POST-EMERGENCE WEED CONTROL IN FIELD BRASSICAS

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Summary

The effects of nitrofen and desmetryne alone and in combination with each other were studied in several field trials. There were no serious differences in tolerance of most varieties of swedes and turnips to nitrofen: choumoellier and rape were also tolerant. Most common annual cropping weeds were controlled by nitrofen if application was before the 4-true-leaf stage and crop competition was good. After the 4-true-leaf stage, desmetryne was the most efficient material for use in choumoellier. Swedes, turnips and choumoellier were tolerant to picloram not exceeding 1 oz when added to nitrofen; but this mixture appeared necessary only if early spraying could not be carried out.

INTRODUCTION

THE FIELD BRASSICAS, rape, kale, choumoellier, swedes and turnips constitute by far the largest crop acreage in New Zealand: the latest known acreage is 734,000 acres in 1964–5, whereas the cereals constitute only 393,000 acres. Thus, there is tremendous interest in herbicides for selective use in brassicas, but few really effective materials have been available until comparatively recently when nitrofen was introduced for post-emergent use in all field brassicas, and desmetryne was introduced for post-emergent use in kale or choumoellier only.

Mason (1964, 1965), A. Thompson (1964, 1965) and F. B. Thompson (1964) all report on the use of nitrofen and nitrofen mixtures. In general it was shown that, if applied to weeds in the early true leaf stage, nitrofen at 1.5 to 2 lb a.i./acre will give adequate control of most of the important cropping weeds. No permanent injury to the five important New Zealand brassica crops was noted. Particular emphasis was laid on the evaluation of nitrofen/picloram mixtures in an effort to overcome the restrictions placed on the field use of nitrofen through its need for critical timing of application.

Desmetryne has been more extensively examined in the U.K., where its usefulness appears to be restricted mainly to choumoellier. At light (6 oz a.i./acre) rates it has shown excellent promise for the control of fathen and other weeds, but crop damage is sometimes severe and spraying has to be delayed until the crop has reached the 5-true-leaf stage.

This report deals with trials conducted by the Invermay weed research team during 1964–5 in which nitrofen, desmetryne, combinations of the two, and nitrofen with and without picloram were evaluated under field conditions on the Taieri Plain.

MATERIALS AND METHODS

Brief details of the crop weeds and treatments applied are given in each section of the results. All treatments were applied during good spraying conditions, unless otherwise stated. Volume of water applied was 30 gal/acre: all treatments were applied through a modified Oxford Precision Sprayer fitted with 8002 Teejet nozzles. Randomized block layouts with adequate replication were used; plot size was usually 7 ft × 30 ft.

All rates quoted are in lb or oz active ingredient per acre: the formulations used were 24% w/v nitrofen, 25% w/w desmetryne, and 17.3% w/v picloram.

When root crops were harvested, the foliage and roots were removed before weighing. All yields are quoted in tons of green weight per acre unless otherwise stated.

RESULTS

CROP TOLERANCE

Turnips — Experiment A

A weed-free vigorous crop of soft turnips (var. Red Globe) was sprayed at the 2- to 4-true-leaf stage with nitrofen at the rates shown in Table 1 and hand-singled two weeks later. Severe reduction in leaf cover occurred initially but later inspections showed full recovery.

TABLE 1: EXPERIMENT A — SOFT TURNIPS: TOLERANCE TO NITROFEN

Treatment (lb)	*Yield (tons/acre)*	*No. Bulbs/acre*
Nitrofen 1.2	30.6 aA	25,800 a
Nitrofen 1.5	27.7 bB	25,400 a
Nitrofen 2.0	29.5 abAB	25,400 a
Nitrofen 2.5	28.6 bAB	25,600 a
Control	28.7 bAB	25,200 a
CV	5.0%	6.0%

Nitrofen at rates up to 2.5 lb had no adverse effect on yield or ultimate plant population (Table 1).

