WEED CONTROL IN FIELD BRASSICA CROPS

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Summary

A promising new development for selective post-emergent broadleaf weed control in field brassica crops using a substituted phenyl ether known as nitrofen is outlined. When applied to young weeds in the early true leaf stage, nitrofen at 2 lb active ingredient per acre has given very adequate control of fathen (*Chenopodium album*) and also to some extent of the common cropping weeds, spurrey (*Spergula arvensis*), redshank (*Polygonum persicaria*) and redroot (*Amaranthus hybridus*). No permanent injury to any of the five important New Zealand brassica feed crops, choumoellier, turnips, rape, kale, and swedes, has been noted in any field tests. Significant yield increases for choumoellier and turnips treated with 2 lb nitrofen have been obtained where heavy infestations of fathen were present. The importance of time of application in relation to stage of weed development and growing conditions is stressed for most efficient weed control.

INTRODUCTION

BECAUSE OF THE more severe climatic conditions, particularly in the South Island, pasture production during periods of reduced growth in summer and winter must be supplemented by the root and green feed brassica crops, swedes, turnips and rape, kale, and choumoellier. These crops occupy nearly three-quarters of a million acres of New Zealand farming land.

One of the major problems in satisfactory establishment of these crops, especially swedes, turnips and rape is the competition from the broadleaf weeds, fathen (*Chenopodium album*) and spurrey (*Spergula arvensis*), in the South Island provinces of Canterbury, Otago and Southland. In these fat lamb production areas these brassica crops form an integral part of the farming economy.

In the North Island, redshank (*Polygonum persicaria*), redroot (*Amaranthus hybridus*) and nightshade (*Solanum nigrum*), together with fathen and spurrey, commonly occur in choumoellier and swede crops.

The only recommended post-emergence selective treatment has been the application of sodium chloroacetate at 10 to 13.6 lb (all rates given in lb active ingredient per acre) for rape, choumoellier and swedes, after the four-leaf stage (Thompson 1960), but no control of fathen is obtained. Unfortunately, soft turnips are too severely injured unless they are well smothered and therefore protected by the weeds. In practical use sodium chloroacetate has been of little value in the South Island and restricted in the North Island almost to choumoellier infested with young redshank and redroot, but entirely free of fathen.

The potential use of pre-emergence techniques in brassica crop weed control has been well reviewed by Foreman (1960). The use of non-residual contact herbicides (such as pentachlorophenol and more recently diquat) is practical only when applied to the stale seed bed soon after crop sowing. Brassicas germinate so rapidly under normal conditions that the weeds must be allowed to strike in the prepared ground up to two weeks before crop sowing for effective contact herbicide control. But this delay technique is

unacceptable to many farmers, and any weeds emerging even immediately after treatment are not controlled.

A range of residual pre-emergence treatments has been evaluated in the last three years (Foreman, 1960; F. B. Thompson, 1962; A. Thompson, 1962), but only sodium trichloroacetate at 15.9 lb has been regularly used on a larger scale by the few farmers who recognize the critical soil moisture conditions required for successful results.

In the last three years Ivon Watkins Ltd. has evaluated a wide range of other potential selective pre-emergence type materials involving turnips, swedes and choumoellier. The only compounds with a wide margin of safety proved to be DCPA 2 to 8 lb and nitrofen 2 to 8 lb.

As pre-emergence treatments, both these compounds gave rather limited weed control at 2 lb, but generally adequate weed control at 6 to 8 lb per ac. Nitrofen (FW 925) was more consistent in its performance under lower soil moisture conditions than the very low solubility DCPA. However, it was recognized that this very variable factor of soil moisture conditions, especially in Canterbury brassica crops, limited the reliability of such pre-emergence treatments.

In viewing these earlier trial results and the pattern of current farmer usage of herbicides it is obvious that there is a pressing need for a safe and reliable broad spectrum herbicide for post-emergence weed control in all the brassica feed crops and especially in the more easily smothered root crops, swedes and turnips.

Using a bicycle-mounted logarithmic sprayer, the selectivity of a range of potential post-emergence herbicides was evaluated. In two replicated trials in Canterbury on uniform fathen infestations in choumoellier and rape, nitrofen proved to offer outstanding safety to both these crops with no permanent damage at rates decreasing from 16 and 8 lb. The selectivity factor seemed to depend mainly on the stage of fathen development rather than that of the crop. A safety factor of at least four times was evident for both crops. An intensive evaluation programme on nitrofen was therefore begun to establish, more critically, treatment dosages in relation to stage of weed growth and brassica crop tolerance under a range of field conditions. Out of 20 trials carried out this last season only, two yield trials will be reported in detail.

