NITROFEN AND PICLORAM ON BRASSICAS

C. C. McLEOD

Research Division, Department of Agriculture, Timaru

Summary

Until 1963, pre-emergence chemicals, though the most effective brassica crop weedkillers, gave extremely variable results depending on the correct soil moisture. After 1963, nitrofen gave very good results. However, it had to be applied at a very early stage of crop and weed development. This favoured further weed invasion with post-spraying showers, poor crop smothering and the need for further spraying. Hot dry conditions after spraying could also cause leaf defoliation, plant thinning and reduced crop yields. The inclusion of picloram with nitrofen has meant a lower rate of nitrofen need be used. The mixture can also be applied later which reduces the risk of further weed invasion. $\frac{3}{4}$ oz picloram + $\frac{3}{4}$ lb nitrofen per acre appears to be a satisfactory rate of application for brassica crops. Higher rates can cause crop damage particularly to the bulb brassicas. Although cultivation appears to reduce the risk of picloram residues to negligible proportions, it is recommended that the possibly susceptible crops, peas, potatoes and lucerne not be sown after picloram and nitrofen brassica spraying.

UNTIL 1963, the control of weeds in brassicas was usually unsuccessful. Prior to that date, the most effective weedkillers were the pre-emergence chemicals. However, they gave variable results depending on the correct soil moisture conditions and were regarded as stop-gap treatments until more suitable chemicals became available. Until the mid-1960s no post-emergence weedkillers proved sufficiently selective for general use in weed control in brassicas. Post-emergence treatment was virtually restricted to SMA which had severe limitations and gave poor results against spurrey (*Spergula arvensis*) and fathen (*Chenopodium album*) in the South Island.

In 1963, nitrofen was introduced into New Zealand. It appeared promising as a post-emergence treatment, having a reasonably wide weed control spectrum and fairly low level of crop damage at an early stage of growth. When applied to young weeds in the early true leaf stage at 2 lb (all rates in active ingredient per acre), it gives very adequate control of fathen and to a lesser extent spurrey, willow weed (*Polygonum persicaria*) and wireweed (*P. aviculare*).

It usually causes no permanent damage to brassica feed crops. However, in Canterbury if hot dry weather is experienced immediately after nitrofen application, the weedicide can cause severe leaf defoliation, plant mortality and reduced crop yields. In nitrofen spraying there is also the importance of time of application in relation to stage of weed development and weeds have to be sprayed in the early true-leaf stage. Unfortunately, even where good weed control is obtained, showers of rain soon after spraying can cause further weed strikes which will necessitate additional spraying. Because nitrofen must be applied early, the crop is also at a very early growth stage and is frequently not vigorous enough to smother weeds which emerge after spraying.

Under Canterbury conditions, at the recommended 2 lb applied at a satisfactory stage of growth, nitrofen's value in brassica weed control is thus governed by the possibility of dry conditions and crop retardation or showers and successive weed strikes after spraying.

In April 1963, a new systemic herbicide, picloram, became available and in 1964 weed control in brassica trials which included nitrofen and picloram were commenced in South Canterbury. Plots were 25 × 25 links (1/100 acre) in area and were replicated three to four times. All materials were applied per knapsack in 15 to 20 gal water per acre at the 2- to 4-leaved stage unless otherwise stated. Yields are given in green-weight tons per acre.

1964 TRIALS

Two trials were conducted, one in rape and the other in swedes. In the rape trial, although crop in the 4 lb rate was checked initially, large increases in yield were obtained with increased rates of nitrofen. A mixture of 1 lb nitrofen plus 2 oz picloram gave further yield increases. In the swede trial, very dry conditions persisted after spraying and low yields were obtained. Nitrofen caused severe leaf defoliation and bulb malformation and, at the 4 lb rate or in association with 2 oz picloram, the crop suffered a decrease in yield.

