# ORCHARD TREATMENTS OTHER THAN SPRAY APPLICATION OF FUNGICIDES THAT REDUCE POSTHARVEST ROTS OF AVOCADOS

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## ABSTRACT

Three on-orchard treatments to reduce postharvest rots of avocados were evaluated on two orchards, one organic orchard in the Bay of Plenty and the other conventional orchard in Whangarei. The treatments were applied in a split plot factorial design. Calcium was applied to the soil under trees for one treatment, dead branches were removed from the canopy and the lower branches were trimmed to a height of 1 m for the second treatment, and trees were irrigated and treated with phosphorous acid for the third treatment. Mulch was applied instead of phosphorous acid in the organic orchard to improve root health. Irrigation in combination with controlling root rots by injecting with phosphorous acid reduced both body rots and stem-end rots in fruit from the Whangarei orchard, but irrigation in combination with application of mulch did not reduce rots in fruit from the Bay of Plenty orchard. The application of calcium to trees reduced body rots in fruit from both orchards. The removal of dead wood from the canopy reduced rots in fruit from the Bay of Plenty orchard, but not in fruit from the Whangarei orchard.

***Keywords***: body rots, stem-end rots, *Phytophthora*, irrigation, canopy management, calcium.

## INTRODUCTION

Avocados are susceptible to fungal rots that infect through the side of the fruit (body rots) and the cut stem (stem-end rots) and express postharvest. These rots are usually controlled by orchard spray applications of copper fungicides (Everett and Pak, 2002), and by postharvest application of prochloraz (Everett, 2002). Other factors have been shown to influence postharvest rots of avocados, including calcium content of the flesh, rainfall, Phytophthora infection, and canopy density (Everett *et al.*, 2007). This project was conducted to investigate the effect of these factors on postharvest rots of avocados.

## METHODS

Two trial sites were selected. These were in Croucher Road Whangarei, and at Pikowai, State Highway 2, Bay of Plenty. The second site was an organic orchard. There were three treatments allocated to trees in a split plot factorial design (Figure 1). Calcium was applied to the soil under trees for one treatment (N), dead branches were removed from the canopy and the lower branches were trimmed to a height of 1 m for the second treatment (C), and trees were irrigated and treated with phosphorous acid for the third treatment (R). Mulch was applied instead of phosphorous acid to improve root health in the organic orchard for treatment R. The Whangarei site was set up in 2007, and the Bay of Plenty site in 2008. All treatments were carried out on both sites. Treatments N and R were applied for two years before harvest in Whangarei, and for one year in the Bay of Plenty. The canopy treatment was applied once only on both orchards.

Trees were not sprayed with copper, but an industry standard insecticide spray programme was followed in Whangarei, and an organic programme in the Bay of Plenty.

