BENOMYL FOLIAR SPRAYS FOR CONTROL OF *SCLEROTINIA* AND *CLADOSPORIUM* IN TOMATOES

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Summary

Benomyl, applied as a foliar spray on Scoresby dwarf tomatoes, was effective in reducing infections caused by either one, or both, the fungi, *Sclerotinia minor* and *S. sclerotiorum*. Treated tomatoes produced higher yields in several trials. Benomyl at 1.0 lb applied 4 times at intervals of 10 to 18 days, and commencing within 10 days of transplanting, is the programme suggested to growers for control of *Sclerotinia* in tomatoes. Benomyl at 0.5 lb significantly reduced *Cladosporium* leaf mould.

INTRODUCTION

SCLEROTINIA DISEASE of dwarf tomatoes, varieties Scoresby and Stonor, consistently causes spectacular crop losses in Hawke's Bay in crops grown for processing factories. The disease is caused by either one or both of two fungi, *Sclerotinia minor* and *S. sclerotiorum* (sometimes referred to as "major"). Losses of up to 40% of plants have been recorded (Horticultural Division, Hastings, 1969) but, until the advent of a therapeutant which gave a high degree of disease control, it was not realized that losses of up to 16.6 tons per acre canning grade may occur on occasion (Corbin, 1970). District losses in Hawke's Bay range from \$25,000 in 1966-67 season (Brandon, 1968) to \$42,500 in 1969-70 and considerably higher again in the 1970-1 season on our assessments. The disease has long been recognized as important in tomatoes in New Zealand (Chamberlain, 1932) and responsible for the restriction in yield improvement in Hawke's Bay (Brandon, 1970). However, as recently as 1968 there was, in our opinion, no reliable control measure available, even including the use of fumigation and polythene or paper mulching.

In 1966, a new therapeutant, benomyl, was released for experimental use, and gave early promise for better control of *Sclerotinia* diseases. This paper reports data on its performance against New Zealand strains of the *Sclerotinia* fungi.

EXPERIMENTAL AND RESULTS

All studies reported were conducted on Scoresby variety of tomatoes with isolates of the *Sclerotinia* fungi from Hawke's Bay.

TABLE 1: MYCELIAL INVASION INDICES* FOR BENOMYL TREATMENTS IN THE GLASSHOUSE

(Data selected from Pennycook, 1970)

Treatment Rate (lb)	<i>S. sclerotiorum</i> Test 1	Test 1	<i>S. minor</i> 2	3
2.0	7 a	0 a	10 a	13 a
1.0	27 a	20 a	40 b	47 b
0.5	20 a	40 b	60 b	60 b
Water	70 b	77 b	90 c	97 c

*Invasion index: 0 = no growth from inoculum, 100 = collapse of all plants.

TABLE 2: *SCLEROTINIA MINOR* CONTROL BY BENOMYL

Benomyl at 1.0 lb, 150 gal/ac	Feb. 8	% Plants with <i>S. minor</i> Feb. 23	Mar. 22
15 Jan. only	10	34	88
15 Jan. + 9 Feb.	9	32	86
15 Jan., 9 Feb., 23 Feb.	8	28	93
Untreated	15	88	100

TABLE 3: TOMATO TRIAL, HASTINGS, 1969-70 SEASON

Treatment (lb)	Apothecia <i>S. sclerotiorum</i> per 50 sq.ft	% Plants Infected at Final Harvest Date <i>S. sclerotiorum</i>	% Plants Infected at Final Harvest Date <i>S. minor</i>	Canning Yield (tons/ac)
benomyl 1.0	10.2 b	15	10	30.7 a
benomyl 0.5	18.5 b	26	32	26.7 b
dicloran 2.0	6.4 a	50	54	23.0 b
dicloran 1.0	16.0 b	56	78	22.8 b
Untreated	12.6 b	67	70	18.0 c

TABLE 4: TOMATO TRIAL, HB/104, HASTINGS 1970-71 SEASON

Treatment and Rate (lb)	<i>Sclerotinia</i> spp. incidence				<i>Cladosporium</i> Leaf Mould
	Main Leader		% Plants Diseased		% Plants Infected
	Feb. 19	Mar. 16	Feb. 19	Mar. 16	Feb. 26
dichlozoline 1.0	0.0	0.1	0.0	8	85.0
benomyl 2.0	0.05	0.4	2.5	30	0.0
benomyl 1.0					
+ Surfactant*	0.15	1.0	15.0	54	2.5
benomyl 1.0	0.15	1.7	15.0	63	5.0
benomyl 0.5	0.9	2.8	40.0	93	17.5
Control	1.8	5.0	67.5	100	70.0

*Surfactant added at rate 4 oz/100 gal.

A series of glasshouse trials were conducted (Pennycook, 1970; Corbin, 1971) in which foliar sprays were applied to deached leaves. Table 1 presents the data from these tests (all rates are lb active ingredient per acre equivalent of sprayed leaf surface).

Data suggest that high rates of benomyl are required to prevent *Sclerotinia* activity but that even low rates greatly reduced activity in some tests. In the 1968-9 season foliar applications of benomyl were made in a randomized 4-replicate trial at Hastings. Plots were 3 rows wide $\times$ 30 ft. The sprayed areas were observed regularly and no harvesting was done of these areas. The grower's harvest was spread over 7 picks between January 23 and March 18.

