FURTHER DEVELOPMENTS IN FIELD BRASSICA WEED CONTROL

G. W. MASON

Ivon Watkins-Dow Ltd., New Plymouth

Summary

Mixtures of nitrofen and picloram at rates not exceeding 1 lb plus 1 oz active ingredient per acre, respectively, appear sufficiently selective to warrant large-scale field tests for post-emergence selective broadleaf weed control in both leafy and root brassica field crops. The risk of persistent soil residues from such low rates of picloram which might affect the establishment of white clover (*Trifolium repens*) in subsequent permanent pastures seems limited provided soil cultivation is thorough. Desmetryne and nitrofen/desmetryne mixtures have been insufficiently selective on root brassicas but appear worthy of more detailed study on the leaf brassicas, especially in spurrey (*Spergula arvensis*) dominant sites and at various stages of development of the crop and weeds.

INTRODUCTION

THE CONTROL of broadleaf weeds in field brassica crops continues to retain the interest of New Zealand research workers, with the prospect of additional compounds being available to supplement nitrofen which has become widely established in use by the farmer. The deficiencies of nitrofen as regards its critical timing of application, its variable performance under hardened growth conditions, problems with tolerant weed species, and its limited pre-emergence effectiveness have necessitated studies with additional herbicides. The most promising have included picloram (formerly known as Tordon*) and desmetryne applied alone and each in mixture with nitrofen. However, compared with nitrofen, both picloram and desmetryne have shown a lower margin of safety to the brassicas, especially the root varieties. It has therefore been necessary to establish their tolerance limits to the various brassica crops and at different stages of crop and weed growth. In their spectrum of weed control, picloram and desmetryne complement nitrofen, hence they have been deemed worthy of more detailed test in combination using low rates of each to achieve greater crop-weed selectivity.

The need for further work on picloram to assess critical crop tolerance, especially turnips, together with the need for data on its soil residual toxicity, was stressed at a previous conference (Mason, 1964; A. Thompson, 1964; F. B. Thompson, 1964).

The present investigation sets out to answer some of these problems and specifically to find the minimum rate of picloram in combination with nitrofen necessary to achieve adequate weed control with sufficient margin of crop safety and lack of soil residue problems.

* Trade mark of the Dow Chemical Company, U.S.A.

EXPERIMENTAL

All small plot treatments were applied with an Oxford precision sprayer to 31 ft × 7 ft plots using fan nozzles applying 32 gal of water per acre at 30 lb/sq. in. pressure. The yield trials were set out in randomized blocks with treatments replicated six times. All treatments are expressed as rate of active ingredient per acre. The mixture treatments consisted of emulsifiable formulations of the combined active ingredients and not "tank" blends. Ratings were made using the 0-10 scale by two independent observers.

TRIAL I: SWEDES, SOUTH TARANAKI

Wilhelmsburger swedes were sown at 1 lb per acre in 7 in. rows on a silt loam soil. At the time of treatment 1 month later, the swedes were in the 4 to 8 true leaf stage, 2 to 6 in. in height, with the weeds in active growth, but in a more advanced stage than is considered optimum for the standard treatment of nitrofen at 2 lb. At the time of treatment, the weed population consisted of regrowth shoots of Californian thistle (*Cirsium arvense*) 40%, broadleaf dock (*Rumex obtusifolius*) 30%, redshank (*Polygonum persicaria*) 2 to 6 leaf 10%, black nightshade (*Solanum nigrum*) 10%, and fathen (*Chenopodium album*) 4 to 8 leaf 10%. The weeds collectively did not form an extremely dense stand.

Evaluations for Californian thistle control and/or crop vigour were made 2, 5, 12 and 15 weeks after treatment. Yield data were obtained by sampling the swedes from a 30 sq. ft area in each plot to give whole plant and bulb fresh weights (Table 1).