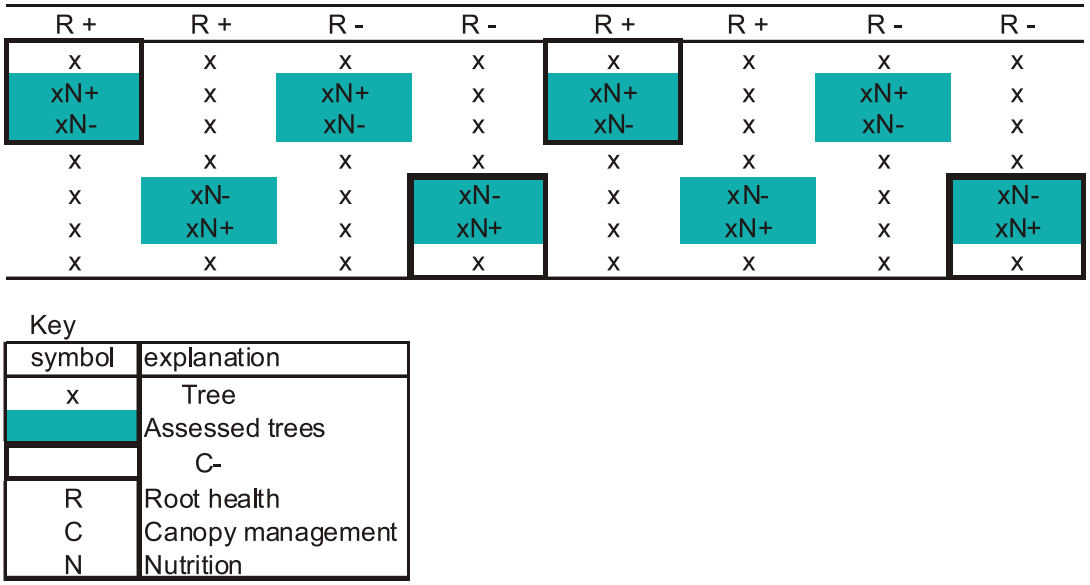


**Figure 1.** Strip plot trial design for managing rots on avocado orchards without applying foliar fungicide sprays. Root treatments were applied to trees in columns as indicated.

Canopy management was applied to all trees except those indicated as treatment C-. Dead branches were removed from the canopy of all other trees, and the lower branches were trimmed to a height of 1 m. Trees in the root health positive treatments (R+) were irrigated and treated with phosphorous acid on the conventional orchard. For the organic orchard, mulch was applied instead of phosphorous acid to the root health treatments. Calcium was applied to the ground under trees designated N+ in the nutrition treatment.

On 19 December 2008, 800 fruit were harvested from the Whangarei orchard, and on 9 February 2009, 800 fruit were harvested from the Bay of Plenty orchard. On both orchards 50 fruit, 25 per box, were harvested from each of 16 assessed trees as shown in Figure 1, for the final evaluation of treatment effects.

*Fruit assessment*

After harvest, fruit were placed in a coolstore at the Mt Albert Research Centre of PFR at 5.5°C for 28

**Table 1.** Effect of various on-orchard treatments on avocado rots, showing results of multi-factorial regression analysis.

| | Region | | | | | |
|---|---|---|---|---|---|---|
| | Whangarei | | | Bay of Plenty | | |
| **Factors** | **Body rots** | **Stem-end rots** | **Total rots** | **Body rots** | **Stem-end rots** | **Total rots** |
| Tree | NS | NS | NS | NS | NS | NS |
| Box | NS | NS | NS | 0.05[1] | NS | NS |
| N | 0.004 | NS | 0.002 | 0.05 | NS | NS |
| R | <0.0001 | <0.0001 | <0.0001 | NS | NS | NS |
| C | NS | NS | NS | NS | NS | 0.03 |

[1]Numbers indicate a significant *P* value. NS not significant ($P > 0.05$).

**Table 2.** Effect of various on-orchard treatments on avocado rots; data are mean severity ± standard error.

| | | Region | | | | | |
|---|---|---|---|---|---|---|---|
| | | Whangarei 2009 (year 2) | | | Bay of Plenty 2009 (year 1) | | |
| **Rots** | **Factors** | N | R | C | N | R | C |
| body rots | - | 1.75±0.26 | 1.90±0.24 | 1.50±0.21 | 1.82±0.29 | 1.81±0.30 | 1.78±0.29 |
| | + | 1.28±0.16 | 1.13±0.15 | 1.53±0.23 | 1.50±0.25 | 1.51±0.24 | 1.51±0.25 |
| stem-end rots | - | 5.53±0.47 | 5.33±0.51 | 4.30±0.46 | 1.14±0.22 | 1.03±0.22 | 1.28±0.18 |
| | + | 3.80±0.45 | 4.00±0.45 | 5.03±0.55 | 1.05±0.16 | 1.15±0.16 | 0.89±0.20 |
| total rots | - | 11.64±1.28 | 12.44±1.07 | 9.87±1.34 | 1.48±0.17 | 1.42±0.19 | 1.53±0.17 |
| | + | 9.14±1.27 | 8.34±1.32 | 10.91±1.27 | 1.28±0.17 | 1.33±0.15 | 1.20±0.16 |

days. After that time, fruit were placed at 20°C and evaluated daily until ripe. When fruit were ripe, as judged by gentle hand squeezing, they were cut in quarters, peeled and rots were assessed according to the procedures in the Avocado Industry Council assessment manual (Dixon, 2003).

