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CONTROL OF BROWN ROT AND TRANSIT ROT OF PEACHES WITH POST-HARVEST FUNGICIDAL DIPS

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SUMMARY

In 17 trials conducted between 1972 and 1977 in the Granite Belt fruit growing area near Stanthorpe in south-eastern Queensland, benomyl, carbendazim, iprodione, triforine and A6770 were the most effective of the fungicides applied as post-harvest dips for the control of brown rot (*Monilinia fructicola*) of peaches. Transit rot (*Rhizopus stolonifer*) was controlled by dicloran, A6770 and to a lesser extent iprodione.

As a result of these trials dips containing benomyl or carbendazim (250 mg l^{-1}) and dicloran (400 mg l^{-1}) have been used commercially in the Granite Belt since 1973, iprodione (500 mg l^{-1}) since 1977 and triforine (250 mg l^{-1}) plus dicloran (400 mg l^{-1}) since 1978.

I. INTRODUCTION

Brown rot (*Monilinia fructicola* (Wint.) Honey) is a more serious post-harvest disease of peaches in the Granite Belt than in other peach growing areas of Australia which have lower rainfall in mid-summer when fruit is ripening. Transit rot (*Rhizopus stolonifer* (Fhrenb. ex Fr.) Lind.) develops during the subsequent marketing of the fruit and often causes serious additional losses.

Wade and Gipps (1973) found that benomyl at 800 mg l^{-1} was very effective for control of post-harvest brown rot in New South Wales. This rate of benomyl was subsequently reduced to 500 mg l^{-1} by Koffman and Kable (1975) based on experimental testing at 600 to 1200 mg l^{-1}. The addition of dicloran at 400 mg l^{-1} was also found by Wade and Gipps to be very effective for control of transit rot.

The aims of this work were to test a range of fungicides, to develop satisfactory control measures, and to establish whether lower rates of some of the fungicides used in other states were effective.

II. MATERIALS AND METHODS

The fungicides used in these experiments were benomyl, captan, carbendazim, chlorothalonil, dicloran, diphenylamine, folpet, iprodione, sodium hypochlorite, sodium salicylanilide, thiabendazole, thiophanate methyl, triforine and vinclozolin.

Experimental fungicides used were A6770 (N-(3, 5-dichlorophenyl) succinimide), A9085 (O, O-diethyl 2-[(3'-methoxycarbonyl)-thioureido]-phosphoramidothioate), CGA 38140 (methyl-N-(2, 6-dimethyl-phenyl)-N-furoyl-(2)-alinate), Dowco 269 (2-chloro-6-methoxy-4-(trichloromethyl) pyridine), DS 9073 and PP 073 (polymeric hexamethylene diguanide hydrochloride formulations), S 7131 (N-(3^1, 5^1-dichlorophenyl) 1, 2-dimethyl cyclopropane-1, 2-dicarboximide), SN 41073 (N-(3-dimethylamino-propyl) thiocarbamic acid-S-ethylester-hydrochloride).

Firm ripe peaches of the cvs. Starking Delicious, Halehaven, Elberta, Golden Queen, Kakamus and Glenalton were used.

In the brown rot experiments, wounded or unwounded fruits were immersed in spore suspensions of *M. fructicola* (2·5 to 10 x 10^3 conidia per ml) prepared by washing diseased peaches inoculated in the laboratory, or collected in orchards. Wounds were inflicted with a pin or sharpened bodkin (Fripp and Dettman 1969) to a depth of 1 to 2 mm or with an electrically powered twist drill (9-mm diameter) to a depth of 2 mm. The latter method provided a standard severe injury designed to simulate the type of damage sometimes encountered in peaches grown in the Granite Belt. The peaches were dipped for 10 to 20 minutes in the spore suspension, removed and kept at ambient temperature for 16 to 18 h, and then dipped in freshly prepared fungicide suspensions.

In the transit rot experiments the peaches were similarly wounded prior to inoculation in suspensions containing 5 to 40 x 10^3 conidia per ml of *R. stolonifer* washed from peaches previously inoculated in the laboratory. In trial 6 the storage time before treatment was reduced to 3 h for two treatments to examine the effect of shorter incubation time on the efficacy of the treatments.