EXPERIMENTAL

All treatments were applied with an Oxford Precision Sprayer to 1/200th acre plots (31 ft × 7 ft) using 37 Solid Cone nozzles applying 46 gal of water per ac at 40 lb/sq. in. pressure. Treatments were replicated six times in randomized blocks.

RESULTS AND DISCUSSION

CHOUMOELLIER (Wanganui)

Choumoellier variety Superlative Medium Stem was sown at 2 lb per ac in 7 in. rows in a Pohangina silt loam. The applications were made to the choumoellier three weeks old when actively growing, up to 4 in. in height and in the four-true-leaf stage. The weed population consisted of fathen (95%) with odd redroot, wild turnip (*Brassica campestris*) and cornbind (*Polygonum convolvulus*). At the time of treatment the fathen was in the four- to six-true-leaf stage and up to 2 in. in height and in active growth.

Evaluations for weed control and crop vigour were made three and six weeks after treatment. Yield data in Table 1 were obtained by harvesting the centre 4 ft of each plot by mowing off at ground level 15 weeks after treatment. The crop and weeds were separated and yields were recorded as fresh weight of plant tops.

TABLE 1: ASSESSMENT OF WEED CONTROL AND CROP YIELD IN CHOUMOELLIER

Treatment (lb)	Weed Control Weeks*		Crop Vigour Weeks†		Weed Tops (Ton/Ac)	Crop Yield (Ton/Ac)	Relative
	3	6	3	6			
nitrofen 0.5		3.7	6.2	9.7	0.6 b B	14.8 a A	144
nitrofen 1.0		6.6	8.5	9.6	0.6 b B	13.3 a AB	129
nitrofen 2.0		8.1	9.0	8.3	0.6 b B	14.9 a A	145
nitrofen 4.0		9.2	9.2	8.4	0.5 b B	14.2 a A	138
control		0	1.1	10	2.0 a A	10.3 b B	100
C.V.					56.0%	15.6%	

* Weed control: 0 = No control;
 10 = Complete control.
 † = Crop vigour; 0 Crop eliminated;
 10 = No crop retardation.

TABLE 2: ASSESSMENT OF WEED CONTROL AND CROP YIELD IN SOFT TURNIPS

Treatment (lb)	Weed Control Weeks*		Crop Vigour Weeks†		Weed Tops (Ton/Ac)	Crop Yield (Ton/Ac)		Relative
	2	4	2	4		Total	Roots	
nitrofen 1.0		7.3	6.7	6.4	3.0 b B	27.1 ab AB	17.6	143
nitrofen 1.0 + sodium chloroacetate		8.9	7.9	6.9	2.7 b B	26.7 ab AB	17.4	141
nitrofen 1.5		8.0	8.1	8.5	1.1 c C	31.2 a A	20.9	165
nitrofen 2.0		8.2	8.2	8.6	1.1 c C	33.4 a A	22.4	177
nitrofen 3.0		9.2	9.1	9.5	0.4 d D	33.2 a A	21.8	176
nitrofen 4.0		9.2	8.9	9.6	0.2 d D	34.8 a A	22.6	184
control		1.0	1.6	0.8	6.7 a A	18.9 b B	11.7	100
C.V.					10.5%	23.4%		

* Weed control: 0 = No control;
 10 = Complete control.
 † = Crop vigour; 0 Crop eliminated;
 10 = No crop retardation.

Although light rain (0.02 in.) almost to the point of leaf run off, fell less than one hour after completing the applications, it is considered from earlier observations that this would not have seriously reduced the activity of the nitrofen. The emulsifiable concentrate formulation of nitrofen may allow rapid penetration into the leaf and this seems to offer some "weather insurance".

At 2 and 4 lb nitrofen produced some leaf cupping, necrosis and temporary stunting evident at the three-week inspection, but no reduction in crop numbers. The crop recovery was nearly complete after six weeks (see Table 8). Although the ratings for weed control between the dosages of nitrofen show wide differences, this is not reflected in weed weights recorded at harvest time. This may be partly due to the maturing and dry state of much of the weed tops. However, between weed weights recorded for all nitrofen treatments compared with the control, there is a significant difference, and this is also reflected in the crop yield.

