CONTROL OF POSTHARVEST DISEASES OF AVOCADO

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SUMMARY

Postharvest dipping in prochloraz (250 mg/litre) provided good control of anthracnose in avocados. Field sprays of captafol, or of captafol and prochloraz, were less effective than dipping. Used in combination with dipping, these field sprays did not improve the control obtained by dipping alone. Field sprays of a copper fungicide were ineffective. Up to 30% of the ripened fruits of cv. Hass were affected with an internal browning and excessive softening. *Botryosphaeria parva* was isolated regularly from the affected tissues. Neither the field sprays nor the post-harvest dip reduced the incidence of the browning and softening.

INTRODUCTION

Until recently post-harvest rots of avocado fruit were of little economic significance in New Zealand crops. However the 1984-85 cv. Hass crop was severely affected by anthracnose. The anthracnose pathogen has been reported as *Colletotrichum gloeosporioides* in the USA (Ahmed and Barmore 1980) and *Glomerella cingulata* in Australia (Muirhead *et al* 1982). In New Zealand some of the isolates have been identified as *G. cingulata* but the majority as *Colletotrichum acutatum* (unpublished). Whether the pathogens in New Zealand are different from those occurring overseas or whether different taxonomic opinions are involved is uncertain.

In this paper we describe laboratory and field trials to control anthracnose.

METHODS

Preliminary trials

These used fruit cv. Hass and cv. Macdonald taken from the DSIR Research Orchard, Te Puke. Some fruits were inoculated on the tree by placing foam pads (c 5 cm²) soaked in an inoculum of a *C. acutatum* spore suspension washed from diseased fruits. The pads were covered with plastic tape to prevent drying out and were removed after 3 days. Post-harvest inoculations and fungicide treatments were applied by completely immersing the fruits in a suspension of *C. acutatum* spores (10⁶/ml) or of fungicide in a 10 litre pail for c 1 min. After each dip the fruits were drained and air dried before further treatment or storage. Fruits were stored in paper bags and inspected at 2 day intervals. Each treatment consisted of four replications of five fruits each. Fruits were removed when disease was first detected or when fully ripe (c 2 days after full colour change).

Infection was assessed on an arbitrary scale (0-3) where:

- 0 = no symptoms
- 1 = 1-3 disease lesions (<10% surface area affected)
- 2 = 4-10 disease lesions (10-50%)
- 3 = 10 disease lesions (>50%)

Field trial

A group of 16 mature trees cv. Hass in a commercial orchard at Te Puna was divided into four blocks of four trees each. One tree in each block received no fungicide treatment pre-harvest; the other three were sprayed to run-off (c 15 litres/tree) with 2.4 g ai/litre captafol on 13 March 1985 using a hand-gun. One of these three trees in each block then received a follow-up application of 1.6 g ai/litre captafol on 11 September and another tree an application of 0.25 g ai/litre prochloraz on 12 December. A randomised block design was used when assigning the treatments to individual trees. In

Proc. 39th N.Z. Weed and Pest Control Conf.

addition one tree adjacent to each block that had been sprayed by the grower in March, September and December with copper hydroxide (1.0 g Cu equivalent/litre) was sampled at harvest.

Fruits (100 fruits/tree or such lesser number as were available) were harvested on 7 January. Half of the fruits were packed into typical marketing trays (c 20 fruits/tray). The remaining fruits were completely immersed in a drum containing 7.5 g prochloraz/30 litres for 1 minute, then drained, air dried and packed. The prochloraz dip was renewed after fruit harvested from each block had been treated.

Fruits were kept in a laboratory (ambient temperature c 23 °C) at Mt Albert Research Centre and inspected at 2 day intervals. Fruits were removed from the trays when diseased or fully ripe and the date of removal noted. The proportions of the surface area of each fruit affected by *C. acutatum* and *G. cingulata* were estimated and the numbers of fruits affected by premature softening and internal browning noted. Fungal isolates were made from representative samples showing internal browning.

Data were analysed by analysis of variance after arcsine and complementary log-log transformations for incidence and severity of fruit rots respectively.

RESULTS

Preliminary trials

Although fruits inoculated 3 months before harvest did not show disease symptoms when picked, disease severity in these fruits when ripe was greater than in uninoculated fruits. Prochloraz gave good control of fruit rots (Table 1). Imazalil and guazatine did not control fruit rots (Table 1).

TABLE 1: Amount of post-harvest rots in avocado fruits which had been inoculated, or not, with *Colletotrichum acutatum*, and dipped in fungicide at harvest.

Time of inoculation	Untreated (not dipped)	Fungicide ¹		
		prochloraz	imazalil	guazatine
		Disease mean score/fruit (>10 lesions = 3)		
3 months pre-harvest	2.6	1.1	2.7	2.3
at harvest	1.5	0.0	0.2	0.7
not inoculated	1.0	0.0	1.2	1.1
S.E.			(± 0.37)	

¹ all fungicides were tested at 250 mg ai/litre

Later work has confirmed the efficacy of prochloraz. Evidence suggests that optimum control is obtained by dipping fruit within 4 h of harvest (unpublished data).

