in severely reducing the growth of the crop plants. Even the hand-weeded control plots, which were first cleaned five weeks after sowing and again four weeks later, had the crop plants reduced in vigour from the initial competition in the five weeks after sowing. This is particularly true for the slower germinating parsnips, which offered even less competition to the more fully developed weeds. The single application of 60 gal per acre of "carrot oil" under these conditions proved insufficient to reduce competition of the weeds, many of which survived and matured following the treatment.

The triazine weedkillers, propazine 1, 2 and 3 lb, and ipazine 2 lb, have given excellent control of all the annual broadleaf weeds present, especially for the critical period of crop establishment in the first two months. There is no significant difference in the weed control (at the time of harvest) between the three rates of propazine and also between the two rates of ipazine for both carrots and parsnips. However, in the case of parsnips, ipazine at 1 lb has given a reduced crop yield which reflects the poorer initial weed control evident in the visual ratings recorded after nine weeks. Although not significant, carrots also show the same trend. The weed control given by ipazine at 1 lb appeared to be hardly commercially acceptable at the nine week inspection for both crops.

Although the residual weed control in both crops with propazine at 3 lb has been slightly more effective than 2 lb the effect of critical initial weed control has not been improved at the higher dosage rate. Even propazine at 1 lb has given sufficient weed control to give yields for both crops comparable with the highest dosage. The rather low weed control ratings at the final assessment are due to the later developing infestation of the perennial weeds, such as broadleaf dock, sorrel, yarrow (*Achillea millefolium*) and occasional Californian thistle (*Cirsium arvense*). These evidently did not greatly interfere with the later crop growth nor with the harvesting operations. Both carrots and parsnips seem to be about equally tolerant of the propazine and ipazine at comparable rates. Even 3 lb propazine under these particular conditions has not reduced the initial vigour of the carrots and parsnips. At the time of the pre-em. applications the soil was quite dry, but within 24 hours of treatment 0.10 in. rain fell. Table 3 lists the rainfall pattern for the trial.

TABLE 3: RAINFALL FROM KARIOI STATE FOREST (in.)
(5 miles east of trial site)

				1961-62		1958-61
December	.....	.....	.....	1.97	.....	3.64
January	.....	.....	.....	2.81	.....	4.43
February	.....	.....	.....	2.38	.....	4.20
March	.....	.....	.....	2.79	.....	2.72

Compared with the mean recordings for the previous three years, it is evident that the weather conditions in the more critical two months following treatment were rather dry. The lower soil moisture would have aggravated the reduction in crop growth in the initial stages where weed control was inadequate.

The weed control and crop yield data indicate that pre-em. application of propazine at 1 to 2 lb is an efficient means of obtaining selective weed control in carrots and parsnips considering the soil type and moisture conditions experienced in this trial. Although ipazine appears to be well tolerated by the carrots and parsnips, the residual weed control activity of this compound appears to be about 70% of that of propazine. From the data presented it would appear that at the 1 lb rate ipazine may give marginal weed control under more difficult environmental conditions.

CELERY

Very effective weed control is indicated in Table 4 for all triazine treatments in the first four weeks of the celery growth. After nine weeks the weed control activity of ipazine at 1 and 2 lb had declined, but weed control activity was maintained at an acceptable level by ipazine at 3 lb and by propazine at all rates. Crop vigour ratings indicated some initial set-back from propazine at 2 and 3 lb, but recovery was nearly complete even with the propazine at 3 lb post-

TABLE 4: POST-PLANT WEED CONTROL AND YIELD
OF CELERY
(Celery var. Utah 15/20 — Green)