In each of the 17 experiments, after fungicidal dipping for 60 s, the peaches were packed in experimental units of 18 to 31 peaches in disposable plastic trays, arranged in a randomized block design with four replicates. Diseased fruit were counted daily for 5 to 15 days for brown rot and 3 to 8 days for transit rot.

III. RESULTS

Brown rot control

Brown rot was controlled by any of the following fungicides at the rate(s) stated; benomyl (250 or 500 mg l^{-1}), carbendazim (250 or 500 mg l^{-1}), thiophanate methyl (700 mg l^{-1}), iprodione (500 or 1000 mg l^{-1}), triforine (70 to 190 mg l^{-1}), vinclozolin (1000 mg l^{-1}), A6770 (250 or 500 mg l^{-1}) and A9085 (500 mg l^{-1}). Captan, chlorothalonil, S7131 and dicloran were unsatisfactory (table 1).

Transit rot control

Of the 14 fungicides tested only dicloran (400 to 1000 mg l^{-1}), A6770 (250 mg l^{-1}) and iprodione (1000 mg l^{-1}) were very effective (table 2).

Captan, folpet, sodium hypochlorite, sodium salicylanilide and PP073 were not satisfactory. Chlorothalonil, and SN41073 (500 to 1000 mg l^{-1}) in an additional trial were completely ineffective.

TABLE 1

Brown Rot of Peaches After Chemical Dips

Chemicals	Treatment (mg l⁻¹)	Brown Rot (%)						
		Elberta Trial 1	Elberta Trial 2	Elberta Trial 3	Golden Queen Trial 4	Starking Delicious Trial 5	Golden Queen Trial 6	Starking Delicious Trial 7
A6770	250	..	1·0 a	..	..	..	..	..
A6770	500	4·6 a	0·2 a	..	..	..	..	..
A9085	500	20·2 b	..	..	..	..	..	..
benomyl	250	20·0 b	5·4 ab	0·0	17·1 bc	..	16·6 b	..
benomyl	500	..	3·3 a	..	1·1 a	..	..	26·9 bc
benomyl + dicloran	250 + 400	..	..	1·7	6·1 a	..	..	11·6 b
captan	1 000	..	..	..	..	..	95·0 d	..
carbendazim	250	..	..	..	12·7 ab	7·0 a	..	..
carbendazim	500	..	..	..	13·7 ab	3·9 a	..	..
carbendazim + dicloran	250 + 400	..	..	..	5·1 a	..	..	..
chlorothalonil	1 000	..	..	..	..	..	99·1 d	..
diphenylamine	2 000	..	15·0 bc	..	..	..	..	..
iprodione	500	..	..	..	3·5 a	28·4 b	1·8 a	4·4 a
iprodione	1 000	..	..	..	0·8 a	..	..	..
S7131	250	..	..	..	..	90·1 c	63·9 c	..
thiabendazole	680	30·7 b	..	..	..	..	..	..
thiophanate methyl	700	..	18·1 c	..	..	..	..	..
triforine	70	..	..	..	..	4·0 a	..	..
triforine	150	..	..	..	..	0·7 a	0·7 a	..
triforine	190	..	..	..	..	..	..	1·5 a
triforine	250	19·4 b	0·9 a	0·0	..	..	..	..
triforine + dicloran	250 + 400	..	..	1·8	..	..	..	..
vinclozolin	500	..	..	..	..	..	..	31·5 c
vinclozolin	1 000	..	..	..	..	..	..	16·6 b
water	..	..	..	94·9	89·1 d	95·5 c	..	99·7 d
water + Agral surfactant	280	98·4 c	83·5 d	94·7	..	..	..	..

Arcsin transformation used for analysis. Figures in the one column having the same postscript do not differ at P = 0·05. Trial 3 was not analysed as statistical analysis was unnecessary.

