WEED CONTROL IN BEAN CROPS

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Summary

Chemical weed control in both haricot and green bean crops was investigated over four seasons. The early trials left a short list of pre- and post-sowing treatments which were developed further in various combinations. Any two of the materials monolinuron, chloramben and dinoseb-acetate gave adequate weed control with crop safety. Preliminary applications of trifluralin and possibly EPTC were considered worth while but in one such combination trifluralin followed by chloramben resulted in a yield reduction. No post-emergence treatment can yet be recommended for these crops.

SINCE 1967 the Weed Control Section of Levin Horticultural Research Centre has been examining weed problems in *Phaseolus* spp. bean crops. Herbicide development trials have been carried out in the North Island in both haricot beans which are threshed when mature and green beans which are picked at a stage suitable for fresh consumption, canning, freezing or dehydration.

Approximately 1,500 acres of green beans, representing three-quarters of the national total, are grown in Hawke's Bay where the crop is mainly machine harvested for processing. It is grown in rows 24 or 36 in. apart at a seed rate of 100 lb/acre.

The area devoted to haricot beans is much smaller, about 100 acres in all, in the predominantly pasture, cereal and pea growing country around Martinborough in the Wairarapa. Achievement of reliable chemical weed control would remove a major obstacle to increased production. The acreage could expand in this district and others where late summer weather is suitable for ripening the pods. Haricot beans are grown like a pea crop in narrow rows, 6 to 7 inches apart and at a seed rate in the range 90 to 120 lb/acre.

DEFINITION OF THE WEED CONTROL REQUIREMENT

There are several important considerations which affect the efficiency of weed control methods.

- (1) After sowing, beans germinate quickly. The main crops are sown in summer under relatively high soil temperatures and can emerge within 4 or 5 days.
- (2) After emergence, while the first trifoliate leaves are developing, the young bean plant is slow growing. Before it begins to "run" it is susceptible to early weed competition.
- (3) Beans produce a mass of fine feeding roots near the soil surface.
- (4) The crop often establishes under fairly dry seedbed conditions.

Traditionally, "row-crop" beans are tractor hoed. This operation gives effective weed control between the rows but can easily damage the shallow root system. Dinoseb-amine can be used in the short period before the crop emerges but this treatment is primarily contact in action, and thus ineffective against unemerged weeds, and in any case several important broadleaf and grassy weeds are resistant. Weeds are still quite often hand-pulled.

The development of satisfactory herbicide treatments is important because mechanical and hand methods, even when practicable, are likely to be too damaging or become too expensive.

LEVIN EXPERIMENTS

During the period 1967-71, a total of 13 experiments was carried out, nine on haricot and four on green beans, either at the Levin station or on growers' properties in the Hawke's Bay and Wairarapa districts (see Table 1). In the earlier trials a range of materials was examined but most of them proved to be too toxic to the crop. More detailed work was done with trifluralin, monolinuron, dinoseb-acetate and chloramben which were sufficiently selective and latterly two other contenders, nitratin and EPTC, were added.

Two distinct procedures have been adopted in laying out and treating these trials. Off-station haricot bean experiments were established after the crop had been drilled in 7 in. rows with a grain drill. Plots 5 to 7 ft wide and 25 to 30 ft long were placed across the rows so that each plot contained a large number of short lengths of row. Spraying was done with hand-held propane-powered equipment with a boom covering the full plot width.

All other trials were marked out, then drilled down the length of the plot using Stanhay or Planet units. When included, pre-sowing treatments were incorporated to 1.5 to 2 in. depth with a small rotary hoe. The number of rows per plot varied from 1 to 4 and row widths ranged from 15 to 36 in. but a total of at least 15 ft of row was used for assessment. The same sprayer was used and boom widths altered as necessary.

In green bean trials, the variety used at Levin was Processor, and in Hawke's Bay Galletin. In all haricot bean trials Sanilac was grown. All these varieties are of American origin.

Weed counts were taken on all experiments. The species assessed are listed below.

Most important:

Redroot (*Amaranthus retroflexus*)
Fathen (*Chenopodium album* agg.)
Black nightshade (*Solanum nigrum*)

Less important:

Scotch thistle (*Cirsium vulgare*)
Poa annua (*Poa annua*)
Wireweed (*Polygonum aviculare*)
Willow weed (*Polygonum persicaria*)
Wild portulaca (*Portulaca oleracea*)
Spurrey (*Spergula arvensis*)
Clovers (*Trifolium* spp.)

The first three were by far the most important in Hawke's Bay and Wairarapa trials and, in the latter, clovers were also a problem.

Crop response was assessed by vigour scores and, in the case of the later green bean trials, by yield of pods. In trial No. Y708 yields were recorded from successive hand picks and in two others, Nos. Y818 and Y819, a single pick was made at the correct maturity stage for freezing.