Swedes — Experiment B

A relatively weed-free area of swedes (var. Sensation) rather variable in time of crop emergence and subsequent population, was treated with nitrofen 1.5 and 2.1 lb at three stages:

A. Late cotyledon to early 2-true-leaf (Jan. 6, 1965)

B. Early 5-true-leaf (Jan. 14, 1965)

C. Late 5- to 6-true-leaf (Jan. 20, 1965)

Severe reduction in leaf cover occurred initially, but subsequent recovery was good, and there were no adverse effects whatever on subsequent plant populations. There were no yield differences (Table 2) between sub-plot treatments, but analysis of main effects showed a small but significant reduction from early applications.

TABLE 2: EXPERIMENT B. SWEDE TOLERANCE TO NITROFEN
(Yield — tons/acre)

Treatment (lb)	*Early 2-leaf*	*Early 5-leaf*	*Late 5-leaf*	*Untreated Control*
Nitrofen 1.5	21.6 a	24.4 a	24.3 a	22.6 a
Nitrofen 2.1	21.1 a	21.8 a	23.8 a	

Main Effects

Nitrofen 1.5 lb	23.4 a	Early 2-leaf	21.3 bA
Nitrofen 2.1 lb	22.3 a	Early 5-leaf	23.2 abA
		Late 5-leaf	24.1 aA

CV = 10.6%

VARIETAL TOLERANCE

Experiment C

A recommended group of swede and turnip varieties was sown and treated with nitrofen in the 1963–4 season, but the trial was atypical through abnormally high plant population levels and the full results are not considered here. It is sufficient to comment that the average yield of all varieties was reduced from 24 tons to 20 tons/acre (significant at 1%).

The following year the same varieties (detailed in Table 3) were established by precision seeders on flat seedbeds, at 3 in. spacing, in rows 24 in. apart. Nitrofen at 2 lb was applied when the swedes were at the 2-true-leaf stage, while the turnips were much more advanced and more variable — *i.e.*, 2- to 6-true-leaf. Only Calder swede yield was significantly affected by treatment, while Grandmaster swede population was significantly greater where sprayed (Table 3). The yield reductions in Doon Spartan and Green Globe turnip were not significant.

TOLERANCE OF CHOUMOELLIER TO DESMETRYNE OR NITROFEN/DESMETRYNE MIXTURES

Experiment D

Desmetryne at 3 and 4 oz and desmetryne 3 oz + nitrofen 1.2 lb were applied Jan. 27, 1965, Feb. 1, 1965, and Feb. 8, 1965; the choumoellier at these times had 4, 5, and 5 to 6 true leaves, respectively. Weed density was low (5% cover) and consisted of bindweed (*Polygonum convolvulus*), wireweed (*P. aviculare*), and spurrey (*Spergula arvensis*).

Weed control was good, particularly from the first two times of application, but wireweed was poorly controlled by the time of the third application. However, crop vigour was subsequently good, and surviving weeds were suppressed. No vigour differences were evident within two months of treatment. The trial could not be harvested satisfactorily owing to lodging.

Experiment E

Six combinations of nitrofen and desmetryne (desmetryne 3 oz plus nitrofen 0.9, 1.2 or 1.5 lb, and desmetryne 4 oz plus nitrofen 0.9, 1.2, or 1.5 lb) were applied Dec. 30, 1965, to a vigorous crop of choumoellier at the 4-true-leaf stage. Weed density was low

TABLE 3: EXPERIMENT C — VARIETAL TOLERANCE TO NITROFEN 2 lb

Variety	*Bulbs No. per acre* Sprayed	Unsprayed	*Yield (tons per acre)* Sprayed	Unsprayed
SWEDES				
Superlative	51400 a	51500 a	31.3 a	32.0 a
Grandmaster	51500 a	46200 bA	32.6 a	33.0 a
Crimson King	45100 a	40200 a	30.2 a	30.2 a
Wilhelmsburger	59600 a	56800 a	29.7 a	31.6 a
Doon Spartan	52700 a	53100 a	27.3 a	29.6 a
Calder	49400 a	50000 a	28.1 bA	30.9 aA
Sensation	45500 a	45900 a	30.1 a	30.5 a
Doon Major	42000 a	42700 a	34.1 a	34.6 a
Wye	41200 a	41800 a	30.4 a	30.4 a
TURNIPS				
Green Globe	48300 a	51100 a	34.1 a	36.6 a
Red Globe	47600 a	45200 a	32.2 a	33.3 a
Purple Globe	42500 a	44200 a	34.2 a	35.1 a
York Globe	503002a	50300 a	42.7 a	43.8 a
Purple Top Yellow	47800 a	44300 a	16.9 a	18.0 a
	CV 7.6%		CV 5.6%	

