EVALUATION OF A NEW CHEMICAL AND TWO BIOLOGICAL CONTROL AGENTS FOR POSTHARVEST ROT CONTROL IN AVOCADOS

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ABSTRACT

In 2006/07, several fungicides and biological control agents (BCAs) were screened in the laboratory against the five most common fungi that cause postharvest rots in avocado. Three of these products were selected for further evaluation in preliminary postharvest trials. The two BCAs included were *Bacillus subtilis* QST 713 (Serenade® Max) and *Serratia marcescens* HR42, an experimental HortResearch BCA. The fungicide boscalid/pyraclostrobin (Pristine®) was also tested. Postharvest application of Pristine® significantly reduced rots in fruit from the Far North and Whangarei harvested on 19 February and 5 March 2008, respectively, but was not effective when applied to fruit from Te Puke harvested on 20 March 2008. The two biological control agents were not effective in these trials.

Keywords: *biological control, boscalid/pyraclostrobin, Bacillus subtilis QST 713, Serratia marcescens HR42.*

INTRODUCTION

Postharvest solutions to control fruit rots need to be taken in the context of an integrated disease control strategy that begins in the orchard. If rot 'potential' can be reduced in the orchard, then further reduction in rots following an effective postharvest treatment will deliver fruit of the best possible quality to the consumer.

Currently prochloraz is the only postharvest fungicide registered for applying to New Zealand avocados. However, this chemical is not allowed on fruit destined for the USA market. It would be desirable to have access to alternative postharvest fungicides which can be used for treating fruit destined for all markets, including the USA.

Evaluation of potential postharvest fungicides for control of postharvest rots in avocados identified an active ingredient, thiabendazole (TBZ), which has an existing maximum residue limit (MRL) for avocados in the USA. Thiabendazole is not registered for use on avocados in New Zealand. Testing of the liquid formulations of TBZ available in New Zealand showed that the more TBZ that was applied, the greater the number of postharvest rots (Everett, 2000). An alternative to a liquid formulation would be a wettable powder formulation of TBZ. The wettable powder formulation of TBZ needs to be tested before firm conclusions can be made, but to date, this formulation has not been available.

Other potential postharvest treatments for rot control in avocados include biological products. For both Europe and the USA, biological products comply with the standards required for nil residues. Biological products have been shown to be as effective as fungicides in small postharvest trials and laboratory tests. One microorganism isolated by HortResearch, *Serratia marcescens* HR42 (Everett, 1996; Everett, 2002), and a commercially available biological product of *Bacillus subtilis,* Serenade® Max (Everett and Timudo-Torrevilla, 2006; Everett and Timudo-Torrevilla, 2007; Everett *et al.,* 2007) were sufficiently effective to be tested further.

On the basis of previous laboratory and postharvest results (Everett and Timudo-Torrevilla, 2006; Everett and Timudo-Torrevilla, 2007) 3 products were selected for further testing as postharvest treatments for rot control of avocados for last year (2007/08).

Three dilutions of 2 biological control agents (Serenade® Max and HR42) and a new fungicide (boscalid/pyraclostrobin; Pristine®) were tested on fruit from three different avocado-growing regions of New Zealand.

MATERIALS AND METHODS

Avocado fruit were harvested from an orchard in the Far North (Burnage Road, Hohoura) on 19 February, from Whangarei (Croucher Road, Maungatapere) on 5 March, and from the Bay of Plenty (Rangiuru Road, Te Puke) on 20 March 2008. A standard copper fungicide programme was applied by the growers in the Far North and in Te Puke, and a standard insecticide programme by all growers. Copper fungicides were not applied in the field to the fruit from Whangarei. There were 12 treatments: an untreated control, a water control, a prochloraz control, and three dilutions each of boscalid/pyraclostrobin, *B. subtilis* QST 713 and S. *marcescens* HR42 at the rates described in Table 1. At each location, 100 ungraded fruit per treatment were immersed in 40 L of each solution, with agitation for 2 min, and air-dried. Fruit were then placed 20 per avocado box in a total of 5 boxes per treatment. Untreated controls were placed directly into avocado boxes. These fruit were transported to the Mt Albert Research Centre (HortResearch) within 24 hours and placed in the coolstore at 5.5°C.

