BIPYRIDYL HERBICIDES AND THE DIRECT ESTABLISHMENT OF CROPS IN UNCULTIVATED SOIL. 2. BRASSICAS

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Summary

The direct establishment of rape, choumoellier and swedes in pastures sprayed with paraquat or paraquat mixed with other bipyridyls was investigated. Of the bipyridyls used (paraquat, diquat, PP745, PP831 and PP945) only PP945 controlled clovers. Paraquat at 8 to 32 oz alone controlled grasses but clovers recovered quickly. Grasses recovered to some extent when PP945 was added to paraquat to control clovers in a ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) pasture. The application of nitrogen increased yield in all trials except one. The results suggest that, in some conditions, efficient suppression of clovers could reduce the need for added nitrogen.

INTRODUCTION

A GENERAL BACKGROUND to the direct establishment of crops was given in the foregoing paper (Part 1—Cereals). Most of the research in New Zealand has been concerned with winter-feed brassicas. The recovery of clovers was reported as a major problem. The present paper deals with trials carried out in the South Island to compare the effects of different bipyridyl herbicides and mixtures of these herbicides on grasses and clovers and the subsequent effects on brassica establishment and growth.

EXPERIMENTAL METHODS

All trials were drilled in pasture previously grazed by sheep. Herbicides were applied in 22 to 26 gal of water per acre to plots varying in area from 1/35 to 1/70 acres between trials. Treatments were arranged in randomized blocks with four or five replicates. Nitrogen was broadcast on sub-plots of about 1/100 acre.

The grain and fertilizer drill referred to in Part 1 was used fitted with V-shaped coulter points. Seed with basal reverted superphosphate fertilizer was placed in narrow, open, vertical grooves with rows six inches apart, normally with no subsequent rolling or harrowing.

One or two square yards (rape) or four square yards (choumoellier) were harvested by cutting at ground level. Fresh weight was recorded. Comparison with cultivation has not been undertaken except where areas adjacent to trials were cultivated for a general comparison.

TRIAL DETAILS AND RESULTS

TRIAL B1: *Direct-drilled rape, Lauriston silt loam, Rakaia*

Pasture, mainly perennial ryegrass (*Lolium perenne*), goose grass (*Bromus mollis*) and white clover (*Trifolium repens*) with patches of

hairgrass (*Vulpia* spp.) and yarrow (*Achillea millefolium*), was grazed to a height of about one inch. Rape (var. Broad-leaf Essex) at 3½ lb with 1½ cwt reverted superphosphate per acre was drilled (except in Treatment 1) after applying the following treatments:

1. Paraquat at 6 oz (not drilled).
2. Paraquat at 8 oz.
3. Paraquat at 16 oz.
4. Paraquat at 8 oz with PP745 at 6 oz.
5. Paraquat at 8 oz with PP831 at 6 oz.
6. Paraquat at 16 oz with PP831 at 6 oz.

Treatments were applied on October 30 and the crop drilled on November 3. Ammonium sulphate at 1½ cwt per acre was broadcast as follows:

- (a) No nitrogen.
- (b) Early nitrogen: applied November 4.
- (c) Late nitrogen: applied December 7.
- (d) Early and late nitrogen: applied November 4 and December 7.

Malathion was applied on November 24 to control springtails (*Collembola* spp.). Rape was sampled on January 11 and the remaining plant material on January 12. The response to nitrogen application was significant at each time of application with the early response almost twice that of the late one. In the absence of evidence of an interaction between nitrogen application and herbicide treatment, the results were analysed as shown in Table 1. In general, yield increased with higher rates of chemical application. Neither PP745 nor PP831 caused any marked effect on yield of rape or the total yield. Although the application of nitrogen increased the yield of rape and depressed that of clovers and weeds in Treatment 6, the yield of clovers and weeds increased with added nitrogen in Treatment 1; this is attributed to increased growth of grasses which eventually recovered from the initial spray application.

Separation of clovers from weeds in five samples, taken at random, showed that the fresh weight of clovers varied from 66 to 85% of the

TABLE 1: TRIAL B. EFFECT OF HERBICIDE AND NITROGEN TREATMENT ON YIELD OF RAPE AND TOTAL YIELD OF RAPE, CLOVERS AND WEEDS

Treatment (oz)	Yield of rape		Total Yield	
	No N	E + L*	No N	E + L*
	(lb fresh weight/sq. yd.)			
1. Paraquat 6			0.7cC	1.0bB
2. Paraquat 8		0.6cC	1.3bB	3.0aA
3. Paraquat 16		1.1bB	2.6bA	3.1aA
4. Paraquat 8/PP745 6		1.0bB	1.6bB	3.3aA
5. Paraquat 8/PP831 6		1.0bB	1.6bB	3.2aA
6. Paraquat 16/PP831 6		1.8aA	2.2aA	4.0aA
CV		16.8%	14.6%	23.3%

*E + L: 30 units N applied November 4 and December 7.

total fresh weight of clovers and weeds: on average, clovers represented four-fifths of the total fresh weight.