From Table 1 it is evident that the luxury weed control obtained with nitrofen at 4 lb has not resulted in an increase in crop growth compared with the 2 lb dosage, even though there is little difference evident in initial crop retardation.

It is clear that a reduction in fathen competition at the early stage has allowed maximum crop growth and its utilization of soil moisture and nutrients. Under some growing conditions it is possible that the taller choumoellier brassica crop can over-top early maturing weeds such as fathen. However, where other bulky weeds such as redshank and redroot predominate it has been observed that more complete initial weed control is necessary, which may require about 2 lb nitrofen.

SOFT TURNIPS (Rakaia, Mid-Canterbury)

Soft turnips as a mixture (6 oz each) of the varieties Green and York Globe were sown in 7 in. rows on a Rakaia silt loam. Two weeks later the trial site was pegged out when the crop had just emerged and the fathen (95%) cover was already up to 1 in. high and in the two- to four-true-leaf stage. Three weeks later treatments were made (95% cover) when the fathen was up to 3 in. high and in the six- to eight-true-leaf stage, but in very active growth.

Evaluations for weed control and crop vigour were made two, four and ten weeks after treatment. Yield data recorded in Table 2 were obtained by hand pulling the crop and the weeds from two centre sections of each plot. After weighing the whole plant the turnips were topped and roots recorded separately.

Two weeks after treatment the fathen was beginning to overtop the turnip in the control plots. Nitrofen at 1.5 lb appeared to give adequate weed control, while 3 to 4 lb gave near "luxury" control. The mixture of nitrofen and sodium chloroacetate improved the level of initial fathen control over the 1 lb treatment of nitrofen alone, but this was accompanied by a marked increase in turnip damage. There was an observable loss in crop numbers which was evident in roots counted at harvest. After two weeks the expected symptoms of nitrofen injury were present in the form of stem twisting, leaf cupping and thickening and a slight height suppression of the crop especially from dosages of 3 and 4 lb. These symptoms had almost disappeared after four weeks and completely so after ten weeks.

Highly significant increases in total turnip weights are evident from all nitrofen treatments above 1 lb. All nitrofen treatments gave a highly significant reduction in weed weights compared with untreated controls. The same trends are evident in turnip root weights. However, there has been only a non-significant increase

brassicas. Wild turnip may have been reduced slightly in one trial in density and plant numbers.

Redshank, redroot and spurrey have shown slightly more resistance to nitrofen treatments. It is evident that these weeds must be treated at the very first true-leaf stage, otherwise recovery from nitrofen 2lb can occur. This is especially evident under drier soil conditions leading to retarded weed growth and the consequent development of more mechanical tissue.

All perennial species arising from tap roots and rhizomes such as docks (*Rumex* spp.), Californian thistle (*Cirsium arvense*) and couch (*Agropyron repens*) have not been adequately controlled by practical rates of nitrofen, although seedlings of the former two appear to be well controlled. It has been evident that the most important factor determining weed control efficiency, apart from the weed species present, appears to be the age and vigour of growth of the weeds at the time of treatment. A delay of one week in application may more than double the size of weeds and also of the dosage rate required for the equivalent effectiveness in control.

Little residual pre-emergence weed control has been noted from nitrofen at rates less than 2lb, but higher rates appear to give some control of later germinating fathen.

The mode of action of nitrofen has not been clearly established, but it would appear to have both systemic growth regulatory effects and some contact injury towards the weeds. Severe terminal bud inhibition is evident in many weeds and the additional necrosis and dehydration which results may lead to the death of the plant. This depends on the species involved, the age of the seedling and its state of growth activity at treatment time. For less susceptible plants, such as redroot, the immediate cessation of growth and rapid necrosis of leaf tissue after several days may be followed by fresh lateral growth about two weeks later.

CONCLUSIONS

The selectivity of nitrofen to crop and weed members of the Cruciferae indicates that it is worthy of much wider scale field testing throughout New Zealand in brassica feed crops. It is necessary to establish the critical levels for adequate broad spectrum weed control in relation to crop yield under a wide range of environmental conditions. The most efficient dosage rates of nitrofen need to be established more exactly, especially for the common brassica crop weeds other than fathen.

With the development of nitrofen for selective brassica crop weed control it would appear that for some situations at least a solution to New Zealand's greatest cropping weed problem is at hand.

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