FURTHER DEVELOPMENTS IN FIELD BRASSICA WEED CONTROL

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Summary

With the introduction of nitrofen in the 1963-64 season, post-emergence weed control in field brassica crops in New Zealand has become a practical reality. Wide-scale farmer use of nitrofen, up to 2 lb per acre, has generally confirmed the research findings of the need for critical timing of application of nitrofen to young weeds in active growth, especially for the more tolerant species such as spurrey (*Spergula arvensis*) and redroot (*Amaranthus hybridus*). Under dry soil conditions leading to hardened growth, the level of final weed control has been reduced, especially with less competitive crop stands.

Combinations of nitrofen with "Tordon" (4-amino-3,5,6-trichloropicolinic acid) have been shown to increase the degree and spectrum of weed control without serious loss of crop tolerance. The most versatile mixture for field brassicas has been nitrofen 1 lb plus "Tordon" 0.1 lb. The potent herbicidal activity of "Tordon" has been well established, but the margin of crop tolerance, particularly of the root brassicas, requires further study.

INTRODUCTION

IN THE LAST two years, a much greater interest in herbicides for field brassicas has been shown by research workers in New Zealand and overseas with the discovery of two selective post-emergence compounds for these crops. Elliott and Cox (1963) found that low rates of two methyl mercapto triazines had specific selective properties for the control of fathen (*Chenopodium album*) in kale, and this led to the release of desmetryne in England after wide-scale field testing (Baker *et al.*, 1963). In New Zealand with the root brassicas, swedes and turnips, desmetryne alone has shown insufficient crop safety, and some weeds such as redroot (*Amaranthus hybridus*) have proved rather difficult to control.

Tolerance to all of the field brassica crops in New Zealand has been established with nitrofen, and satisfactory control of many of the associated annual broadleaf weeds has been achieved with 2 lb of this compound (Mason, 1963). Widespread usage of nitrofen from 1.5 to 1.8 lb by more than 250 farmers throughout New Zealand during the last season has confirmed its crop safety and also the critical need for early stage weed treatment, especially under dry, hardened growth conditions. A critical survey of the weed control obtained gave the following results:

Excellent 42%, good 19%, acceptable 20%, poor 19%. Of the poor results 58% were considered due to late application. A second germination or regrowth of existing weeds was recorded in 29% of all crops treated but in only one instance did this result in crop failure.

TABLE 1: ASSESSMENT OF WEED CONTROL AND CROP YIELD IN RAPE (HAWKE'S BAY)

Treatment (lb)	Weed Control* Weeks			Crop Vigour† Weeks			Weed Tops (tons/acre)	Relative	Crop Yield (tons/acre)	Relative
	2	4	6	2	4	6				
Nitrofen 1.0 + "Tordon" 0.09	9.4	9.3	9.7	9.6	9.2	9.7	0.1a	A	5.5a	A
"Tordon" 0.09	6.9	6.4	7.5	9.7	8.2	8.6	1.4 b	B	3.4	de BC
"Tordon" 0.18	8.6	8.6	9.2	9.7	8.4	8.8	0.2a	A	4.0	bcd ABC
"Tordon" 0.36	9.3	9.5	10	9.7	8.2	8.9	0 a	A	4.4abc	AB
Nitrofen 2.0	4.8	5.2	6.2	9.8	9.0	8.9	2.1 c	B	5.6a	A
Nitrofen 1.5	3.3	4.4	4.0	9.8	8.9	8.7	3.2 d	C	5.2ab	A
Unweeded control	0	0	0.3	10	8.7	6.7	5.9 e	D	2.6	e C
C.V.							8.4%		23.9%	

* 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 RAPE (MANAWATU)

Treatment (lb)	Weed Control Weeks		Crop Vigour Weeks		Weed Tops (tons/acre)	Crop Yield (tons/acre)	Relative
	1	3	1	3			
Nitrofen 1.0 + "Tordon" 0.09	8.3	10	6.2	7.0	0	20.4 b	CD
"Tordon" 0.09	5.0	9.7	8.8	8.1	0	20.8 b	BCD
"Tordon" 0.18	5.8	10	7.8	6.8	0	19.5 b	D
Nitrofen 2.0	8.5	9.0	5.4	8.0	0	24.3a	ABC
Nitrofen 1.5	8.5	8.3	5.2	8.3	0.02	23.6a	ABC
Unweeded control	0.6	1.8	9.7	10	0.4	23.1a	ABC
C.V.						8.2%	

Good control has been achieved of fathen, cornbind (*Polygonum convolvulus*), redshank (*Polygonum persicaria*) and, to a lesser extent, of redroot and spurrey (*Spergula arvensis*), where a strongly competitive stand of crop develops. Only limited suppression of thistles — e.g., "Scotch" thistle (*Cirsium vulgare*) and nodding thistle (*Carduus nutans*) — has been achieved with nitrofen, while no practical control of Californian thistle (*Cirsium arvense*) and buttercup (*Ranunculus* spp.) has been obtained.

