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PROTECTION OF TOMATOES FROM HERBICIDE INJURY BY PLUG-MIX PLANTING

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Summary

Plug-mix planting, particularly where activated carbon was included in the planting mixture, protected tomato (*Lycopersicon esculentum*) plants from herbicides effective against black nightshade (*Solanum nigrum*). Tomatoes planted in plug-mix with activated carbon withstood pre-emergence applications of metribuzin at 1.0 kg/ha, alachlor at 3.0 kg/ha and simazine at 1.0 kg/ha without reduction in plant numbers or yield, although alachlor reduced early crop vigour. Method of establishment had no effect on weed control.

INTRODUCTION

A number of herbicides are available for weed control in tomatoes (Cox 1978; Stevenson 1977), however some weed species still present difficulties. Of particular importance are the solanaceous weeds, principally black nightshade. Because of their taxonomic affinity, biochemical selectivity between these weeds and the crop is difficult to obtain.

Plug-mix planting consists of the precision placement of seed in a matrix of growing medium into planting sites in the field. The usual growing medium is a mixture of shredded peat and vermiculite, to which fertilizer and other ameliorants may be added. The method was developed for establishing tomatoes and other small-seeded crops in Florida, where it was used to assist establishment under adverse soil conditions (Hayslip 1974, 1979). More recently it has been used in California (Lange *et al* 1978) and Canada (Friesen and Marriage 1978).

The matrix of adsorptive organic material around the seeds provides protection to the establishing crop from soil incorporated or surface applied pre-emergence herbicides. Friesen and Marriage (1978) demonstrated that protection from surface applied materials could be increased by placing a layer of an activated carbon-vermiculite mixture over the plug. Protection from both surface applied and soil incorporated herbicides was enhanced by including activated carbon in the plug mix (Ashton *et al* 1978; Lange *et al* 1978). This extra protection permitted the use of herbicide treatments which were phytotoxic to drill sown tomatoes.

The experiment described in this paper was carried out to test, under New Zealand conditions, the feasibility of using plug-mix planting to protect tomatoes from herbicide treatments known to control black nightshade. Three herbicides were selected. Metribuzin is tentatively recommended by Cox (1978) for pre-emergence use in tomatoes, although crop damage has been reported if adverse weather conditions follow application (Stevenson 1977). A small degree of protection to the crop would allow this herbicide to be used safely and it should give some control of black nightshade if rates could be increased. Alachlor is tentatively recommended as a post-emergence herbicide in tomatoes (Cox 1978) but is phytotoxic if used pre-emergence. It will control black nightshade pre-emergence, but not post-emergence. Simazine was included as a representative of the s-triazines and substituted ureas. These herbicides will control black nightshade when applied pre-emergence, but are not selective in tomatoes.

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Materials and Methods

The experiment was carried out at Levin Horticultural Research Centre on a Levin silt loam. It was laid down in a split plot design, with three establishment methods as main plots and seven herbicide treatments as sub-plots. Tomatoes (cv 'Castlong') were grown in single rows 1.5 m apart on raised beds. Sub-plots were single rows 6 m long.

Establishment methods:

1. Drill sown with a "Stanhay" seeder. Mean spacing between seeds was 4.1 cm.
2. Plug-mix planting. The plug-mix was made up of 23 litres peat, 23 litres vermiculite (Winstone Chemicals Grade 1), 350 g of 10:18:8 fertilizer and 15 g tomato seed. Sufficient water was added to make the mixture moist but free flowing.
3. Plug-mix plus activated carbon. To the above mix 2.8 litres of activated carbon was added.

Both plug-mix treatments were planted with a hand operated "plugger" based on the design of Hayslip (1979). Approximately 100 ml of loose mixture was used for each plug which resulted after compaction in a plug approximately 4.5 cm in diameter and 5 to 6 cm deep, with the top level with the soil surface. Plugs were spaced 30 cm apart.

Herbicide treatments (see Tables) were applied as pre-emergence sprays in 350 litres/ha 2 days after sowing was completed. Crop counts were taken over the whole of each sub-plot 4 weeks after sowing, and crop vigour was assessed visually 6 weeks after sowing. Weed counts were taken from two 30 cm x 30 cm quadrats per sub-plot 5 weeks after sowing. The weed population comprised principally black nightshade, twin cress (*Coronopus didymus*), Shepherd's purse (*Capsella bursa-pastoris*), willow weed (*Polygonum persicaria*), poa annua (*Poa annua*), spurrey (*Spergula arvensis*) and fat hen (*Chenopodium album*). All the above species were counted individually, but results for only black nightshade and total weeds are presented.

Six weeks after sowing all plots were cultivated and thereafter kept weed-free by hand weeding. At the same time the tomato plants were thinned to a minimum of 25 cm apart in the drill-sown plots, and a maximum of three plants per plug in the plug-mix planted treatments.

The crop was treated with chlorethephon 123 days after sowing to promote ripening, and harvested 12 days later. Weights of factory grade (coloured), green and rotten fruit were recorded from the centre 2.5 m of each sub-plot.