TABLE 1: RESULTS OF 1964 TRIALS

<i>Treatment</i>					<i>Rape</i> (<i>Rosewill</i>)	<i>Swedes</i> (<i>Rosewill Valley</i>)
nil	....	....	....	....	4.2 D S	9.1 AB P
nitrofen 1 lb	....	....	....	....	7.7 C S	11.3 AB P
nitrofen 2 lb	....	....	....	....	10.5 B QR	11.4 A P
nitrofen 4 lb	....	....	....	....	12.4 A PQ	8.6 AB P
nitrofen 1 lb/picloram 2 oz	....	....	....	....	13.2 A P	8.3 B P
CV	....	....	....	....	10.2%	18.7%

1965 TRIALS

Three trials on rape, choumoellier, and choumoellier and swedes were conducted. Two rates of nitrofen and two rates of picloram alone and in combination were compared with the untreated.

In the rape trial, 1 lb nitrofen had little effect on either crop or fathen. In all other treatments the crop was initially retarded and fathen eliminated. 2 oz picloram alone or with 2 lb nitrofen gave lower yields than the 1 oz rate in which rape made the best recovery.

In the two choumoellier trials different results were obtained. In the Adair trial very dry conditions occurred soon after spraying and caused severe plant distortion and leaf loss in all spraying treatments. Only occasional showers a fortnight after spraying prevented complete crop loss. Nitrofen plus picloram caused permanent malformation and retarded development in the swedes. Picloram was very effective against

fathen, spurrey and shepherds purse (*Capsella bursa-pastoris*) and also severely checked Californian thistle (*Cirsium arvense*) and docks (*Rumex obtusifolius*). Choumoellier was initially checked but recovered as did swedes at the 1 oz rate.

Nitrofen was effective against fathen but all other weeds recovered. In the nitrofen treatments, both choumoellier and swedes were almost eliminated. Nitrofen alone was much more severe than the nitrofen/picloram mixtures. In this trial 2 oz picloram was the best treatment.

In the choumoellier trial at Southburn, all treatments except 1 lb nitrofen (25% short fathen) gave excellent control of very dense fathen which was at the 2- to 8-leaved stage at spraying. Hot dry conditions after spraying caused severe crop distortion and leaf loss in all treatments initially but fortunately warm showery conditions later allowed the crop to recover. Weedicide application, however, caused plant thinning and at the higher rates resulted in very thick, bushy-topped, high yielding stems. 2 lb nitrofen plus 2 oz picloram was the outstanding treatment in a very responsive trial.

TABLE 2: RESULTS OF 1965 TRIALS

Treatment				Rape (Rosewill)	Choumoellier & Swedes (Adair)	Choumoellier (Southburn)
nil	....	....	....	11.7 B R	10.5B Q	7.6 D S
nitrofen 1 lb	....	....	....	12.3 B QR	nil C R	33.1 C R
nitrofen 2 lb	....	....	....	14.1 AB PQR	2.3C R	36.7 B Q
picloram 1 oz	....	....	....	17.1 A P	14.6 AB PQ	34.1 B QR
picloram 2 oz	....	....	....	16.6 A PQ	18.4 A P	37.1 B Q
nitrofen 1 lb/picloram 1 oz				16.8 A P	14.8 AB PQ	38.3 B Q
nitrofen 2 lb/picloram 2 oz				15.8 A PQR	14.8 AB PQ	41.0 A P
CV				12.7%	28.6%	6.8%

1966 TRIALS

In 1966, because of the previous good results from picloram application and the frequent adverse effects from nitrofen, rates of picloram were compared with one rate of nitrofen and the untreated.

In a rape trial at Seadown, dry conditions prevailed for several days after spraying, followed by warm showery weather. Weedicide application gave very good fathen control and good yield increases. 1½ lb nitrofen was the best treatment. 1 and 2 oz picloram caused crop leaf crinkling and distortion.