The strong reduction in Californian thistle achieved by the nitrofen/picloram mixture is evident compared with the lack of control by non-picloram treatments. Later emerging thistle shoots were grossly distorted and suppressed by the higher rate picloram treatments, while virtually complete control of the annual weeds was obtained as well. Although the crop stand was somewhat variable, significant increases in bulb yield were obtained from all nitrofen/picloram treatments over unweeded control. There was no consistent pattern of bulb cracking or distortion in any treatments, except in the higher picloram treatment, to suggest that this is likely to be a real problem associated with the use of low rates of picloram as reported elsewhere (A. Thompson, 1964).

TRIAL II: TURNIPS, NORTH TARANAKI

York Globe turnips were sown in volcanic alluvial loam in 12 in. rows on a site in the first season cultivated from pasture. The crop at the time of treatment one month later was 2 to 5 in. high, up to the 6-leaf stage and in most active growth. The trial block contained a low population of seedling "Scotch" thistle (*Cirsium vulgare*) and black nightshade (*Solanum nigrum*), both weeds being in a 2- to 4-leaf stage, ½ to 1½ in. diameter.

Evaluations were made for weed control (of the very limited population) and for crop vigour 1, 2 and 5 weeks after treatment. Total crop and bulb weights were obtained as for Trial I two months after treatment (Table 2).

Extremely moist conditions prevailed throughout this trial and the rain which fell within the first 24 hours (not until 17 hours after treatment) would have undoubtedly reduced the phytotoxicity of some of the treatments. This could explain the greater than expected selectivity of desmetryne to the young turnips, the survivors of which, though seriously retarded initially by leaf chlorosis, managed to recover under the subsequent moist growing conditions.

TABLE 1: ASSESSMENT OF WEED CONTROL, CROP VIGOUR AND YIELD IN SWEDES (SOUTH TARANAKI)

Treatment (lb)	Californian thistle Control*			Crop Vigour† Weeks	Bulb‡ Distortion Weeks	Fresh Crop Yield (tons/acre)		Relative		
	Weeks					Whole Plant	Bulbs	Whole Plant	Bulbs	
	2	5	12							
Nitrofen 1.5/picloram 0.09		6.0	8.6	7.8	9.9	8.7	34.2 aA	25.0 aA	161	181
Nitrofen 0.5/picloram 0.03		2.5	5.2	4.8	10	8.3	30.0 abAB	23.1 aAB	142	167
Nitrofen 1.0/picloram 0.06		4.3	7.2	5.0	9.9	8.8	28.6 abcAB	20.3 abABC	135	147
Nitrofen 2.0		0	1.3	1.8	10	8.6	28.6 abcAB	19.6 abcABCDE	135	142
Nitrofen 1.0		0	1.7	1.8	10	9.5	23.8 bcdAB	15.7 bcdBCDE	112	114
Nitrofen 1.0/desmetryne 0.06		0	0.7	2.8	8.2	8.7	23.7 bcdAB	15.9 bcdBCDE	112	115
Unweeded control		0	1.2	1.5	10	8.8	21.2 bcdAB	13.8 cdCDE	100	100
Desmetryne 0.25		0	3.7	1.1	4.0	7.0	19.2 dB	12.4 dCDE	91	90
Nitrofen 1.0/desmetryne 0.125		0	2.7	0.9	6.8	8.5	16.7 dB	10.4 dE	79	75
C.V.							6.1%			

Rainfall: 24 hr — 0.05 in.; 48 hr — 0.30 in.; 2 weeks — 1.5 in.; 6 weeks — 4.07 in.

* Weed control: 0=No control, 10=Complete control.

† Crop vigour: 0=Crop eliminated, 10=No crop retardation.

‡ Bulb effect: 0=All bulbs cracked, 10=No cracking or distortion.

