Vegetable Crops

EVALUATION OF HERBICIDES FOR DIRECT-SEEDED TOMATOES

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Summary

Eleven trials were conducted over three seasons to determine weed control efficacy and crop response to herbicide treatments in direct-seeded tomatoes. Pre-sowing incorporated treatments providing the best weed control with safety in the crop were U-27-267, napropamide, pebulate, napropamide plus pebulate and trifluralin plus diphenamid. Pendimethalin plus napropamide and mixtures of sulfallate with napropamide or isopropalin gave some control of black nightshade (*Solanum nigrum* complex), but reduced crop vigour during unfavourable growing conditions. Pre-emergence metribuzin was very damaging in some trials, but post-emergence applications at the four to six leaf stage were well tolerated.

INTRODUCTION

With developments in machine harvest of process tomatoes there has been a rapid increase in the area of this crop established by direct seeding. Approximately 380 ha of tomatoes were direct-seeded for the six mechanical harvesters operating in Hawkes Bay and Gisborne during the 1976/77 season.

Cultural practices, among them weed control, play a very important role in obtaining the required uniformity of maturity for successful machine harvest. A wide spectrum of annual weeds often infest tomato crops both at crop emergence and throughout the growing season. Particularly troublesome are the solanaceous weeds, such as black nightshade (*Solanum nigrum* complex) and hairy nightshade (*Solanum sarachoides*).

In the absence of suitable herbicides growers have had to rely on mechanical and hand weeding control methods. These can be expensive and often damage the crop. The use of a 'stale-seedbed' with paraquat/diquat sprays applied just prior to crop emergence has successfully reduced early weed competition. More recently metribuzin has been registered for pre- and post-emergence use in direct-seeded tomatoes. However, it has caused unacceptable damage in some crops and has not gained widespread acceptance.

Extensive evaluations conducted in the U.S.A., such as those reported by the University of California (Fischer *et al* 1975; Orr 1976), have found a range of herbicides selective to direct-seeded tomatoes. In New Zealand, Cox (1971) reported on several herbicide treatments selective in this crop. More recently, Cox (1973) and E.G.R. Wallace (pers comm) have evaluated pre- and post-emergence applications of metribuzin.

Proc. 30th N.Z. Weed and Pest Control Conf.

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During the period 1974-77 11 trials were conducted in Hawkes Bay and Gisborne to evaluate a range of pre-sowing incorporated, pre-emergence and post-emergence herbicides.

EXPERIMENTAL

The trials were of randomised block design with four or five replications. Herbicides were applied with a modified Oxford precision sprayer to pre-formed beds (1.5 m centres). Soil incorporated treatments were applied 1-10 days prior to seeding and mixed into the top 7-10 cm of soil with power driven rotary bed formers. Single rows were seeded in the centre of the beds with commercial seeding units. Pre-emergence treatments sprayed within 6 days of seeding and post-emergence treatments were applied at the four to six leaf stage.

Weed control was assessed by sampling three 0.25 m² quadrats per plot. Black nightshade was present in all trials while the other principal weed species were redroot (*Amaranthus powellii*), fathen (*Chenopodium album* agg), barnyard grass (*Echinochloa crus-galli*), portulaca (*Portulaca oleracea*), speedwell (*Veronica arvensis*) and shepherd's purse (*Capsella bursa-pastoris*). Effects on the crop were assessed at the three leaf stage by counting plant numbers and scoring for vigour. All plots were then thinned to clumps (two or three plants per clump) 20 cm apart and hand-weeded. Yield information was obtained from selected trials by harvesting a 3-5 metre length of row from the centre of each plot when at least 80% of the fruit was in the breaker to red colour stage. Immature fruit was harvested separately to determine if any treatments affected crop maturity.

RESULTS

Herbicides Discarded After Early Evaluation

Those giving inadequate weed control

Sulfallate (4.5 kg/ha) incorporated) gave only poor and short-lived weed control. However, it did provide some control of black nightshade and in later trials was evaluated in combination with other herbicides (Table 1).

Diphenamid incorporated at 5.0 kg/ha gave poor control of barnyard grass and most broadleaf weeds. It was one of the few pre-sowing incorporated materials which controlled shepherd's purse and in later trials was evaluated in combination with other herbicides (Table 1).

Isopropalin (2.0 kg/ha incorporated) provided reasonable control of grasses and broadleaf weeds, but was discarded in favour of more promising alternatives.

Those not safe enough in the crop

Dinitramine incorporated at 0.6 kg/ha and methyl-N-(3,4-dichlorophenyl) carbamate (2.0 kg/ha) surface-applied pre-emergence severely reduced crop stand.