*Statistical analysis*

Results were analysed using the General Linear Model (analysis of variance) or regression functions of MINITAB® (version 15.0), and means were separated using Dunnett's test (α=0.05). The results presented are the mean severity values, which are expressed as percentages. The ORIGIN® (version 7.5) graphical package was used for drawing graphs.

## RESULTS

Results of multi-factorial regression analysis of the effect of various factors in this trial on mean severity of rots showed that in the second year after these factors were applied, treatments N (calcium application) and R (irrigation and either phosphorous acid or mulch) had significant effects on total rots and also on body rots in Whangarei. Treatment R (Root irrigation and either phosphorous acid or mulch) significantly reduced stem-end rots on this orchard (Tables 1 and 2). The first year after these factors were applied on the organic orchard in Bay of Plenty, there was a significant effect of Treatment N (calcium application) on body rots, and of Treatment C (canopy management) on total rots.

When those trees treated with all treatments were compared with the untreated controls, there were fewer rots in fruit from treated trees, and the severity of these rots was less in fruit from treated trees (Figure 2). The reduction in rots was greater in fruit from Whangarei for both mean severity and incidence than in fruit from Bay of Plenty.

## DISCUSSION

The root (R) and nutrition (N) treatments were more effective at reducing postharvest rots than was canopy management. Canopy management is a labour-intensive activity, and was only effective at reducing avocado fruit rots on the Bay of Plenty orchard. The trees on this orchard were 5 to 6 years old and it was possible to remove most of the dead wood from within the canopy. However, trees in the orchard in Whangarei were 15-20 years old and it was not possible to remove all the dead wood from these canopies. The inability to remove a significant proportion of the inoculum sources may have been the reason that this treatment had little effect in the Whangarei orchard. On older orchards, removing inoculum every year for several years may be required before a significant effect on reducing fruit rots is achieved.

The combined treatments reduced rots more effectively in fruit from Whangarei than in fruit from the Bay of Plenty. The effect of increased calcium content in the fruit, irrigation and *Phytophthora* treatment may be cumulative over time. The effect may have been greater in Whangarei because the treatments had been applied for two years.