TABLE 1: Tomato plant populations and vigour 6 weeks after planting as affected by method of establishment and herbicide treatment

Herbicide	Rate (kg/ha)	Drill sown		Plug mix		Plug-mix + activated C	
		No/m row	Vigour*	No/m row	Vigour	No/m row	Vigour
metribuzin	0.5	3.9	2.3	16.9	5.8	13.5	6.8
metribuzin	1.0	0.5	0.5	4.5	2.5	10.6	6.5
alachlor	1.5	2.5	0.8	14.8	4.3	15.3	4.0
alachlor	3.0	0.3	0.0	5.0	2.0	10.9	3.0
simazine	0.5	3.4	0.5	6.0	2.8	14.8	6.8
simazine	1.0	0.0	0.0	0.0	0.1	13.4	5.5
nil		13.0	3.3	20.7	7.8	14.2	7.5

MSD plant number (P = 0.05) 6.00

* Crop Vigour 0 = dead 10 = healthy

RESULTS

Populations of drill sown tomato plants were significantly reduced by all

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herbicide treatments (Table 1). Plug-mix sown plants received some protection, but all treatments except the lower rates of metribuzin and alachlor caused significant reductions in plant stand. In the plug-mix plus activated carbon treatments no herbicide application caused a significant reduction in plant stand. Crop vigour ratings (Table 1) show, however, that plant growth was retarded by the alachlor treatments.

Black nightshade and total weed numbers (Table 2) were not significantly affected by crop establishment methods, so only herbicide treatment means are presented. Black nightshade numbers were significantly reduced by all herbicide rates except the lower metribuzin rate. Total weed numbers were reduced by all herbicide treatments, however, control obtained with the lower alachlor rate was significantly inferior to that achieved by all other herbicide treatments. The higher rates of all herbicides gave weed control significantly superior to the lower rates.

TABLE 2: Populations of black nightshade and total weeds (plants/m²) as affected by herbicide treatments.

Herbicide	Rate (kg/ha)	Black nightshade	total weeds
metribuzin	0.5	29.2	38.4
metribuzin	1.0	6.0	6.9
alachlor	1.5	11.1	72.2
alachlor	3.0	1.4	23.6
simazine	0.5	16.7	34.7
simazine	1.0	4.2	7.4
nil	-	45.4	292.1
MSD (P = 0.05)		17.9	25.6

All herbicide treatments except the lower rate of metribuzin significantly reduced both total and factory grade yield of drill sown tomatoes (Table 3). Factory grade yield of plug-mix planted tomatoes was significantly reduced by the higher rates of metribuzin and alachlor, and by both rates of simazine. Total yield was significantly reduced by the higher rates of alachlor and simazine only. No treatment significantly reduced the total yield in the plug-mix plus activated carbon treatment, however, the higher rate of alachlor reduced the factory grade yield.

A maturity index was derived by expressing the weight of factory grade fruit as a fraction of the sum of factory grade plus green fruit. The amount of rotten fruit was small and not significantly affected by treatment, and could be disregarded. Analysis of the maturity index indicated that maturity was significantly delayed by all herbicide treatments in the drill sown crop, by all treatments except the lower rates of metribuzin and alachlor in the plug-mix treatment, but by no treatment in the plug-mix plus activated carbon treatment.

TABLE 3: Yield of factory grade tomatoes and total yield, in parenthesis, as affected by establishment method and herbicide treatment (tonnes/ha).

Herbicide	Rate (kg/ha)	Drill sown	Plug-mix	Plug-mix + activated C
metribuzin	0.5	7.9 (19.6)	28.5 (47.5)	27.1 (44.2)
metribuzin	1.0	0.0 (0.0)	13.1 (31.3)	26.7 (53.4)
alachlor	1.5	0.1 (0.3)	22.0 (42.5)	20.4 (37.7)
alachlor	3.0	0.0 (0.0)	7.4 (19.3)	12.3 (25.1)
simazine	0.5	1.1 (2.6)	10.6 (27.3)	28.5 (51.1)
simazine	1.0	0.0 (0.0)	0.6 (2.8)	22.9 (48.7)
nil		16.5 (29.7)	29.2 (42.9)	26.2 (41.0)

MSD (P = 0.05) 11.05 (17.02)

DISCUSSION

Plug-mix planting, particularly where activated carbon was included in the plug, provided significant protection against the herbicides tested. It appears to be a technique with considerable potential for manipulating the selectivity of herbicides. This method has advantages over previously used methods of protection. It provides a larger zone of protection than carbon coating of seed, with a resultant longer period of protection. Unlike surface-applied carbon strips, it protects few in-row weeds, and can be used with soil-incorporated herbicides.

Protection against alachlor was poorer than against the two triazine herbicides. Ashton *et al* (1978), however, found that plug-mix with activated carbon gave protection against alachlor at rates twice that used in the current experiment. In their experiment the herbicide was incorporated into the soil before planting, whereas in this experiment application was to the soil surface after planting. This difference may produce significant variation in protection from a herbicide such as alachlor which is taken up principally by stem tissue, and is active in the vapour phase (Cox 1974).

Plug-mix planting provided greatly increased herbicide selectivity, allowing the use of herbicides which would otherwise damage the crop. The technique may present a solution to the problem of weeds which are resistant to herbicides normally considered selective in tomatoes. Although this experiment was not designed to test other agronomic advantages of plug-mix planting there are consistent indications that the technique may lead to better crop growth and higher yields of earlier maturing fruit.

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