Chlorthal (9.0 kg/ha) and aziprotryne (1.5 kg/ha) applied post-emergence at the four leaf stage were too damaging.

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Herbicides Further Evaluated

It was evident in the early trials that a number of pre-sowing incorporated treatments were very well tolerated by direct-seeded tomatoes. Also, whilst metribuzin surface-applied pre-emergence and post-emergence damaged the crop in some earlier trials, they provided excellent broadleaf weed control and were considered worthy of further evaluation.

Table 1 lists weed susceptibilities to treatments and Table 2 summarises crop selectivity information.

Pre-sowing incorporated treatments

These treatments gave good control of redroot, fathen, barnyard grass, portulaca and speedwell. Only U-27-267 and trifluralin plus diphenamid controlled shepherd's purse.

Butralin provided the best control of black nightshade. Pendimethalin alone and in combination with napropamide and mixtures of sulfallate with napropamide or isopropalin had some useful effect on black nightshade. In extensive trials conducted by the University of California (Fischer *et al* 1975; Orr 1976) pebulate alone and in combination with napropamide have provided good control of black nightshade. However, in the work presented here these treatments provided only some initial suppression of this weed.

U-27-267, napropamide, pebulate, napropamide plus pebulate and trifluralin (half rate) plus diphenamid exhibited excellent selectivity in the crop. Trifluralin, pendimethalin and butralin considerably reduced crop stand and/or vigour. Pendimethalin and butralin did not reduce yields, but trifluralin reduced yield in one of four trials. The half rate of trifluralin used with pebulate, pendimethalin plus napropamide and mixtures of sulfallate with napropamide or isopropalin also reduced crop vigour but not yield.

Vigour reductions were minimised when there was a delay of five days or more between application and seeding and in later sowings when warmer soil temperatures and more favourable weather conditions allowed rapid emergence and seedling growth.

Surface-applied pre-emergence treatments

Metribuzin (0.18 and 0.35 kg/ha) provided excellent control of a wide range of broadleaf weeds including shepherd's purse. Control of black nightshade and barnyard grass was variable, depending on the rate used and weather conditions prevailing after application. Cool wet conditions generally gave better control.

In most trials although metribuzin reduced crop stands by up to 15%, crop vigour and yields were similar to the control. However, the 0.35 kg/ha rate reduced crop stands by up to 60% in the early season sowings where conditions were cool and wet following application. In two trials the yield of process grade fruit was significantly reduced. The 0.18 kg/ha rate was safer in the crop but reduced yield in one trial. Indications were that some of the yield reduction in these trials was caused by delayed fruit maturity.

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TABLE 1: Weed Susceptibilities

Treatment	Rate (kg/ha)	black nightshade	redroot	fathen	barnyard grass	portulaca	speedwell	shepherd's purse
trifluralin	0.8 pre-sow	R	S	S	S	S	S	R
pendimethalin	1.0 pre-sow	MR	S	S	S	S	S	R
butralin	2.2 pre-sow	MS	S	S	S	S	S	R
U-27 267	2.6 pre-sow	VR	S	S	S	S	S	S
pebulate	6.0 pre-sow	R	MS	MS	MS	S	S	R
napropamide	2.25 pre-sow	VR	S	S	S	S	S	MR
trifluralin	0.4 pre-sow	VR	S	S	MS	S	S	MS
+ diphenamid	5.0 pre-sow	VR	S	S	MS	S	S	MS
trifluralin	0.4 pre-sow	R	MS	MS	MS	S	S	R
+ pebulate	4.3 pre-sow	R	S	S	S	S	S	MR
napropamide	1.5 pre-sow	MR	MS	S	MS	MS	S	MR
+ pebulate	4.3 pre-sow	MR	S	S	S	S	S	MR
napropamide	1.5 pre-sow	MR	S	S	S	S	S	MR
+ sulfallate	4.5 pre-sow	MR	S	S	S	S	S	MR
napropamide	1.5 pre-sow	MR	S	S	S	S	S	MR
+ pendimethalin	1.0 pre-sow	MR	MS	MS	S	S	S	VR
isopropalin	1.7 pre-sow	MR	S	S	MS	S	S	S
+ sulfallate	4.5 pre-sow	R	S	S	MS	S	S	S
metribuzin	0.18 pre-em	MR	S	S	MS	S	S	S
metribuzin	0.35 pre-em	MR	S	S	MS	S	S	S
metribuzin	0.35 post-em	MR	S	S	MS	S	S	S

S — susceptible
 MR — moderately resistant, some useful effect
 MS — moderately susceptible
 R — resistant, minor reduction in numbers
 VR — very resistant