TABLE 2: ASSESSMENT OF WEED CONTROL, CROP VIGOUR AND YIELD IN TURNIPS (NORTH TARANAKI)

Treatment (lb)	"Scotch Thistle" Control Weeks			Crop Vigour Weeks			Fresh Crop Yield (tons/acre)		Relative Bulbs		
							Whole Plant	Bulbs			
	1	2		1	2	5					
Nitrofen 0.5/picloram 0.03				4.5	2.4	8.8	8.9	9.8	45.0	33.2 aA	101
Nitrofen 1.0				3.2	0.3	8.4	9.0	9.9	44.0	32.8 aA	100
Unweeded control				0	0.2	9.9	10	9.7	43.6	32.5 abAB	100
Nitrofen 2.0				3.7	0.5	7.8	8.7	9.8	41.5	31.5 abABC	97
Nitrofen 1.0/picloram 0.06				5.8	4.0	8.3	8.0	9.9	41.9	31.1 abcABC	96
Nitrofen 1.5/picloram 0.09				6.3	6.3	7.2	7.2	9.3	40.1	29.8 bcdABC	97
Desmetryne 0.25				5.7	1.4	4.4	7.1	9.8	37.3	28.9 cdBCD	89
Nitrofen 1.0/desmetryne 0.06				4.3	0.7	5.0	7.3	9.7	39.9	28.9 cdBCD	89
Nitrofen 1.0/desmetryne 0.125				3.4	1.3	6.1	7.4	9.8	39.3	28.6 cdCD	88
C.V.										7.1%	

Rainfall: After 24 hr — 0.23 in.; 2 weeks — 3.16 in.; trial total — 13.80 in.

The yields from all desmetryne treatments were significantly reduced. Neither bulb distortion nor cracking was seen in any picloram treated samples and only above the 1 oz rate in the mixture is there a slight trend towards bulb weight suppression compared with the near weed-free control. Although some of the initial leaf cupping was present in the 1.5 oz picloram treatment, these symptoms had almost disappeared from the turnips at harvest. In this trial the low weed population enables crop tolerance to the treatments to be assumed without the need for a hand-weeded control.

TRIAL III: CHOUMOELLIER, WANGANUI

Medium Stem choumoellier 2 lb with a light sowing of turnips 0.5 lb were broadcast sown in a silt loam. Three weeks later when the crop was 2 to 4 in. high in the 2 to 4 true leaf stage, treatments were applied to a dense population of weeds consisting of red root (*Amaranthus hybridus*) 45%, variegated thistle (*Silybum marianum*) 25%, all at the 2 to 4 true leaf stage, ½ to 1 in. high and up to 2 in. in diameter.

An evaluation for weed control was made at the time of harvest fourteen weeks after treatment (Table 3). A 30 sq. ft sample was cut off at ground level from each plot to give total fresh weight of tops of choumoellier. The stand of turnips proved to be too scattered for harvest.

TABLE 3: ASSESSMENT OF WEED CONTROL AND CROP YIELD IN CHOUMOELLIER (WANGANUI)

Treatment (lb)	Weed Control	Choumoellier Yield (tons/acre)	Relative
Desmetryne 0.25	8.4	26.4	330
Nitrofen 1.5/picloram 0.09	9.8	21.4	267
Nitrofen 1.0/desmetryne 0.125	7.4	20.3	254
Nitrofen 0.5/picloram 0.03	9.1	16.7	208
Nitrofen 1.0/picloram 0.06	10	16.2	202
Nitrofen 1.0/desmetryne 0.06	6.5	14.4	180
Nitrofen 1.0	4.6	11.9	149
Nitrofen 2.0	5.5	9.4	117
Unweeded control	3.9	8.0	100

The outstanding feature of this trial was the almost complete control of the variegated thistle by the nitrofen/picloram mixture treatments even down to the 0.5 oz rate of picloram. No symptoms of injury to the turnips present were shown in these treatments, in strong contrast to the desmetryne containing treatments which almost completely eliminated the turnips. Although the addition of 2 oz of desmetryne to the nitrofen greatly improved the thistle control, it was not comparable with that achieved with 4 oz of desmetryne alone or with that from the nitrofen/picloram treatments. Even at the 2 lb rate, the deficiency of nitrofen alone in controlling the variegated and occasional "Scotch" thistle was quite evident. The strongly significant increase in yield of choumoellier obtained with the desmetryne 4 oz treatment is no doubt partly due to the complete elimination of the turnips, thus reducing still further the competition to the choumoellier, a factor not present in the picloram treatments. Obviously desmetryne could not be safely used in mixed stands of leaf and root brassicas.