RESULTS OF EXPERIMENTS

HERBICIDES EVALUATED IN THE EARLIER TRIALS

Pre-sowing, post-sowing and post-emergence possibilities were tested (refer to Table 1) but most of the post-sowing and post-emergence treatments proved to be either too toxic or inadequate weedkillers.

The performance of particular chemicals whose development was discontinued early in the programme can be summarized as follows.

Discontinued in Favour of More Promising Alternatives

Both metobromuron and buturon compared reasonably well with the best treatments but were never quite as effective. Metobromuron was safe at 2 lb (all rates in a.i. per acre) and gave adequate control of black nightshade and fathen. Buturon produced some stunting and mortality at doses above 0.5 lb; black nightshade was partially controlled.

Not Safe Enough in Beans

Bromacil and terbacil were tested at 2 oz but effects were suspected on the crop later in the season even at this low dose. Linuron at 0.75 lb caused definite crop damage. Nitrofen caused severe damage at 3 lb. At 4 lb chloroxuron produced stunting and venal chlorosis; dichlormate gave slight scorch at this dose. Alachlor at 2 lb produced serious crop damage in one experiment.

Two herbicides which were tested post-emergence, dinoseb-acetate and phenmedipham, were found to be generally too damaging although subsequent work has shown that dinoseb-acetate can provide a "salvage" treatment if applied at the first trifoliate leaf stage.

Safe, but giving Inadequate Weed Control

At 1.5 lb the activity of "WL9385-D" was unreliable under field conditions.

HERBICIDES TAKEN ON FOR FURTHER DEVELOPMENT

It was clear from the early trials that *Phaseolus* spp. beans possessed adequate tolerance to applications of trifluralin before sowing, and of chloramben, dinoseb-acetate and monolinuron after sowing. In addition, increased interest in New Zealand in the development of nitratin and EPTC made these chemicals worth further study.

Pre-sowing, Soil-incorporated Treatments

These treatments were trifluralin 1 lb, nitratin 1.5 lb, and EPTC 4 lb. Figure 1 summarizes results of the treatments against the major weeds. Redroot was reliably controlled by trifluralin, EPTC was less effective. On average fathen was adequately controlled by both trifluralin and nitratin, whereas EPTC was more uncertain. As was anticipated, black nightshade was resistant to all three chemicals although there was some indication that EPTC might give a useful partial suppression.

In one trial, EPTC caused some distortion of the young crop (Table 2) but this was not reflected by the yield (Table 3). Apart from this one instance, the soil-incorporated treatments have shown no effect on the growth and yield of beans.

TABLE 1: HERBICIDES INCLUDED IN WEED CONTROL PROGRAMME ON HARICOT AND GREEN BEANS, 1967-71

Season	1967-8				1968-9				1969-70				1970-71			
LOCATION	Wairarapa	Levin	Wairarapa	Wairarapa	Levin	Levin	Levin	Levin	Wairarapa	Wairarapa	Levin	Hawke's Bay	Hawke's Bay			
EXPERIMENT No.	Y477	Y484	Y589	Y590	Y602	Y603	Y604	Y708	Y709	Y710	Y814	Y818	Y819			
CROP	Haricot beans, H				H				H				H			
	Green beans, G								G				G			
PRE-SOW, SOIL INCORP.																
trifluralin		x										x	x	x		
nitralin		x										x	x	x		
EPTC												x	x	x		
POST-SOW, PRE-EM																
monolinuron	x	x	x	x			x	x	x	x	x	x	x	x		
dinoseb-acetate		x	x	x	x			x	x	x	x	x	x	x		
chloramben			x	x	x		x	x	x	x	x	x	x	x		
buturon	x		x	x												
chloroxuron	x															
metobromuron	x	x														
linuron	x															
bromacil	x															
terbacil	x	x														
alachlor			x	x												
nitrofen	x															
"WL 9385-D"	x	x														
dichlormate	x	x	x	x												
POST-EM																
dinoseb-acetate		x	x	x	x	x	x									
phenmedipham	x	x	x	x												

Post-sowing Treatments

These were chloramben 4 lb, dinoseb-acetate 2 lb and monolinuron 1 lb. Any of these treatments usually gave adequate control of fathen. A wider range of results was obtained against black nightshade and, on the whole, dinoseb-acetate was best. On much less evidence, chloramben may be preferred when redroot is likely to be a problem.

○ *Amaranthus retroflexus* ● *Chenopodium album* ◐ *Solanum nigrum*

FIG. 1: Major weeds surviving most promising treatments in all trials, 1967-70

Concerning other weeds not included in Fig. 1, all three chemicals have given good control of twin cress (*Coronopus didymus*) spurrey and wild portulaca. Scotch thistle was susceptible to dinoseb-acetate and monolinuron but resistant to chloramben.

It is clear that appreciably better results are obtained when any two of these three herbicides are applied together. In particular, black nightshade has been effectively controlled by mixtures of dinoseb-acetate with either chloramben or monolinuron.