Data in Table 2 suggest that the first spray applied had a marked effect in reducing *Sclerotinia minor* for up to 5 weeks after application. The percentage of infected plants in sprayed areas at final harvest was similar to unsprayed but the intensity of infection (number of main leader equivalents diseased) was considerably less on inspection.

In the 1969-70 season, a randomized 6-replicate, 4-treatment trial was conducted using benomyl and dicloran, each at two rates applied with the grower's commercial spray rig at 300 lb/sq.in. First application was within 10 days of transplanting. Seven applications were made at 11 to 19 day intervals between November 5 1969 and January 31, 1970. Application ranged from 40 to 240 gal/ac over the season. Therapeutant concentration was adjusted to apply a constant rate of active ingredient per planted acre at each application. Higher rates with both chemicals were obtained by double spraying. Dicloran treatments were discontinued after two applications because of phytotoxicity and thereafter these plots were unsprayed. All replicate plots were harvested over a 7-pick harvest period between January 12 and March 5, 1970. Trial data are given in Table 3.

Benomyl gave high disease control with accompanying increased yields. Notwithstanding the cost of application of 7 sprays plus added harvesting costs for the increased tonnage, the net marginal profit of this treatment exceeded \$150 per acre. Benomyl and dicloran reduced *Sclerotinia* incidence, but only dicloran at the higher rates reduced apothecial emergence. *Cladosporium fulvum* (leaf mould) became prevalent in dicloran and untreated areas late in the season.

In the 1970-1 season, two trials with foliar sprays were established in the same field at Hastings. Scoresby tomato seedlings were transplanted on November 24, 1970. Plots were 3 rows $\times$ 10 plants and treatments replicated 4 times. Four sprays were applied between December 4, 1970 and January 9, 1971 at 8 to 16 day intervals. Therapeutants were applied with a knapsack sprayer and hand lance. Harvesting of trial No. HB/204 (Table 5) commenced 14 days after the last application and 6 picks were made between February 12 and April 6, 1971. Drought conditions, late blight *Phytophthora infestans* and *Cladosporium* leaf mould affected the trial area.

Results in Tables 4 and 5 show that the number of plants infected with *Sclerotinia* fungi (both species) continued to increase in proportion to the time interval that had elapsed since the last spray. Also the higher the rate of application of benomyl the lower the incidence of *Sclerotinia*. All rates of benomyl reduced *Cladosporium* leaf mould.

In the control of *Sclerotinia*, dichlozoline was effective while triarimol and dicloran were unsatisfactory. All three therapeutants failed to control *Cladosporium* leaf mould.

TABLE 5: TOMATO TRIAL, HB/204, HASTINGS 1970-71 SEASON

Treatment and Rate (lb)	Sclerotinia spp. incidence				Cladosporium	
	Main Leader		% Plants		Leaf Mould	Canning
	Equivalents	Diseased	Diseased	Diseased	% Plants	Yield
	Feb. 19	Mar. 16	Feb. 19	Mar. 16	Feb. 26	(tons/ac)
*benomyl 2.0	0.0	0.8	0.0	50	0	17.2 a
*benomyl 1.0	0.2	2.3	13.3	78	3	18.2 a
*benomyl 0.5	0.4	7.2	23.0	100	9	14.9 ab
dicloran 0.5	1.5	5.7	54.8	100	90	13.4 bc
triarimol 0.08	1.5	6.3	67.5	100	89	13.2 bc
Control	1.8	7.2	70.5	100	95	11.2 c

*All with surfactant added at 4 oz/100 gal.

DISCUSSION

The past four seasons were of variable character in Hawke's Bay over the period when these trials were conducted. Weather patterns fluctuated from drought to near flood rains, and complex problems arose from blossom-end rot (a physiological condition), leaf mould caused by a fungus (*Cladosporium fulvum*) and *Verticillium*. These considerably confused the evaluation of *Sclerotinia* control with newer therapeutants in dwarf tomatoes except in one trial (Table 3). An appreciation of the complexity of conducting tomato trials can be obtained from recent work at Levin (Tate, 1970) in which *Sclerotinia* and *Cladosporium* were not present but several other fungi and bacterial diseases were.

The above reports, together with others (Corbin and Woon, 1970; Eade and Corbin, 1970; Rainbow, 1970; Eade, 1970), show that benomyl is effective in reducing *Sclerotinia* infections in Hawke's Bay. Sometimes it significantly increases yield (Eade and Corbin, 1970; Eade, 1971; and Tables 3 and 5) and other times it significantly decreases apical emergence (Corbin and Woon, 1970). It is quite superior to dicloran (Table 5; Eade 1970) and to quitozene (Eade and Corbin, 1970; Corbin, 1971), and is non-damaging to tomato plants.

FIG. 1: Trial No. HB/104 taken on March 16, 1971. Benomyl treated tomatoes on right side with absence of *Sclerotinia* (white laterals) and *Cladosporium* (blight leaves) present in untreated areas on left-hand side.

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