In the choumoellier trial at Elephant Hill, all treatments gave good fathen suppression and large yield increases. There was some leaf distortion in the 1 oz and particularly the 2 oz picloram plots and some plant thinning in the 1½ lb nitrofen. This favoured the growth of thick stems in the nitrofen treatment which gave the highest yield.

In the ridged swede trial at Otipua, similar good results were obtained. Picloram was effective against fathen, docks, Californian thistle and to a lesser extent fumitory (*Fumaria muralis*). Nitrofen was effective against only fathen. In this trial, however, late weed recovery which was not smothered by the slower growing swede crop took place in the 1½ lb nitrofen. As a result, it was outyielded by all the picloram treatments. An interesting feature of this trial was that, above ½ oz picloram per acre, bulb size decreased and yield of tops increased.

TABLE 3: RESULTS OF 1966 TRIALS

Treatment		Choumoellier (E. Hill)			Total	Swedes (Otipua)		
		Rape (Seadown)	Leaf	Stem		Top	Bulbs	Total
nil	....	3.8 C R	4.5	7.0	11.5 B Q	3.0	2.6	5.6 B Q
picloram	¼ oz	5.9 BC QR	10.7	11.6	22.3 A P	10.4	17.0	27.4 A P
picloram	½ oz	9.6 AB PQR	11.2	10.7	21.9 A P	10.8	17.5	28.3 A P
picloram	1 oz	9.0 AB PQR	10.9	11.1	22.0 A P	14.4	14.9	29.3 A P
picloram	2 oz	11.2 A PQ	10.4	11.0	21.4 A P	15.8	14.8	29.8 A P
nitrofen	1½ lb	13.4 A P	9.9	16.6	26.5 A P	9.6	16.8	26.4 AB P
CV		31.2%			20.2%			22.8%

1967 TRIALS

In 1967, because of the probability of picloram alone not being available for commercial application, the new series of trials included rates of combinations of nitrofen and picloram.

In one choumoellier trial in which spurrey (70%) and fathen (10%) were the main weeds, dry conditions prevailed after spraying and nitrofen alone or in combination caused permanent crop damage. Although spurrey was checked and not eradicated, 1 oz picloram alone gave good yield increases.

TABLE 4: RESULTS OF 1967 CHOUMOELLIER TRIAL, HAZELBURN

Treatment		Choumoellier (Hazelburn)		
nil	....	....	....	5.1 D RS
picloram	1 oz	....	....	7.6 C QR
nitrofen	1 lb/picloram 1 oz	....	....	4.9 D RS
nitrofen	2 lb	....	....	2.6 E S

In the second choumoellier trial at Waihaorunga, the fathen was dense but of variable size (2 to 15 in. high) owing to successive strikes after showers. Good growth conditions prevailed after spraying and good fathen control and large yield increases were obtained. 1 and 2 oz picloram caused some leaf cupping. The mixtures of nitrofen and picloram were superior to nitrofen or picloram alone, with 1 lb nitrofen plus 1 oz picloram the best treatment, giving a 50% increase in yield. The highest rate, 2 lb nitrofen plus 2 oz picloram, gave a lower yield than half that rate.

At Seadown the same treatments applied as an overall spray to very dense fathen 3 to 6 in. high in ridged swedes also gave good yield increases. The mixture of nitrofen and picloram tended to be superior to either weedicide applied singly. In this trial ½ lb nitrofen plus ½ oz picloram gave the highest yields which tended to fall if 1 lb plus 1 oz was exceeded. At 1 and 2 oz, picloram alone or in combination caused crop leaf cupping and bulb twisting.