TRIAL IV: MIXED SWEDES, NORTH TARANAKI

A mixture of three swede varieties, Superlative, Dominion and Grandmaster, was sown at a total rate of 1 lb on a volcanic loam recently cultivated from permanent pasture. At the time of treatment 2½ weeks later, the crop was very tender in the 2 to 5 true leaf stage, 1 to 4 in. high. The only weeds present were a few Californian and "Scotch" thistles (1 to 1½ in. diam.) which at harvest time appeared to be of very limited competition in the control plots. Very adequate moisture was present and growth was active during the whole trial period. The valuations of crop vigour on this near weed-free situation were made 2 and 5 weeks after treatment. Yields were obtained as for Trial I 12 weeks after treatment (Table 4).

TABLE 4: ASSESSMENT OF CROP VIGOUR AND YIELD IN MIXED SWEDES (NORTH TARANAKI)

Treatment (lb)	Crop Vigour Weeks		Crop Yield (tons/acre)		Relative
	2	5			
Nitrofen 1.0/picloram 0.06	7.9	9.2	31.8	aA	102
Nitrofen 0.5/picloram 0.03	8.1	9.1	30.8	aAB	101
Unweeded control	9.8	9.8	30.3	aAB	100
Nitrofen 1.0/desmetryne 0.06	2.7	7.6	29.4	aAB	97
Nitrofen 1.0	8.5	9.0	28.3	abAB	93
Nitrofen 2.0	8.3	9.3	28.3	abAB	93
Nitrofen 1.5/picloram 0.09	7.7	9.0	27.6	abAB	91
Nitrofen 1.0/desmetryne 0.125	0.8	5.6	20.5	bcBC	68
Desmetryne 0.25	0.6	4.5	13.2	cC	44
C.V.			24.0%		

Rainfall: 24 hr — nil; 48 hr — 0.02 in.; 2 weeks — 3.25 in.; trial total — 10.45 in.

This trial provided a uniform mixed crop of swedes in a very soft state of growth at the time of treatment. It therefore was an ideal site for assessment of crop tolerance under more or less weed-free conditions. The results indicate that nitrofen/picloram mixtures at not more than 1 lb plus 1 oz, respectively, have not suppressed turnip bulb yield, although there has been a trend towards a non-significant reduction in yield at the 1.5 oz rate. No signs of bulb cracking, distortion or decay were present in the crop at the time of harvest. Although the 1 lb/1 oz rate of the nitrofen/desmetryne mixture did not suppress yields significantly, there has been obviously less than a 2× safety margin, especially from the triazine component. Again desmetryne at the suggested rate for kale has severely depressed the growth and yield of the turnip bulbs when applied under what might be considered optimum growth recovery conditions. The initial burning and stunting of this leaf-tender brassica, even down to the 1 oz rate of desmetryne in the mixture, would be unacceptable to most users.

TRIAL V: RAPE, NORTH CANTERBURY

Giant rape sown in 18 in. rows on a silt loam was treated three weeks later at the ideal "nitrofen" stage, when the crop was in

the 2 to 4 leaf stage, $\frac{1}{2}$ to 2 in. high. The dense weed population was fathen 75%, and wireweed (*Polygonum aviculare*) 25%, both in the cotyledonary to 4-leaf stage, $\frac{1}{2}$ to 1 in. high. Rain fell during the trial applications, lessening in intensity towards the end of the treatments. Therefore all treatments were applied to wet foliage under run-off rainy conditions. The rape and weeds were harvested 6 weeks after treatment by mowing two samples at ground level from two centre rows 15 ft long from each plot. Yields were recorded as fresh weight of tops (Table 5).

All treatments have proved remarkably effective in their near-complete control of the fathen and wireweed considering the quite heavy rain experienced during and following the applications. The subsequent hot, dry weather conditions severely stressed the plants in the untreated controls which showed significantly reduced crop yields compared with all treated plots. The nitrofen/picloram mixtures have not shown any real improvement over the standard 2 lb nitrofen treatment in weed control. However, the applications were ideally suited for the correct stage of growth for a straight nitrofen treatment of a predominantly fathen population of weeds.