TABLE 4: EXPERIMENT F — EFFECT OF NITROFEN 2 lb OR DESMETRYNE 6 oz AT VARIOUS GROWTH STAGES OF CHOUMOELLIER

Treatment	*Approx. Crop Stage*	*Approx. Weed Stage*	*Yield (tons/acre)*	*No. Plants (1,000/acre)*
Nitrofen	Late cotyledon	1 true leaf	30.6 abA	133 a
Nitrofen	1–2 true leaf	2–3 true leaf	32.6 aA	118 a
Nitrofen	3–4 true leaf	4–6 true leaf	30.9 abA	129 a
Nitrofen	4 true leaf	Tillering	27.9 abcA	127 a
Desmetryne	Late cotyledon	1 true leaf	23.8 bcA	Not counted
Desmetryne	1–2 true leaf	2–3 true leaf	23.2 cA	Not counted
Desmetryne	3–4 true leaf	4–6 true leaf	27.0 abcA	Not counted
Desmetryne	4 true leaf	Tillering	32.7 aA	117 a
Control			26.5 abcA	125 a
Main Effects:				
Nitrofen			30.5 aA	
Desmetryne			26.7 bA	
CV			15.7%	

(only 5%) and consisted mainly of wireweed, bindweed and occasional fathen (*Chenopodium album*). Ten days later all treatments were showing 25% leaf scorch on the choumoellier and loss in height of 3 in. to 6 in. Two months later the crop appeared normal, and was only 1 to 2 in. less in height than control: at harvest there were no differences between treatments in yield or plant population, but all yielded significantly better than control.

Stage of Growth

Two trials on separate sites — Experiments F and G — studied the effect of nitrofen 2 lb and desmetryne 6 oz at various growth stages of a choumoellier crop and its accompanying weeds. (Tables 4 and 5.)

TABLE 5: EXPERIMENT G — EFFECT OF NITROFEN 2 lb OR DESMETRYNE 6 oz AT VARIOUS GROWTH STAGES OF CHOUMOELLIER

Treatment	*Approx. Crop Stage*	*Approx. Weed Stage*	*Yield (tons/acre)*
Nitrofen	Late cotyledon	Cotyledon	25.7 abA
Nitrofen	1–2 true leaf	1–2 true leaf	26.1 aA
Nitrofen	2–3 true leaf	2–3 true leaf	22.0 cB
Nitrofen	4–5 true leaf	Tillering	21.9 cB
Nitrofen	5 true leaf	Early flowering	21.8 cB
Desmetryne	4–5 true leaf	Tillering	25.1 abAB
Desmetryne	5 true leaf	Early flowering	23.1 bcAB
Control, hand-weeded			25.5 abA
Control, untreated			18.3 dC
CV 7.0%			

Observations showed that while nitrofen gave a temporary check to the crop there was no subsequent effect on crop yields or population for the first two stages of application (Tables 4 and 5).

Good control of bindweed, fumitory (*Fumaria officinalis*) and spurrey was noted up to and including the 2- to 3-true-leaf stage of crop and weeds (in this respect the unsatisfactory response to nitrofen at the 2- to 3-leaf stage in Table 5 must therefore be considered anomalous). Apart from this instance, good weed control was followed by corresponding yield increases. However, wireweed was possibly resistant by this time (2- to 3-leaf stage), spurrey was rapidly becoming resistant, and application at the tillering to early flowering stages of weeds was too late to achieve an optimum response to nitrofen.

Desmetryne 6 oz gave excellent weed control in both trials, and if applied during the 4- to 5-true-leaf stage of choumoellier it gave yield increases similar to those given by nitrofen at the earlier stages.