TABLE 2

TRANSIT ROT OF PEACHES AFTER CHEMICAL DIPS

Chemicals	Treatment (mg l⁻¹)	Transit Rot (%)								
		Kakamus Trial 1	Golden Queen Trial 2	Kakamus Trial 3	Elberta Trial 4	Halehaven Trial 5	Glenalton Trial 6	Elberta Trial 7	Elberta Trial 8	Golden Queen Trial 9
A6770	125	..	..	24·0 c	..	..	..	..	..	..
A6770	250	..	0·0	0·5 a	5·6 a	3·8 a	..	..	..	..
A9085	500	..	..	99·8 e	..	..	..	..	..	..
CGA38140	500	..	..	..	..	..	..	..	..	98·6 c
captan	1 000	44·2 a	..	92·4 d	..	..	..	..	..	..
chlorothalonil	940	85·6 b	..	..	..	..	..	..	..	..
chlorothalonil	1 125	..	87·8 b	..	..	..	..	..	..	..
dicloran	400	..	0·0	7·4 b	8·8 a	0·6 a	7·4 a	22·8 a	9·0 b	35·8 ab
dicloran	600	..	..	..	..	..	..	..	1·0 a	24·0 a
dicloran	1 000	0·0	..	..	..	..	..	..	..	..
Dowco 269	250	..	..	..	..	99·7 c	..	..	..	..
DS9073	500	..	..	..	91·3 b	..	..	..	..	..
DS9073	1 000	..	..	..	93·4 b	..	..	..	..	..
folpet	1 000	..	66·5 a	..	..	..	..	..	..	..
iprodione	500	..	..	..	..	..	..	62·1 bc	18·0 b	59·0 b
iprodione	1 000	..	..	..	..	..	..	44·0 ab	28·9 c	49·0 ab
iprodione	1 500	..	..	..	..	..	..	33·6 a	17·1 b	..
iprodione	2 000	..	..	..	..	..	..	22·5 a	..	..
iprodione + sodium hypochlorite	500 + 1 000	..	..	..	..	..	..	..	..	49·7 ab
PP073	250	..	..	..	..	97·7 c	..	..	..	..
PP073	500	..	..	..	..	95·0 c	..	..	..	..
PP073	1 000	..	..	..	..	70·4 b	98·1 c	..	..	..
PP073	2 000	..	..	..	..	..	99·0 c	..	..	..
PP073—3 hrs after inoculation	1 000	..	..	..	..	..	73·3 b	..	..	..
PP073—3 hrs after inoculation	2 000	..	..	..	..	..	68·0 b	..	..	..
sodium hypochlorite	1 000	..	..	..	..	..	..	..	..	90·5 b
sodium hypochlorite	1 250	58·2 a	..	..	..	..	..	..	..	..
sodium salicylanilide	4 900	47·4 a	..	..	..	..	..	..	..	..
thiabendazole	1 000	..	100·0 c	..	..	..	..	..	..	..
triforine	250	..	..	99·8 e	..	..	..	..	..	..
triforine	500	..	..	..	100·0 c	..	..	..	..	..
water	..	..	..	..	..	99·4 c	99·0 c	95·4 d	79·6 d	99·7 c
water + Agral surfactant	280	96·4 c	99·1 c	99·8 e	97·6 c	..	95·3 c	..	..	..

Arcsin transformation used for analysis. Figures in the one column having the same postscript do not differ at $P = 0{\cdot}05$. Zero values were not included in the statistical analysis.

IV. DISCUSSION

The results indicate that brown rot and transit rot can be controlled by dipping in iprodione on its own, or in a mixture of dicloran and any one of the fungicides benomyl, carbendazim or triforine. Although A6770 was very effective against both diseases it has been withdrawn because of health hazards. PP073, which gave some control of transit rot in trial 6 when the time between inoculation and dipping was reduced to 3 h may be of use for such control under less testing conditions.

Dips of benomyl or carbendazim (250 mg l^{-1}) plus dicloran (400 mg l^{-1}) have been used successfully in packing sheds in the Granite Belt since 1973, iprodione (500 mg l^{-1}) since 1977 and triforine (250 mg l^{-1}) plus dicloran (400 mg l^{-1}) since 1978.

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