CONCLUSIONS

By combining the different herbicidal properties of nitrofen and picloram, it appears that low rates of each (not more than 1 lb plus 1 oz) can be applied to even the more sensitive root brassica crops including turnips. This has achieved a more reliable safe broadleaf weed control than is possible with the individual components alone. More versatility as regards stage of weed growth, variety of species controlled, and general weather conditions before, during and after treatment have been achieved with the mixture compared with the standard nitrofen treatment alone. Picloram in the nitrofen combination has adequately controlled regrowth perennial weeds such as Californian thistle and broadleaf docks and also such weeds as redroot, redshank, spurrey, most thistles, all of which are inadequately suppressed by nitrofen alone. Some pre-emergence weed control has been indicated with this mixture and this may overcome the problem of second weed germination after the herbicide application—a feature evident in the present standard nitrofen treatment.

The rate required of the picloram component in the mixture for acceptable weed control appears to be 0.5 to 1 oz, depending on the weed species present, their stage of growth, and the prevailing weather conditions. The 1 oz rate may be necessary for weeds not sufficiently susceptible to nitrofen alone, for example, thistles, regrowth docks, and for post-seedling stage weeds generally, but especially for spurrey, redroot, redshank, wireweed growing under hardened dry conditions. Soil residues from less than 1 oz picloram are not likely to be a problem to subsequent white clover establishment, provided the soil cultivation after the brassica crop buries any remaining traces of the chemical. In the subsequent rotations, it would be advisable to avoid picloram-sensitive crops such as peas, potatoes, tobacco, tomatoes and beans. Cereals, linseed or pasture should be suitable in the following crop rotation. Volunteer white clover has been observed to have freely germinated and to grow unaffected in a choumoellier crop 8 weeks after treatment with 0.5 oz of picloram in the nitrofen mixture. Further work is necessary with nitrofen/picloram mixtures for Californian thistle control in heavily infested sites suitable for a brassica cereal pasture rotation. Desmetryne and nitrofen/desmetryne mixtures have been insufficiently selective on the root brassica crops and even

TABLE 5: ASSESSMENT OF WEED CONTROL, CROP VIGOUR AND YIELD OF WEEDS AND RAPE
(NORTH CANTERBURY)

Treatment (lb)	Yields (tons/acre)				
	Weed Control 4 weeks	Crop Vigour 4 weeks	Weed (mainly fathet)	Crop	Relative
Nitrofen 1.5/picloram 0.09	8.6	9.2	0	3.5 a	194
Nitrofen 1.0/picloram 0.06	8.3	8.9	0	3.4 a	189
Nitrofen 1.5	7.2	8.4	0	3.3 ab	184
Nitrofen 2.0	8.4	9.0	0	3.2 ab	178
Nitrofen 0.5/picloram 0.03	6.7	8.1	0	2.9 bc	161
Unweeded control	0	5.3	1.2	1.8 c	100
C.V.				1.1%	

Rainfall: 24 hr — 0.10 in.; trial total — 1.01 in.

down to 1 oz of desmetryne per acre the severe initial injury appears too drastic. Such treatments, however, are worthy of more detailed study on the leaf brassica crops, especially where spurrey occurs as the dominant weed. Applications at various stages of crop and weed growth are warranted to determine the optimum treatment time.

ACKNOWLEDGEMENTS

Grateful acknowledgement for assistance in carrying out the trials and assessment of results is made to A. H. Smith, G. S. Johns, P. G. Coles of the Research and Development Department, Ivon Watkins-Dow Ltd., and to the many farmers who co-operated in making available trial sites.

REFERENCES

- Mason, G. W., 1964: *Proc. 17th N.Z. Weed & Pest Control Conf.*: 85-90.
Thompson, A., 1964: *Proc. 17th N.Z. Weed & Pest Control Conf.*: 91-6.
Thompson, F. B., 1964: *Proc. 17th N.Z. Weed & Pest Control Conf.*: 97-103.