Dose Rates

Two trials which included desmetryne treatments as well as a wide range of nitrofen dosage on choumoellier and weeds were laid down (Experiments H and I, Table 6).

TABLE 6: EXPERIMENTS H AND I — RATES OF APPLICATION

Treatments		*Crop Stage*		*Yield (tons/acre)*	
Exp. H	*Exp. I*	*Exp. H*	*Exp. I*	*Exp. H*	*Exp. I*
Nitrofen 1.2 lb		Late cotyledon to 1 true leaf		26.5 abABC	
Nitrofen 1.5 lb	1.5 lb	Late cotyledon to 1 true leaf		25.1 bcBC	34.3 abAB
Nitrofen 2.0 lb	2.0 lb	Late cotyledon to 1 true leaf		26.7 abAB	36.5 abAB
Nitrofen 2.5 lb	2.5 lb	Late cotyledon to 1 true leaf		27.9 aA	31.4 bB
	3.0 lb	Late cotyledon to 1 true leaf			33.8 aA
Desmetryne 3 oz + Nitrofen 1.2 lb	Desmetryne 4 oz	5 true leaf	3–4 true leaf	25.8 bABC	36.7 abAB
Desmetryne 4½ oz + Nitrofen 1.5 lb	Desmetryne 6 oz	5 true leaf	3–4 true leaf	23.8 cCD	36.2 abAB
Control	Control			21.1 dD	35.3 abAB
			CV	5.1%	9.0%

Note: Weed growth stages at spraying were late cotyledon to 1 true leaf for nitrofen, and early flowering (Exp. H) and tillering (Exp. I) for desmetryne application.

In both trials, it appeared initially that nitrofen 2 to 3 lb gave severe reductions in choumoellier vigour. The main weeds were fumitory and spurrey (Exp. H) and bindweed, chickweed (*Stellaria media*), wireweed and patches of spurrey (Exp. I): total weed cover was visually assessed at 40% (Exp. H) and 20% (Exp. I). Weed control was very good, only 10% of weeds surviving at the lowest rates of 1.2 and 1.5 lb. Spurrey control was good in both trials, but in Experiment H the early spraying allowed more spurrey and fumitory to germinate. Wireweed control was good, but slow in Experiment I: on the other hand, desmetryne alone gave poor control. Control of other weeds by desmetryne with or without nitrofen was good, but the mixture gave slow control of fathen and wireweed.

All rates of nitrofen and the low rate of desmetryne + nitrofen gave substantial increases in yield (Table 6), but the high rate of mixture yielded significantly lower than the high rate of nitrofen. There were no significant yield increases over control in Experiment I, probably because of the more vigorous crop and lower weed density. Plant numbers per acre at harvest in Experiment I were normal and there were no significant differences between treatments.

Specific Weed Problems

Several trials were carried out to study control of certain weeds; not all were harvested.

Experiment J

Nitrofen 1.5 and 2 lb, desmetryne 4 and 6 oz were applied to vigorous choumoellier containing redshank (*Polygonum persicaria*) and pale persicaria (*P. lapathifolium*) at the 4- to 6-true-leaf stage. Nitrofen gave good weed control, while desmetryne was slightly poorer, mainly because of the wireweed present which appeared resistant to desmetryne. Mean choumoellier yield was 46 tons/acre; all treatments increased yields significantly ($P>1\%$) but none was significantly different from hand-weeded control. There were no significant differences in plant numbers.

Experiment K

This experiment studied the control of Buxbaum's speedwell (*Veronica persica*) and annual nettle (*Urtica urens*) which heavily infested a poor crop of choumoellier. Nitrofen at 1.2, 1.5, 2.0 and 2.5 lb gave excellent control of both weeds when applied at 1- to 2-true-leaf stage. Seedling hemlock (*Conium maculatum*) was resistant. Large and significant crop yield increases were recorded.

A further trial studied the control of redshank and pale persicaria in rape but subsequent poor competition from the crop resulted in only fair control by 1.5 and 2.0 lb nitrofen, although 2.5 and 3.0 lb gave very good control. There were some survivors at all rates, while pale persicaria tended to be more resistant than redshank.