The mean yield of rape sampled at 6 points in the cultivated area (2.4 lb per sq. yd) was greater than when drilled on all chemical treatments where no nitrogen was applied. The early addition of nitrogen, however, raised the yield of rape on the direct-drilled plots to a level similar to the cultivated crop (to which no nitrogen was applied). In marked contrast to the direct-drilled crop, the weeds in the cultivated crop were almost entirely fathen (*Chenopodium album*). Apart from clovers, a few fathen plants germinated in the drill rows where soil had been disturbed at drilling. Patches of yarrow caused very poor establishment of rape, irrespective of chemical and fertilizer treatment.

TRIAL B2: *Direct-drilled rape, Waipara silt loam, Amberley.*

An area of dense barley grass (*Hordeum murinum*) 5 to 8 in. in height with only occasional plants of white clover was sprayed on October 26 with the following treatments:

1. Paraquat 8 oz.
2. Paraquat 12 oz.
3. Paraquat 16 oz.
4. Paraquat 24 oz.

Aphid-resistant rape was drilled on November 2 with 1½ cwt reverted superphosphate and calcium ammonium nitrate fertilizer applied to subplots at 0, 1, 2 and 3 cwt per acre 15 days after drilling. Paraquat at 12 oz or higher killed all but occasional plants of barley grass. Paraquat at 8 oz was sufficient for good rape establishment but some barley grass plants had recovered by mid-December. In contrast with other trials, nitrogen application had no apparent effect on rape and none of the plots showed signs of nitrogen deficiency or differences in yield. Annual nettle (*Urtica urens*) germinated where soil was disturbed at drilling over about half the trial area. Unfortunately, sheep broke into the trial in late December and grazed the rape to ground level. The rapid regrowth of rape was sampled on March 29–30. The mean yields were 3.4, 3.5, 3.9 and 3.7 lb per sq. yd for treatments 1 to 4 respectively. The addition of nitrogen did not increase yield.

TRIAL B3: *Direct-drilled choumoellier, Ashley silt loam, Homebush.*

A 31-year-old pasture, mainly perennial ryegrass and white clover with some sweet vernal (*Anthoxanthum odoratum*), *Poa* spp. and chickweed (*Stellaria media*) was sprayed on November 23 with the following treatments:

1. Paraquat at 8 oz.
2. Paraquat at 16 oz.
3. Paraquat at 8 oz with diquat at 8 oz.
4. Paraquat at 16 oz with diquat at 8 oz.
5. Paraquat at 8 oz with PP831 at 8 oz.

Medium-stem choumoellier was drilled on November 24 at 3½ lb with 1½ cwt reverted superphosphate per acre.

By November 29, six days after spraying, clovers were beginning to recover on all plots. The trial was, therefore, resprayed just before the

crop emerged. The trial was divided into two, one half to be resprayed with paraquat at 6 oz the other with PP945 at 6 oz. Ammonium sulphate was broadcast at 1½ cwt/acre on one half of each half-plot at random on November 30 and the plots resprayed on December 3 to give the following sub-plot treatments:

- (a) Resprayed with paraquat (6 oz)—no nitrogen.
- (b) Resprayed with paraquat (6 oz)—nitrogen applied.
- (c) Resprayed with PP945 (6 oz)—no nitrogen.
- (d) Resprayed with PP945 (6 oz)—nitrogen applied.

Malathion was applied on December 9 to control springtails. For comparison, with the direct-drilled crop, an area adjacent to the trial was cultivated and choumoellier drilled on November 24 in rows 21 in. apart. The germination and early growth of the direct-drilled crop appeared to be slower than that growing in cultivated soil.

The crop was sampled between May 16 and June 9. The results are summarized in Table 2: only the data for the area resprayed with paraquat have been statistically analysed. The data show that yields were generally higher where PP945 was applied: statistical comparison cannot be made, however, as the resprayed treatments were not randomized. It is unlikely, however, that the mean difference of about 6 tons per acre was caused by site variability.

The differences between the initial spray treatments were small. Clovers recovered in a strip across the treatments not resprayed on December 3 so vigorously that few crop plants became established. Those that did had grown to about 12 in. in height at the time the trial was sampled. It is apparent, therefore, that none of the initial spray treatments suppressed clovers to any great extent and the relatively similar yields from the treatments was due to the suppression of clovers by the later application of paraquat or PP945. Yields in Treatments 1 and 3 were, however, significantly lower than in other treatments.

The effect of the added nitrogen on yield appeared to be greater where paraquat was applied. It was observed that, even after the respray with paraquat, clovers recovered and at the time of sampling were absent only where the yields of the choumoellier were highest. PP945 killed most of the clover and, in this part of the trial, grasses recovered to a limited extent. Some fathen germinated, generally in the drill row, but did not appear to affect the growth of the crop.

Weeds were more prevalent where choumoellier was drilled after cultivation. Eight samples of this cultivated crop were taken for yield estimation. The fresh weight ranged from 20 to 33 tons per acre: the mean yield was 27 tons per acre.