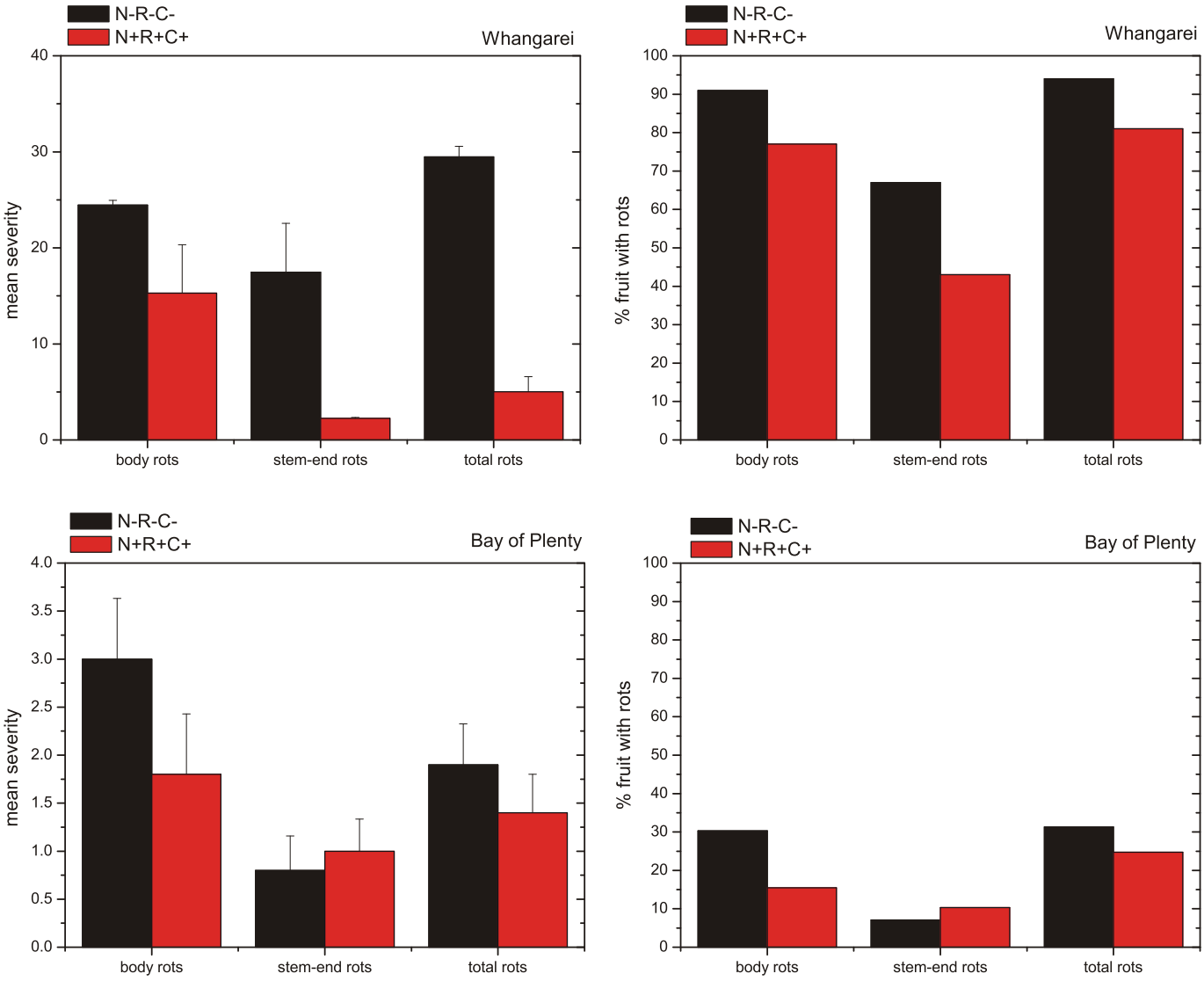


**Figure 2.** Mean severity and incidence of postharvest rots of avocado in fruit treated by applying canopy management (C), nutrition (N) and root health (R) treatments, compared with rots in fruit from untreated trees. Error bars are standard errors of the mean.

Alternatively treatment with phosphorous acid may have had a greater effect on tree health than application of mulch. Mulch has been used to control avocado root rot in California (Faber *et al.*, 2001, Downer *et al.*, 1999) and South Africa (Duvenhage *et al.*, 1993), but *Phytophthora* has not been reported to be controlled by mulches in New Zealand. It has been reported that mulches applied to avocado trees in Bay of Plenty, New Zealand, were not as effective at enhancing growth and yield as those applied to trees in California and South Africa, possibly because of the high organic content in Bay of Plenty soils compared with Californian and South African soils (Dixon *et al.*, 2007).

The rot control achieved by applying calcium, irrigating and injecting with phosphorous acid was statistically significant. For orchards that have high disease pressure, such as the one in Whangarei, these procedures are probably best used in an integrated disease control programme that includes regular application of fungicides.

## CONCLUSIONS

Application of calcium, irrigation and soil treatments such as application of phosphorus acid may have a beneficial effect on reducing postharvest rots in avocado fruit. There was some indication that canopy management may be beneficial in young orchards. In older orchards, removal of inoculum from the canopy may be required for several years before an effect on fruit rots becomes apparent.

## ACKNOWLEDGEMENTS

Many thanks to the growers involved with this study. Thanks to John Chen for technical assistance. This study was supported by a grant from the MAF Sustainable Farming Fund, the New Zealand Avocado Industry Council, BASF, Dupont, Nufarm, Biostart and Elliott Chemicals.

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