Experiment L

Rates of nitrofen from 1.5 to 3.0 lb gave good control of fumitory and annual bindweed in swedes. Good control was evident from all rates, but 1.5 lb is probably insufficient if not followed by adequate crop competition.

Experiment M

A standard nitrofen + picloram trial of the series reported in the following section, was laid down on choumoellier heavily infested with Californian thistle (*Cirsium arvense*). Choumoellier was subsequently poor and no yields were taken. However, observations indicated that good Californian thistle control could be obtained with 1 oz picloram with or without added nitrofen, but that 2 oz picloram gave excellent control. At the end of autumn all picloram-treated choumoellier was poorer in vigour than nitrofen alone, and choumoellier leaf distortion still persisted. No differences in thistle density could be detected in the following year, when the paddock was cropped with wheat.

NITROFEN + PICLORAM

Four trials of standard design were carried out, one each on swedes, rape, choumoellier and one for the control of Californian thistle in choumoellier (reported above). Yields from the three crop trials are shown in Table 7.

TABLE 7: NITROFEN/PICLORAM MIXTURE TRIALS

Treatment	*Yield (tons/acre)* *Swedes (fresh wt.)*	*Rape (dry matter)*	*Choumoellier (fresh wt.)*
Nitrofen 1 lb	39.4 aA	2.6 abcA	38.1 aA
Nitrofen 2 lb	39.5 aA	2.8 abcA	36.6 abA
Picloram 1 oz	37.8 abcA	2.5 bcA	36.2 abA
Nitrofen 1 lb + picloram 1 oz	38.1 abcA	2.8 abcA	36.1 abA
Nitrofen 2 lb + picloram 1 oz	36.1 abcA	2.5 cA	35.8 abA
Picloram 2 oz	37.4 abcA	2.7 abcA	34.5 abA
Nitrofen 1 lb + picloram 2 oz	34.9 bcA	3.0 abA	34.3 abA
Nitrofen 2 lb + picloram 2 oz	34.3 cA	2.9 abcA	33.0 bA
Hand-weeded control	39.5 aA		38.0 aA
Control	38.4 abA	3.1 aA	34.9 abA
CV	6.6%	9.1%	8.2%
Main Effects:			
No nitrofen	37.9 aA	2.8 a	35.2 a
1 lb nitrofen	37.5 aA	2.8 a	36.1 a
2 lb nitrofen	36.6 aA	2.7 a	35.2 a
No picloram	39.1 aA	2.8 a	36.5 aA
1 oz picloram	37.3 abAB	2.6 a	36.0 abA
2 oz picloram	35.6 bB	2.9 a	34.0 bA

Swedes

The treatments were applied to ridged swedes (variety Sensation) mainly in the 4-true-leaf stage. Weed infestation (shepherd's purse (*Capsella bursa-pastoris*), spurrey and bindweed, total cover 50%) was mainly concentrated in the bottom of the ridges.

The addition of picloram to nitrofen improved weed control but some loss in crop vigour occurred. This was reflected in significant yield reductions where 2 oz of picloram was applied, although plant populations were not affected. No adverse effects, such as root deformities, root rots, splitting or callusing, were noted at harvest time.

Rape

Vigorous C.R.R. rape was sprayed at the 4-true-leaf stage. Weed infestation was very low (1% cover).

Crop vigour was initially reduced by nitrofen, particularly at the high rate, but the addition of picloram did not intensify this.

Table 7 indicates that picloram alone may reduce rape yield and in combination this may also occur as with nitrofen 2 lb + picloram 1 oz. However, this trend was not confirmed at the 2 oz picloram rates.

Choumoellier

A vigorous crop at the 2-true-leaf stage was sprayed: again weed infestation was very low (1–2% cover).

Crop vigour was more affected by nitrofen + picloram than by either one alone; nitrofen 2 lb + picloram 2 oz reduced choumoellier vigour for a considerable time, resulting in a significant yield depression. Plant populations were also reduced (not significantly) by three of the nitrofen/picloram combinations, but this also occurred in the hand-weeded control possibly through mechanical damage during hand weeding.