After 28 days of coolstorage, fruit were removed and placed at 20°C for ripening. Ripening fruit were tested for firmness by gentle hand squeezing each day after placement at 20°C. When adjudged ripe, fruit were cut into quarters and peeled. Fruit were assessed for internal rots using the methods described in the NZ Avocado Industry Council Assessment Manual (Dixon, 2003).

Statistical analysis

Results were analysed using the General Linear Model (analysis of variance) function of MINITAB® (version 15.0), and means were separated using Dunnett's test (α=0.05). Data were angular transformed prior to analysis. The ORIGIN® (version 7.5) graphical package was used for drawing graphs.

RESULTS

Boscalid/pyraclostrobin significantly reduced body rots in the fruit from the Far North when applied at two concentrations (undiluted and 1:100 dilution) and in fruit from Whangarei when undiluted and 1:10 dilution (Figure 1). It significantly reduced body rots in Te Puke fruit compared with water-dipped controls, but not compared with

Table 1. Application rates of fungicides tested as a postharvest dip application for control of avocado fruit rots.

Fungicide product	Active ingredient	% a.i.	Rates used/100 L
Sportak®	prochloraz	45	55 ml
Pristine®	boscalid/ pyraclostrobin	25.2/12.8	*60 g, 6 g, 0.6 g
Serenade® Max	*Bacillus subtilis* QST 713	7.3 x 109 cfu/g	*400 g, 40 g, 4 g
HR42	*Serratia marcescens* HR42	1 x 109 cfu/ml	2.5 L, 1.25 L, 625 ml