TRIAL B4: *Direct-drilled swedes, clay loam, Centre Bush, Southland.*

The following treatments were applied to pasture comprising perennial ryegrass, *Poa* spp. and white clover on December 18:

- 1. Paraquat at 8 oz.
- 2. Paraquat at 16oz.
- 3. Paraquat at 32 oz.
- 4. Paraquat at 8 oz with PP945 at 8 oz.
- 5. Paraquat at 16 oz with PP945 at 8 oz.

TABLE 2: TRIAL B3: YIELD OF CHOUMOELLIER
(Tons fresh weight per acre)

Initial Treatment (oz)	Resprayed with Paraquat (6 oz)		Resprayed with PP945 (6 oz)	
	No N	Mean	No N	Mean
1. Paraquat 8	10	14bB	19	23
2. Paraquat 16	15	19aA	23	24
3. Paraquat 8/diquat 8	11	15bB	22	23
4. Paraquat 16/diquat 8	17	21aA	24	24
5. Paraquat 8/PP831 8	15	19aA	21	23

At the time of spraying, the pasture had not been grazed for some time and some grasses were 6 to 8 in in height and at the flowering stage with the major part of the pasture about 3 in. in height. Heavy rain (0.38 in.) fell within a few hours following spraying.

On December 20, three varieties of swede were drilled across the sprayed treatments. However, the pasture quickly recovered following the application of the chemical treatments. Clovers and grasses were assessed on February 2: the results are given in Table 3. Total plant cover was lowest where either 32 oz paraquat alone or 16 oz paraquat with 8 oz PP945 had been applied: these treatments had resulted in just greater than 50% plant cover. Swedes were growing in all plots but were more vigorous where grasses and clovers had been suppressed to the greatest extent.

TABLE 3: TRIAL B4: ASSESSMENT OF CLOVERS AND GRASSES
(0, No plants. 20, Complete plant cover)

<i>Treatment (oz)</i>	<i>Clover</i>	<i>Grasses</i>	<i>Total</i>
1. Paraquat 8	18	3	21
2. Paraquat 16	14	2	16
3. Paraquat 32	10	2	12
4. Paraquat 8/PP945 8	11	7	18
5. Paraquat 16/PP945 8	9	4	13

Comparison of Treatment 1 (paraquat at 8 oz) with Treatment 4 (paraquat at 8 oz with PP945 at 8 oz) shows clearly that the quick recovery of clovers can be an important factor in controlling grass recovery: in Treatment 4 grass regrowth was very noticeable. The application of 16 oz paraquat with PP945 (Treatment 5) suppressed grasses to a lesser extent than the combination of 8 oz paraquat and the resultant clover recovery in Treatment 1. By early February, competition from clovers and grasses recovering from the spray treatments had severely checked the growth of swedes and the trial was subsequently abandoned.

DISCUSSION

As in earlier work in New Zealand, reported by Thompson (1962) and Bramley (1962), the recovery of white clover was a major cause of crop failure. Rape was successfully established where few clover plants were present at the time of spraying. Diquat, PP745, and PP831 showed little effect on clovers in addition to the temporary desiccation effect of paraquat. PP945 proved effective on clovers but it appears that, where paraquat is applied with a clover suppressant, such as PP945, higher rates of paraquat will be required to control grasses. The effects of paraquat at lower rates in suppressing grasses is dependent to some extent on the canopy quickly formed by the recovering clovers. Choumoellier gave high yields where PP945 was applied at 6 oz after drilling and just before crop emergence. The addition of nitrogen in these circumstances increased yield less than where clovers recovered. It is possible that brassicas, in contrast with cereals, are more sensitive to

competition in the early stages, particularly from clovers which can compete for light and apparently do not release nitrogen in soil for uptake by the crop.

It has been observed in a number of trials that the early growth rate of direct-drilled brassicas is slower than that of crops in cultivated ground. In the autumn, the direct drilled crop appears to make extra growth and largely eliminates the difference. The developing crop also tends to shade out grasses or clovers recovering from the herbicide. Temporary suppression of clovers may therefore be adequate. Although recovery of grasses and clovers can reduce crop yields, their grazing value tends to offset this loss. Earlier drilling of direct-drilled brassicas as suggested by Thompson (1962) may counteract the slower growth during the early stages. Where non-residual chemicals are used for direct crop establishment, suppression of vegetation is, at best, only temporary. It is important, therefore, to place seed in the soil in such a way that it germinates and develops as quickly as possible. The use of suitable drilling equipment under favourable soil conditions is therefore essential, together with the application of adequate fertilizer: drilling earlier in the summer in more favourable soil moisture conditions could improve germination and early growth. Furthermore, pasture at this time is usually short following heavy grazing during winter and spring. Such pasture is easily penetrated by normal volumes of spray application and is unlikely to cause blockages at drilling. The possibility of suppressing clovers to release nitrogen for growth of direct-drilled crops needs further investigation. The addition of nitrogen has, in most cases, increased yield. With further information on the time and extent of nitrogen release from clovers (see for example, Simpson, 1965) the need for applied nitrogen could be reduced.

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