Early damage symptoms of two kinds have been noted (see Table 2). After monolinuron treatment, the first (monofoliate) leaves have occasionally become chlorotic and, as growth continues, this has developed into necrosis and premature dropping of these leaves after the first trifoliate leaves have expanded. Although the affected plant is checked in growth, in none of the experiments has this had any long lasting effect on eventual development of the crop.

Occasionally distorted growth has occurred after chloramben and, once, after EPTC application. Typically, the leaves have a puckered and slightly cupped appearance.

Instances of damage have occurred mainly in two experiments, Nos. Y818 and Y819, which were carried out in 1970 in Hawke's Bay. In both cases the trials were established in mid-December under warm, wet seed-bed conditions.

These two experiments, and also No. Y708 carried out the previous year in Levin, provided the most comprehensive yield data and these are presented in Table 3. In Expt. Y819 only, a depression due to chloramben was significant after a pre-sowing application of trifluralin, almost so after EPTC, but did not occur without a pre-sowing treatment. Trifluralin, EPTC, monolinuron or dinoseb-acetate showed no significant effects among themselves. Bean samples from each chemical treatment were taken from the Hawke's Bay trials at harvest time and these were snipped, blanched and frozen according to the processor's usual practice. Tasting panels failed to detect any consistent off-flavour in the cooked produce which would be ascribed to a herbicide treatment.

TABLE 2: FREQUENCY OF DAMAGE SYMPTOMS NOTED IN EXPERIMENTS, FROM ASSESSMENTS MADE AT THE FIRST TRIFOLIATE LEAF STAGE

					<i>No. of Expts. Containing Treatment</i>	<i>No. of Expts. where Treatment Caused (a) Scorch (b) Distortion</i>	
trifluralin	....	....	....	....	4		
nitralin	....	....	....	....	4		
EPTC	....	....	....	....	3		1
monolinuron	....	....	....	....	10	2	
dinoseb-acetate	....	....	....	....	11		
chloramben	....	....	....	....	9		1
monolinuron + dinoseb-acetate	....	....	....	....	8		
monolinuron + chloramben	....	....	....	....	6	2	1
chloramben + dinoseb-acetate	....	....	....	....	8		1

TABLE 3: GREEN BEAN YIELDS IN THREE EXPERIMENTS (tons/acre of pods)

		<i>Experiment Number</i>						
		Y708	Y818		Y819			
Pre-sowing treatment	nil	nil	Trifluralin	EPTC	nil	Trifluralin	EPTC	
Post-sowing treatment								
Control, hoed	6.6	6.5	6.0	6.3	6.1	6.9	7.2	
monolinuron	6.7	6.5	6.3	6.3	6.5	7.3	7.3	
chloramben	6.7	6.5	6.9	6.6	7.2	5.6	6.5	
monolinuron + chloramben	7.1	6.2	6.5	6.7	6.7	6.1	6.9	
dinoseb-acetate	6.4	6.8	6.8	6.7	7.3	6.9	7.6	
monolinuron + dinoseb-acetate	6.6	6.3	6.4	6.5	6.8	8.4	7.7	
chloramben + dinoseb-acetate	6.9	6.4	6.6	6.7	6.3	6.7	7.5	
Sig. diff.	n.s.	n.s.	n.s.	n.s.	n.s.	1.7	n.s.	
CV	7.8%		11.7%			17.0%		

DISCUSSION

The most important conclusion which can be drawn from this work is that none of the materials at present available are likely to be sufficient in themselves. It is also clear that, if combinations are considered, there is a choice of several herbicide programmes which are likely to be effective. Recent experimentation in the United Kingdom has been reported by various authors in the *Proceedings* of the 8th and 9th British Weed Control Conference and advice to the grower following this work (Roberts, 1969) favours a mixture of monolinuron with dinoseb-acetate. We can tentatively add other possibilities likely to give as good control of our major weeds, particularly chloramben plus dinoseb-acetate when black nightshade is present. The use of chloramben to follow up a pre-sowing treatment should be treated cautiously as in one experiment such a combination reduced final yield.

The weaknesses of the pre-sowing herbicides are that they do not control solanaceous or cruciferous weeds. They are effective against germinating grasses, however, and trifluralin in particular has given good results against redroot. EPTC and nitratin showed no advantages over trifluralin against the weeds encountered but more experience of EPTC is required.

Post-sowing, the limitation of the short-lived dinoseb-acetate must be set against its effectiveness against early germinating black nightshade. Monolinuron, although having a longer life, may not work under dry conditions. Chloramben is readily leached in wet soil, but in our experience has controlled redroot well. Other experience suggests that the granular formulation can give more reliable results against other species.

A weed control programme in beans usually should include a pre-sowing treatment, even when some resistant weeds are expected. The task of the following post-sowing treatment, which may encounter difficult soil conditions, is then reduced as much as possible with a consequently better chance of overall success.

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REFERENCE

Roberts, H. A., 1969: *Grower*, 72 (1): 11-12.