**The highest rate was based on the rate recommended for field application*.

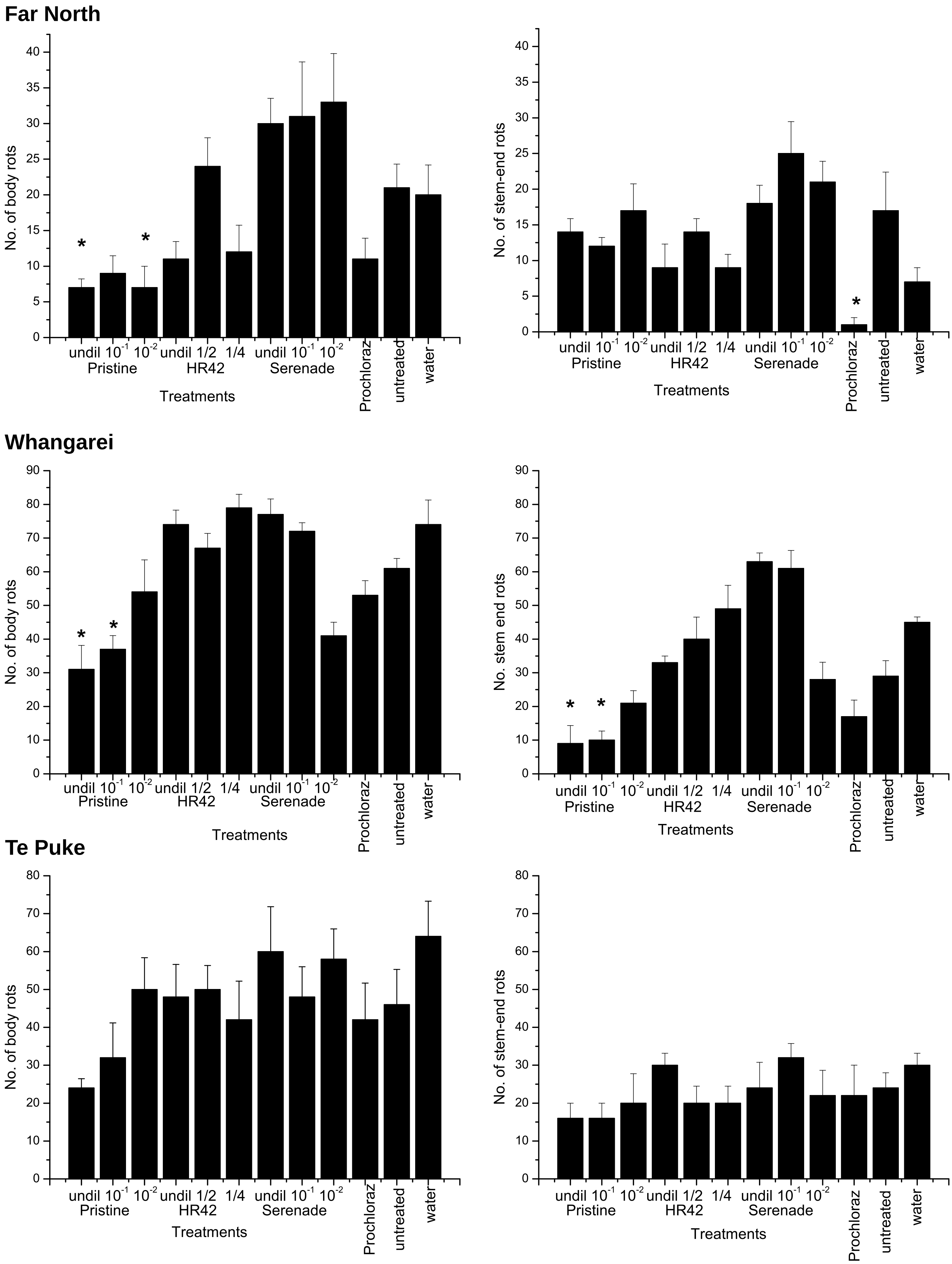

Figure 1. Percentage of avocado fruit with body rots (left) and stem-end rots (right) after application of test fungicides as postharvest treatments. Values are means ± standard errors. Data were angular transformed prior to analysis. Means were separated from the untreated control using Dunnett's test. * denotes a significant difference at $p < 0.05$.

untreated fruit. The application of boscalid/pyraclostrobin to fruit from Whangarei at these dilutions also significantly reduced the numbers of stem-end rots. Application of prochloraz significantly reduced stem-end rots in fruit from the Far North.

DISCUSSION

In these preliminary trials, postharvest application of boscalid/pyraclostrobin significantly reduced body rots in treated fruit from the Far North and Whangarei, and significantly reduced stem-end rots in fruit from Whangarei compared with untreated controls. This fungicide also significantly reduced body rots when applied to fruit from Te Puke compared with water-dipped controls. Overall this fungicide was more effective than the industry standard (prochloraz) in these trials.

However, none of the treatments significantly reduced either stem-end or body rots in fruit from Te Puke compared with untreated controls. This may be because these fruit were harvested very late (20 March). It has been noted by others (Mandemaker *et al.,* 2006) that high disease pressure in late-harvest fruit may overwhelm the protective effect of the fungicides.

Pristine® is a combination fungicide of a carboxamide (boscalid) and a strobilurin (pyraclostrobin). Pyraclostrobin has a single-site mode of action, so there is a risk of resistance developing in fungal populations following repeated use. Boscalid has a different single-site mode of action and in combination with pyraclostrobin there is less chance of resistance developing than if either fungicide is applied alone (Hauke *et al.,* 2004).

There are no maximum residue limits for avocados to pyraclostrobin or to boscalid so this product cannot be used as a postharvest treatment for fruit rots at this stage.

The biological products did not control rots in these experiments. In the past, HR42 has been able to control rots in postharvest dip experiments, in some seasons and on some orchards (Everett, 2002). Biological products can deliver variable results possibly related to different environmental factors. This technology is not yet able to deliver a consistent result.

Pristine® shows promise as a postharvest fungicide, but this fungicide requires residue testing and either the establishment of MRLs in the USA and Australian marketplaces, or withholding periods that result in zero residues, before its use can be recommended.

CONCLUSIONS

Pristine® (boscalid/pyraclostrobin) applied at rates recommended for field application (60g/100L) provided good control of avocado fruit rots when applied as a postharvest dip. This product is not registered for avocados and cannot be recommended as a control option.

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