Field trial

No disease symptoms were seen on the fruits at harvesting. However, fruit stalks frequently had necrotic rings just above the junction with the fruit.

Field sprays of captafol and prochloraz gave some control of *C. acutatum* ($P < 0.001$) (Table 2). The programme of copper sprays had no effect on disease. Prochloraz post-harvest dipping gave good control of *C. acutatum* irrespective of the incidence and severity of disease, as determined by that which developed in undipped fruit. Although disease severity on infected fruits was reduced overall by post-harvest dipping ($P < 0.001$), the extent of the reduction varied between fruits taken from different spray treatments (Table 2).

The incidence of *G. cingulata* was not affected by field sprays but was markedly reduced by the dipping treatment ($P < 0.001$). Disease severity on infected fruits was reduced overall by post-harvest dipping ($P < 0.001$).

Fruits from trees sprayed with captafol and prochloraz took slightly longer to ripen than fruits from untreated trees or trees sprayed with copper ($P < 0.01$). There was a marked delay in ripening of fruits dipped in prochloraz ($P < 0.001$).

TABLE 2: Amount of rot in avocado fruits after different programmes of field sprays and postharvest dips¹.

Field sprays ²	Dipped in prochloraz	Infected fruits (%)			Disease severity (%) ³		Healthy fruit (%)	Days to ripen
		<i>C.a</i> ⁴	<i>G.C</i>	<i>B.p</i>	<i>C.a</i>	<i>G.c</i>		
untreated	no	47	14	17	25	32	43	13.2
	yes	8	0	21	6	0	75	14.4
captafol March	no	33	9	27	23	29	53	13.5
	yes	12	1	30	22	5	61	15.2
captafol March and Sept.	no	22	11	16	23	18	62	13.7
	yes	11	6	26	8	5	69	14.6
captafol March prochloraz Dec	no	23	4	21	28	24	60	13.9
	yes	11	1	25	15	1	65	15.7
copper March	no	64	10	18	29	12	27	13.1
	yes	6	0	23	5	0	73	14.6
mean	no	38	9	20	25	23	49	13.5
	yes	10	2	25	11	2	69	14.9
P ⁵		<.001	<.001	0.12	<.001	<.001	<.001	<.001

Notes: ¹ values given are for untransformed means. Transformed data with statistical parameters available on request.

² application rates (g ai/litre): captafol - 2.4 (March), 1.6 (Sept); prochloraz sprays and dips - 0.25; copper - 1.0 Cu equivalent.

³ disease severity = % surface area affected, infected fruits only.

⁴ *C.a* = *Colletotrichum acutatum*; *G.c* = *Glomerella cingulata*; *B.p* = *Botryosphaeria parva*

⁵ probabilities are for differences between dipped and undipped fruits.

The major disease symptom in this trial was premature and uneven softening of the fruit and browning of the affected portions. Isolations taken from beneath the skin of the affected parts invariably yielded *Botryosphaeria parva* Pennycook and Samuels (anamorph: *Fusicoccum parvum*). Neither the field sprays nor the dipping treatments controlled this disease.

Residues of 0.12 mg/kg and 5.6 mg/kg captafol were detected on fruits sampled immediately before harvesting from the trees sprayed in March only and in both March and September respectively (P.J. Lawson Laboratories); 2.7 mg/kg prochloraz was detected on fruit from unsprayed trees sampled immediately after dipping and draining (Chemistry Division, DSIR).

DISCUSSION

Optimal control of anthracnose (both *C. acutatum* and *G. cingulata*) was obtained with the post-harvest prochloraz dipping treatment. Some control of anthracnose was also obtained by spraying the trees earlier in the season with captafol or with captafol and prochloraz but the level of control was less than that obtained by post-harvest dipping and did not improve the control obtained by dipping alone. Prochloraz has also been found to be effective in control of anthracnose in Australia (Muirhead *et al* 1982). Copper sprays did not control the disease, possibly because only three were applied whereas in Australia spraying at 14-28 day intervals throughout the season is considered to be optimal (Peterson and Inch 1980).

The high incident of *B. parva* was unexpected although it had been isolated occasionally before from soft dimples on fruits and from necrotic pedicel scars similar to those noticed in the field trial (unpublished). Inoculation tests have confirmed that *B. parva* is the pathogen responsible for the soft rot syndrome (unpublished). Subsequent surveys have shown that fruit with necrotic rings on the pedicels usually develop symptoms of *B. parva* on ripening, although this did not occur with fruit from one orchard, and at another orchard some fruits with apparently symptomless pedicels

developed the soft rot. *B. parva* is sensitive to prochloraz (unpublished) so it is possible that neither the field spray nor the dip were applied at the optimum time or to the site of infection to control it in this trial.

The economic importance of *Botryosphaeria* soft rot is uncertain. Although it caused considerable losses in the field trial and was found in other samples from the Te Puna area it has not been found in the DSIR Te Puke orchard nor in samples from Welcome Bay. The soft rot has not been reported as a problem on exported fruit.

Prochloraz residues were within the tolerances set by the Australian authorities (5 mg/kg) but the presence of captafol on the fruit is no longer acceptable.

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