TABLE 5: RESULTS OF 1967 CHOUMOELLIER AND SWEDE TRIALS

<i>Treatment</i>				<i>Choumoellier (Waihaorunga)</i>			<i>Swedes (Seadown)</i>		
				<i>Leaf</i>	<i>Stem</i>	<i>Total</i>	<i>Tops</i>	<i>Bulbs</i>	<i>Total</i>
nil	....	....	....	6.3	6.0	12.3 DE	7.1	7.6	14.7 B
						QR			Q
picloram ¼ oz	....	....	....	7.8	6.4	14.2 CD	9.0	13.8	22.8 A
						PQR			PQ
picloram ½ oz	....	....	....	9.0	8.1	17.1 AB	9.2	13.8	23.0 A
						P			PQ
picloram 1 oz	....	....	....	9.0	6.3	15.3 ABC	10.0	12.4	22.4 A
						PQ			PQ
picloram 2 oz	....	....	....	7.0	3.8	10.8 E	9.8	11.7	21.5 A
						R			PQ
nitrofen ¼ lb/picloram ¼ oz	9.6	7.3	16.9 ABC			P	8.6	15.0	23.6 A
						P			P
nitrofen ½ lb/picloram ½ oz	9.1	8.1	17.2 AB			P	8.5	15.0	23.5 A
						P			P
nitrofen 1 lb/picloram 1 oz	....	9.0	17.9 A			P	9.9	13.1	23.0 A
						P			PQ
nitrofen 2 lb/picloram 2 oz	....	9.9	17.4 AB			P	8.7	12.2	20.9 A
						P			PQ
nitrofen 2 lb	....	8.0	14.7 BCD			PQR	9.0	12.1	21.1 A
						PQR			PQ
CV						9.8%			15.2%

1968 TRIALS

Two trials, one with ridged kale and the other with choumoellier on the flat, were conducted. They included the same treatments used in 1967. In the ridged trial, however, the treatments were applied as a band spray and the crop inter-row cultivated. Both trials initially contained very dense 6- to 8-leaved fathen and stinging nettle (*Urtica urens*).

In both, a quick knock-down of fathen and severe check to stinging nettle were obtained. A combination of nitrofen and picloram was quicker

and more effective than either weedicide alone. Initially treatments which included 1 or 2 oz picloram contained many plants with moderate to severe leaf distortion but these made good recovery after 6 to 8 weeks.

In the choumoellier trial, all spraying treatments gave increased yields. Nitrofen or picloram alone were inferior to the mixture whose three lower rates gave similar yields. At 2 lb nitrofen plus 2 oz picloram, however, the crop yield declined.

In the kale trial, spraying again favoured marked increases in crop yield. The area was particularly weedy and the crop slow growing. In it the higher rates of nitrofen plus picloram gave the best results. The relative poorer yields from the lower rates of the mixture compared with picloram alone are not clear as all mixture treatments were more weed-free than any single treatment application.

TABLE 6: RESULTS OF 1968 TRIALS

Treatment	Kale (Levels)		Choumoellier (Fairview)	
	Leaf	Stem	Leaf	Stem
nil	....	....	....	....
	4.1 D	3.4 D	8.6 D	11.8 D
	S	T	R	T
picloram 1/4 oz	....	....	....	....
	6.1 C	6.2 C	11.6 BC	16.7 BC
	QR	RS	PQR	S
picloram 1/2 oz	....	....	....	....
	7.3 AB	7.3 BC	12.8 ABC	17.6 B
	PQ	QR	PQ	RS
picloram 1 oz	....	....	....	....
	8.2 A	7.3 BC	13.2 AB	17.9 B
	P	QR	PQ	RS
picloram 2 oz	....	....	....	....
	8.1 A	7.3 BC	15.2 A	18.2 B
	P	QR	P	QRS
nitrofen 1/4 lb/picloram 1/4 oz	....	....	....	....
	5.2 CD	4.7 D	14.1 AB	22.5 A
	RS	ST	PQ	PQ
nitrofen 1/2 lb/picloram 1/2 oz	....	....	....	....
	5.4 C	6.1 C	13.7 AB	22.1 A
	RS	RS	PQ	PQR
nitrofen 1 lb/picloram 1 oz	....	....	....	....
	7.7 A	8.3 B	14.7 A	22.8 A
	PQ	PQ	P	P
nitrofen 2 lb/picloram 2 oz	....	....	....	....
	7.3 AB	9.7 A	13.6 AB	16.9 BC
	PQ	P	PQ	S
nitrofen 2 lb	....	....	....	....
	6.3 BC	7.5 BC	10.5 CD	14.0 CD
	QR	QR	QR	ST
CV	9.6%	10.8%	11.2%	10.1 %