In an attempt to overcome these deficiencies of nitrofen, and especially its very restricted application time, the present season's trials were conducted with "Tordon" and "Tordon"/nitrofen mixtures. "Tordon" at up to 2 lb was reported to show some selectivity to members of the Cruciferae family, including the field brassica crops in pre- and post-emergence applications (Pengelly, 1963).

It was first established in green-house and field screening trials that choumoellier tolerated up to 0.5 lb "Tordon", but severe crop suppression occurred at 1 and 2 lb in post-emergence treatments. Further screening tests with "Tordon" at low rates of application (2 oz or less) in mixture with nitrofen 1 to 2 lb showed promise of an improvement in range of species and stage of growth of the weeds controlled with little retarding effect on the brassica crops (Mason, 1964).

A series of replicated field trials was established on sites throughout New Zealand to compare "Tordon" alone and in mixture with nitrofen to establish crop tolerance and weed control under different environmental conditions.

EXPERIMENTAL

All small plot treatments were applied with an Oxford Precision Sprayer to 31 ft × 7 ft plots using 46 fan nozzles applying 30 gal of water per acre at 30 lb/sq. in. pressure. The yield trials were replicated six times and observational trials four times.

RESULTS AND DISCUSSIONS

TRIAL 1: RAPE, HAWKE'S BAY

Aphid resistant Purple Top rape was sown at 3 lb per acre in 7 in. rows on a silt loam soil. At the time of treatment 18 days later, the rape was in the 4 to 6 true leaf stage, 2 to 4 in. in height, with the weeds in active growth in the 3 to 6 true leaf stage and ½ to 2½ in. high. The weed population consisted of fathen 90%, redroot 5%, plus black nightshade (*Solanum nigrum*) and nettle (*Urtica urens*).

Evaluations for weed control and crop vigour were made 2, 4, and 6 weeks after treatment. Yield data were obtained by mowing the centre four feet of each plot seven weeks after treatment. The crop and weeds were separated and yields were recorded as fresh weight of plant tops (Table 1).

The addition of "Tordon" to nitrofen has greatly improved the level of weed control over nitrofen alone, as have the "Tordon" treatments at 0.18 and 0.36 lb. However, as might have been suggested by persistent malformations in leaf growth of the rape, these higher "Tordon" treatments have been responsible for some crop depression, since weed competition has been virtually eliminated. Although the nitrofen treatments at 1.5 and 2 lb have not given complete weed control, the yields for this "light" crop are double that of the unweeded control plot. The mixture of nitrofen 1 lb plus "Tordon" 0.09 lb showed almost no stem and leaf dis-

tortion in the rape and gave an almost complete elimination of weeds. This is reflected in the highly significant increase in crop yield.

TRIAL 2: RAPE, MANAWATU

A further trial was laid on aphid-resistant rape in a relatively weed-free heavy crop to determine any suppressant effect of "Tordon" and "Tordon"/nitrofen treatments on crop yield. At the time of the application, 4 weeks after drilling, the rape had 2 to 6 true leaves and was 1 to 3 in. high. The limited stand of weeds present consisted of black nightshade 60%, fathen 30%, and occasional "Scotch" and Californian thistle 10%, the weeds being about 1 in. high. The results tabulated in Table 2 were obtained as for Trial 1, by rating weed control and crop vigour one and three weeks after treatment, and weed and crop yields after 11 weeks.

From the weed control ratings made one week after treatment, the addition of nitrofen 1 lb to "Tordon" 0.09 lb has clearly aided the rapid knockdown of the weeds compared with "Tordon" alone. In this very competitive, dense stand of rape, nitrofen at 1.5 and 2 lb has caused no significant reduction in crop yield. By contrast, all the "Tordon" treatments have significantly reduced the crop weight, the trend in crop reduction increasing with the rate of "Tordon". Slight cupping of the leaves was evident in all "Tordon" plots, with stunted plants showing in all the higher dosage treatments at harvest.

TRIAL 3: SWEDES, VAR. DOONE MAJOR — MANAWATU

This trial was laid on a silt loam when the crop was in the 2 to 3 leaf stage up to 3 in. high and when the weeds were in the 2 to 6 leaf stage up to 1 in. high. The weeds consisted of black nightshade 80%, Californian thistle 15% and spurrey 5%. Ratings for weed control and crop vigour were made 4 to 8 weeks after treatment (Table 3). The stand of crop was too uneven for a reliable yield assessment.