Treatment (lb)	Weed Control Weeks				Crop Vigour Weeks				Crop Yield (tons per acre) post-plant		
	pre		post		.....	pre		post			
	4	9	4	9		4	9	4		9	
Ipazine 1.0	10	5.3	10	4.5	.....	10	10	10	10	.....	29.0
Ipazine 3.0	10	8.8	10	8.0	.....	9.8	9.5	9.5	10	.....	27.4
Propazine 1.0	10	8.5	10	8.0	.....	9.0	9.7	9.2	10	.....	26.2
Propazine 3.0	10	9.7	10	9.8	.....	7.8	7.7	7.8	9.0	.....	25.0
Ipazine 2.0	10	8.0	10	5.5	.....	10	10	9.5	10	.....	24.6
Propazine 2.0	10	9.7	10	9.0	.....	8.7	8.7	8.3	9.7	.....	24.6
Control	0	6.0	0	7.0	.....	10	10	10	10	.....	23.6

after nine weeks but not from the pre-plant treatment. Yield data indicate no marked differences between treatments, but the trial layout did not allow statistical analysis. The co-operating grower indicated that celery from plots treated with ipazine was exceptional for the quality and consumer acceptance. From the practical point of view it would appear that propazine at 1 lb is likely to give a very economical level of weed control in celery with a satisfactory margin of safety. No soil residues from a previous year's application of propazine at 2 lb were detected in a following planting of the triazine-sensitive lettuce. Pre-emergence applications of propazine at 1 lb have also been used in celery seedbeds with satisfactory tolerance exhibited by the young plants.

PARSLEY

An observational trial in established plantings of parsley has indicated that this umbelliferous crop will tolerate between 1 and 2 lb of propazine quite satisfactorily.

GENERAL CONCLUSIONS

The relative tolerance of umbelliferous crops towards propazine and ipazine suggested from the present tests indicates that there may be some specific enzyme system within these plants which de-activates these particular triazines. The most susceptible stage of the plant to triazine damage is at seedling emergence. At this stage the food reserves from the seed are almost exhausted and root development of the young seedlings has only just been established. In sandy soils that are very light and with a low humus content, a dosage down to 0.5 lb propazine is suggested, particularly if artificial irrigation is used to promote crop germination. In soils with a higher adsorptive capacity, such as that present in the present trials for carrots and parsnips, an adequate margin of safety seems evident with propazine at 2 lb. Sufficient initial and residual weed control has been given by 1 to 2 lb allowing excellent crop establishment. Excessive rain or irrigation near to the point of flooding following the application of propazine to already moist soil may cause reduced germination. From the present yield data it appears that the rate of application of propazine should be selected to give adequate initial control of the weeds expected and with a residual activity sufficient to reduce weed competition until the carrots and parsnips form a competitive top growth about ten weeks after sowing. If the soil is moist to a depth of ½ to 1 in. in the period 1 to 2 weeks after application, adequate weed control, except for

perennial and Panicae grasses, should be given up to 2 lb propazine. In very light soils where there is the possibility of high moisture following treatment, ipazine may be the safer triazine for umbelliferous crops. It has been reported by Rodgers (1962) that ipazine was the most highly adsorbed of four triazines in leaching studies in sandy soils.

ACKNOWLEDGEMENTS

A. H. Smith and G. Johns assisted in the experimental work and P. G. Fenemore supplied statistical analyses. L. Burn, Rangataua, and P. Sisson, Levin, prepared the experimental sites for the various trials.

REFERENCES

- Gregory, P. 1961: A review of developments with triazines. *Proc. 14th N.Z. Weed Control Conf.*, pp. 66-74.
- Mason, G. W. 1961: The substituted triazine herbicides in N.Z. *Proc. 14th N.Z. Weed Control Conf.*, pp. 92-102.
- Rodgers, E. G. 1962: Leaching of four triazines in three soils as influenced by varying frequencies and rates of simulated rainfall. *Proc. 15th Southern Weed Conf.*, p. 268.
- Smith, A. H.; Mason, G. W. 1961: Pre- and post-emergence weed control in carrots. *Proc. 14th N.Z. Weed Control Conf.*, pp. 177-184.
- Thompson, F. B. 1961: Weed control in brassica crops, carrots and onions. *Proc. 14th N.Z. Weed Control Conf.*, pp. 172-176.