DISCUSSION

Nitrofen + picloram mixtures have given excellent control of fathen (the main weed of brassicas in Canterbury) and severely checked wireweed, docks, stinging nettle and Californian thistles so that they are much less in competition with the crop. The addition of picloram has widened nitrofen's weed control spectrum.

The addition of picloram to nitrofen has generally given better results at lower rates than nitrofen alone and this has reduced the risk of higher nitrofen rate crop damage if dry conditions prevail after spraying. Use of the mixture also means that spray application is more reliable and can be carried out later than is normally recommended for nitrofen

alone. This overcomes the problem of critical timing of nitrofen application. With later spraying there is less likelihood of weed restrike with the occurrence of post-spraying showers. In addition, the slow residual systemic activity of picloram even at very low rates inhibits regrowth from the more nitrofen-tolerant weeds such as wireweed, spurrey and the various thistles. With later spraying, the crop is also at a more advanced stage of growth and can play an important part in smothering late emerging weeds.

The main problems associated with the inclusion of picloram in nitrofen/picloram mixtures are crop damage and residual effects. Fortunately, nitrofen and picloram appear to have an additive effect, the mixture usually being superior to either material alone, and at low rates the mixture can give very good results.

Approximately $\frac{3}{4}$ lb nitrofen plus $\frac{3}{4}$ oz picloram appears to be a very satisfactory rate of application for very good weed control with increased crop yields and a minimum of crop damage.

Above these rates, although there is the probability of excellent weed control, there is the distinct risk of crop damage and reduced yields. This applied particularly to the bulb brassicas, swedes and soft turnips, in which plant thinning and gross bulb malformation can occur. In these crops the rates of nitrofen plus picloram applied should probably be no more than $\frac{3}{4}$ lb plus $\frac{3}{4}$ oz per acre. In rape, choumoellier and kale crops, higher rates of the mixture could be used without causing permanent crop damage. However, in these three, normally tall, vigorous crops, a severe weed check is usually sufficient, crop vigour thereafter having a weed smothering effect. For this reason, the rate of nitrofen plus picloram recommended for swedes and soft turnips should also be adequate for rape, choumoellier and kale.

In ridged swede crops, inter-row cultivation should be carried out because it benefits bulb development as well as killing between-row weeds. Weed infestation along the tops of the rows, however, can be severe. It cannot be attacked by inter-row cultivation and, despite such mechanical treatment, weed competition can still cause reduced crop yields.

In such weed-infested crops, it is probable that band spraying at approximately half row width could be carried out with the nitrofen/picloram mixture at the rates previously mentioned. This could give very effective weed control at half the cost of overall spraying.

As far as picloram residues are concerned, provided adequate cultivation is carried out, there is no evidence from South Canterbury trials that even a previous application of 4 oz picloram per acre will be hazardous to clovers (*Trifolium* spp.). As several cultivation operations are usually made after grazing off brassicas and a much lower rate of picloram than 4 oz is recommended, it is unlikely that picloram residues after brassica spraying will be a problem. In farm practice, lucerne, potatoes and peas are possibly susceptible crops, though there is little experimental evidence to support this. However, until investigations are conducted, it would probably be prudent to recommend that these three crops not be sown immediately after picloram sprayed brassica crops.

The use of nitrofen plus picloram appears to offer very good prospects for effective weed control in brassicas, and higher crop yields. With their widespread and continued use, a major source of weed seed build-up could be restricted, to the advantage of subsequent crops, including grass.