TABLE 3: ASSESSMENT OF WEED CONTROL AND CROP VIGOUR IN SWEDES

Treatment (lb)	Weed Control Weeks		Crop Vigour Weeks	
	4	8	4	8
Nitrofen 0.5 + "Tordon" 0.09	8.3	9.5	8.8	9.8
Nitrofen 1.0 + "Tordon" 0.09	9.5	10	7.5	9.3
"Tordon" 0.09	9.4	10	8.9	9.8
"Tordon" 0.18	9.9	10	7.8	9.3
"Tordon" 0.36	10	10	6.5	7.3
Nitrofen 2.0	6.1	6.3	9.8	10
Control	0	1.0	10	10

After 8 weeks, all "Tordon" treatments had given near complete weed control, even 0.09 lb being sufficient to completely suppress Californian thistle shoots and a subsequent germination of black nightshade. Nitrofen failed in both these respects. However, at maturity plots treated with "Tordon" at 0.18, and especially at 0.36 lb, seemed to contain a higher proportion of smaller bulbs with strongly cupped leaves.

TRIAL 4: SOFT TURNIPS — CANTERBURY

Trial 4 was laid down on a Rakaia stony loam when the soft turnips and weeds were in the 4 to 6 true leaf stage, up to 2 in. high, three weeks after drilling. A very dense population of fathen was present with spurrey and broadleaf dock. Ratings for weed control and crop vigour were made 2 and 7 weeks after treatment, but the crop failed to mature sufficiently for yield data because of the extremely dry conditions following.

TABLE 4: ASSESSMENT OF WEED CONTROL AND CROP VIGOUR IN SOFT TURNIPS

Treatment (lb)	Weed Control Weeks		Crop Vigour Weeks	
	2	7	2	7
Nitrofen 0.5 + "Tordon" 0.045	8.5	8.8	9.2	9.1
Nitrofen 1.0 + "Tordon" 0.09	9.3	8.9	9.0	9.3
"Tordon" 0.09	6.5	3.7	9.1	9.2
"Tordon" 0.18	7.2	8.5	9.4	7.5
Nitrofen 2.0	7.5	3.7	8.9	10
Control	0	0	10	9.2

Although initial weed control looked promising with all treatments (Table 4), only "Tordon" above 0.09 lb and the mixtures maintained this level of control. Initial distortion symptoms in the turnips from "Tordon"-treated plots had disappeared after seven weeks except those treated with 0.18 lb.

CONCLUSIONS

It now appears evident from the various trial results that by combining the different herbicidal properties of "Tordon" and nitrofen a versatile weedkilling mixture is obtained for field brassica crops. The addition of low amounts of "Tordon" (about 0.1 lb) to nitrofen (1 lb) allows a greater control of more well established weeds, even including regrowths of such perennials as Californian thistle and broadleaf dock. The mixture promises to overcome the problem of critical timing of application experienced with nitrofen alone and yet without serious loss of crop safety. The slow residual systemic activity of "Tordon" even at very low rates inhibits regrowth, from the more nitrofen-tolerant weeds such as redroot, redshank, spurrey and the various thistles.

In some situations, "Tordon" alone may provide adequate weed control at safe crop dosages, but this appears to be more likely for the leafy rather than the root brassica crops. In one large-scale field demonstration, "Tordon" alone at 0.3 lb completely "saved" a choumoellier crop being "lost" to an advanced infestation of redroot and black nightshade 12 to 18 in. high. This would have been beyond the treatment stage for economic rates of nitrofen.

However, because of the residual toxicity of "Tordon" in soils, especially to succeeding clover pastures, the present practical object should be to determine the minimum dosage of this chemical required for adequate weed control.

The general order of tolerance for field brassicas to "Tordon" suggested from the present trials is as follows: choumoellier, kale,

rape appear the most tolerant, with swedes and finally turnips being the most susceptible.

The selectivity of "Tordon" to weed members of the Cruciferae has been illustrated by the lack of practical control of such weeds as twin cress (*Coronopus didymus*), hedge mustard (*Sisymbrium officinale*) and, as might be expected, wild turnip (*Brassica campestris*).

For future studies, the greatest need is for more exact data on the effect of "Tordon" and "Tordon"/nitrofen mixtures on root brassica crop yields and their storage quality. The possible effect of these "Tordon" treatments on feed palatability for stock and on the nutrient value of the field brassicas generally should be determined.

Specific data are also required on the persistence of "Tordon" in various soils under different leaching conditions in relation to establishment of clover pastures following the treated brassica crop.

The introduction of "Tordon" as a very potent herbicide with its unusual selectivity to the Cruciferae promises to widen the prospects of a more general solution for weed control in New Zealand field brassica crops.

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