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TABLE 2: Crop Selectivity

Treatment	Rate (kg/ha)	Crop ¹ stand	Crop ² vigour	No. trials treatment yielded	No. trials yield significantly reduced below control
untreated		10.0	10.0	6	—
trifluralin	0.8 pre-sow	8.5	7.5	4	1
pendimethalin	1.0 pre-sow	8.0	7.5	4	0
butralin	2.2 pre-sow	9.0	8.0	1	0
U-27-267	2.6 pre-sow	10.0	9.5	4	0
pebulate	6.0 pre-sow	10.0	9.0	4	0
napropamide	2.25 pre-sow	10.0	10.0	4	0
trifluralin	0.4 pre-sow	10.0	9.0	4	0
+ diphenamid	5.0 pre-sow	10.0	9.0	4	0
trifluralin	0.4 pre-sow	9.5	8.5	1	0
+ pebulate	4.3 pre-sow	10.0	9.5	4	0
napropamide	1.5 pre-sow	9.5	8.5	2	0
+ pebulate	4.3 pre-sow	9.5	8.5	1	0
napropamide	1.5 pre-sow	9.5	8.5	2	0
+ sulfallate	4.5 pre-sow	9.5	8.5	1	0
napropamide	1.5 pre-sow	9.5	8.5	2	0
+ pendimethalin	1.0 pre-sow	9.5	8.5	6	1
isopropalin	1.7 pre-sow	9.5	8.5	6	2
+ sulfallate	4.5 pre-sow	9.5	8.5	6	1
metribuzin	0.18 pre-em	8.5-9.5 ³	7.0-10.0 ³	6	1
metribuzin	0.35 pre-em	5.0-8.5 ³	4.0-10.0 ³	6	2
metribuzin	0.35 post-em	10.0	7.5- 9.0 ³	6	1

1. Crop stand 0-10 scale based on seedling accounts

2. Crop vigour 0-10 scale based on visual ratings

3. Results varied considerably in different trials (see text).

0 = no stand

0 = plants dead

10 = stand equivalent to control

10 = vigour equivalent to control

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Post-emergence treatments

Metribuzin (0.35 kg/ha) controlled the same weeds susceptible to pre-emergence applications. The growth stage of both black nightshade and barnyard grass at application influenced the degree of control obtained. Control of these weeds was markedly reduced once they had developed past the two leaf stage.

Metribuzin reduced crop vigour in trials where applications were made to weak plants or during poor growing conditions. In one trial yield was significantly reduced. However, crop selectivity was very good when it was applied to vigorously growing plants after two or more days of fine warm weather. This parallels the work of Phatak and Stephenson (1973). They found, in growth chamber studies, greater damage evident on plants exposed to several days of low light as opposed to high light before metribuzin application indicating a possible relationship between available photosynthate reserves and crop tolerance.

In one trial crop selectivity was excellent when metribuzin application was delayed until the six leaf stage and where three applications of a reduced rate (0.18 kg/ha) were applied at 10-14 day intervals.

DISCUSSION

The prevalence of solanaceous weeds in Hawkes Bay and Gisborne means that complete chemical weed control in direct-seeded tomatoes is not possible at present. If control of these weeds is attempted with residual herbicides, there will be some risk to the crop. Use of a 'stale-seedbed' system has given good initial control of black nightshade in large scale trials.

A number of pre-sowing incorporated treatments exhibited excellent selectivity in the crop. Treatments which gave some control of black nightshade also damaged the crop, particularly when conditions did not allow rapid germination and seedling growth. Although yields were not significantly reduced in most trials, the young stunted plants are more prone to damage during subsequent mechanical operations. The results suggest that pendimethalin plus napropamide and mixtures of sulfallate with napropamide or isopropalin could be useful for later season sowings, especially when there is a delay of five or more days between application and seeding.

As tomatoes are a long season crop the longevity of weed control is important. Californian work (Orr 1976) documents the persistence of several herbicides tested in these trials. In both this information and the trials reported here napropamide and U-27-267 provided long term control of susceptible weeds while pebulate and sulfallate provided only four to six weeks control. As the latter two materials gave some control of black nightshade they would be most effective when used in combination with a longer-lived material. The longer lived materials should be band applied to prevent residues affecting subsequent susceptible crops.

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Pre-emergence metribuzin provided excellent control of broadleaf weeds but significant plant stand reductions suggest considerable risk associated with this method of application. Post-emergence applications were tolerated by vigorously growing seedlings in the four to six leaf stage and could be particularly effective when following a pre-sowing incorporated treatment.

ACKNOWLEDGEMENTS

To the growers who willingly provided trial sites and for the assistance given by G.K. Jenks and B.L. Mackintosh.

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