DISCUSSION

NITROFEN

Work reported at previous conferences has largely been confined to Canterbury and North Island conditions. However, from the work reported in this paper it is evident that crop tolerances are similar under Otago/Southland conditions. Red Globe turnips are clearly tolerant, while Sensation swedes may be checked when sprayed in early 2-leaf stage.

Tolerance work reported by A. Thompson (1964) suggests that a 10% reduction in yield may be expected with 2 lb nitrofen: overall yields from the variety trial reported in this paper tend to support this. Furthermore, among the 14 swede and turnip varieties tested, there would appear to be little risk of any adverse varietal reaction to nitrofen. Calder swede may be more sensitive than others, but the reduction in yield was within the 10% margin noted above, and wide field experience with weed-infested crops now indicates that this reduction is normally cancelled out through weed control. There has been no indication so far that soft turnips are any less tolerant than swedes.

1.5 lb nitrofen appears to be an adequate dosage.

Probably most important is the crop development at the time of spraying. The swede yield reduction through early spraying of a variable seedling population in Experiment B is indicative of this, and it would appear that, now that highly selective herbicides

are available for use in brassica crops, a critical look at some seedling establishment methods is necessary. Certainly, the practice of sowing in ridges is most open to censure, but any field husbandry method that results in straggling emergence of crop or weeds cannot be viewed with favour by anyone responsible for herbicide recommendations. It seems most likely that the optimum method of establishment will be by "precision" seeders placing seed at controlled depth and spacing on firm fine flat seedbeds, and following spraying there will be no reason to disturb the soil surface again until harvest. In fact, herbicide developments have at last brought the agronomist to the stage where optimum brassica population/yield relationships can be examined and traditional row widths and plant spacing questioned.

DESMETRYNE

Stage of growth is critical when applying desmetryne and the rather lukewarm appreciation by F. B. Thompson (1964) of this chemical's potentiality appears to be due to damage resulting from too early application. It is clear that a 6 oz rate should never be applied before the 4-leaf stage (Table 4), although considerable crop recovery can occur if growing conditions and fertility are good. However, 6 oz appeared to give "luxury" weed control at all times; yields in Table 6 and other observations suggest that 4 oz is adequate for Otago/Southland conditions.

Desmetryne/nitrofen mixtures gave good weed control and crop yields at all times, and, while there was little indication as to the best ratio, it was apparent that 4½ oz desmetryne + nitrofen 1.5 is the maximum total rate. While there were no direct comparisons, desmetryne/nitrofen had no advantages over desmetryne alone in these trials, except possibly for wireweed. Most significant was the excellent yield response to weed removal as late as the tillering or early flowering weed stages, indicating both the rapid and total collapse of weeds and good crop tolerance.

PICLORAM

Observations on weed control suggest the main promise for this material lies in combination with nitrofen, and there is probably little need for rates above nitrofen 1 lb + picloram 1 oz.

Usually there is no need for addition of picloram if nitrofen can be applied close to the critical 1- to 2-true-leaf stage of crop or weeds. On the other hand, crop development at this time of the year is rapid, or perennial weeds such as Californian thistle need control. One trial reported here suggests that thistle control may be effective for one season only, but crop competition in this case was very poor, and further investigations are warranted.

However, the most important question at present concerns the persistence of picloram residues in the soil. There is still little critical evidence of the safety of even 1 oz picloram under a wide range of conditions.

Results from one bio-assay at Invermay were inconclusive but there were indications that serious reduction in white clover establishment may occur from residues in the top inch of soil; it is not known what depth of incorporation will be required to dilute this toxic layer.

CONCLUSIONS

Choumoellier, rape and most varieties of swede and turnips are tolerant to nitrofen at 2 lb per acre. Most common annual weeds are controlled at rates of 1.5 lb if application is before the 4-true-leaf stage and crop competition is good.

Desmetryne 4 to 6 oz per acre is the best material for use in choumoellier after the 4-true-leaf stage.

Picloram not exceeding 1 oz should be added to nitrofen to improve weed control in swedes and turnips only if early spraying requirements cannot be met.

The significance of picloram residues needs further investigation.

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