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Effect of Detergent Sanitizers on Post-harvest Diseases of Avocado

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ABSTRACT

Sanitizing agents from the food-processing and dairy industries were evaluated for control of avocado post-harvest diseases. Postharvest pathogens *Colletottrichum gloeosporioides, Nattrassia mangiferae, Thyronectria pseudotrichia, Phomopsis perseae* and *Pestalotiopsis versicolor were* used in wounded and stem-end inoculations on Fuerte avocado fruit prior to treatment with disinfectants. Disinfectants SU319 and Terminator applied as post-harvest dip treatments were generally more effective on wounded inoculations than on stem-end inoculations. The fungicidal treatment proved to be effective against most of the pathogens on wounded inoculations and only against C *gloeosporioides* on stem-end inoculations. SU393 had no effect on wounded inoculations but performed better in certain stem-end inoculations. The possibility of using these disinfectants in combination with other control measures should be investigated further.

INTRODUCTION

Post-harvest disease control of avocado can be obtained through preor post-harvest fungicide applications such as copper oxychloride (Kotzé *et al.,* 1982), benomyl (Darvas & Kotzé, 1987) and prochloraz (Darvas, 1985). However, copper oxychloride leaves unsightly residues (Denner & Kotzé, 1986); prolonged use of benomyl can build pathogen resistance (Darvas & Kotzé, 1987); and prochloraz has not been cleared for the French export market. An approach towards integrated fruit production will further limit the number of fungicides allowed on fruit. Most important of all is the limited number of fungicides available and the prospect of not getting new fungicides registered for the relative small subtropical industry. This, combined with general global chemophobia over the extensive use of agricultural chemicals, makes it desirable to seek alternative control strategies.

Biological control of pre and post-harvest fruit diseases has therefore received much attention over the past 10 years as alternative control strategy (Wilson & Wisniewski, 1989). Subsequently, *Bacillus subtilis* was evaluated for control of avocado post-harvest diseases, with resultant control equal to or better than that achieved with fungicides (Korsten *et al.,* 1989). To further improve efficacy, *B. subtilis* was integrated with fungicides at concentrations equal to, or lower than the registered rate. Although some improvement was noticeable, it was not consistent (Korsten *et al.,* 1989; 1991; 1992; 1993).

Another viable approach was reported by Boshoff *et al.,* (1995) with post-harvest dip treatments using commercially available disinfectants. Quaternary ammonium compounds readily controlled anthracnose and in certain instances stem-end rot (SE). The purpose of this study was to further evaluate the performance of selected disinfectants, both on wounded and on unwounded inoculations of some commonly occurring post-harvest pathogens on avocado.

MATERIALS AND METHODS

Isolations from stem-end rot and anthracnose were made at weekly intervals during harvesting season to determine the range of important post-harvest pathogens at Everdon Estate. Isolations were made on potato dextrose agar and pure cultures were identified with the help of Dr C. Roux (Agricultural Research Council). Post-harvest pathogens *Colletottrichum gloeosporioides* Penzig, *Nattrassia mangiferae* (Syd. & P. Syd.) B. Sutton & Dyko, *Thyronectria pseudotrichia* (Schw.) Seeler, *Phomopsis perseae* Zerova, *Pestalotiopsis versicolor* (Speg.) Steyart were incubated for 14 days at room temperature. Spores were harvested in sterile water prior to inoculations.

Fuerte avocados were commercially harvested early in the morning from orchard B4 at Everdon Estate. Harvested fruit was immediately transported to the commercial packhouse where the untreated fruit was sorted according to size. Ten cartons with count 14 fruit were randomly selected for each treatment. Wounds were made on surfaces of fruit using a sterile needle, and pedicels of fruit were removed prior to inoculations. Each pathogen was used in 20 SE inoculations and 80 wounded inoculations. Each treatment therefore consisted of 100 fruits with 20 fruits per inoculation. The following treatments were performed 24 h after inoculating the fruit: SU319 and Terminator were used at 1,6 % and 0,8 % respectively as dip treatments (3 minutes), and SU393 was sprayed directly onto the fruit. For comparative purposes a chemical treatment was included which consisted of a prochlaraz (Omega, 45 % a.i. E.G., FBC Holdings (Pty) Ltd.) ultra low volume spray application at 4 p.p.m., followed by drying and commercial Tag-waxing (Polyethylene, Sanachem, with benomyl (Benlate, 50 % WP, Du Pont De Nemours International SA.) at 1,7 p.p.m. as well as thiabendazole (Tecto, 45 % a.i., Logos Agvet) at 3 p.p.m.. In addition, untreated controls as well as a water dip control were included in this experiment. Fruit from all the treatments were packed after drying and waxing, and coded for evaluation before cold storage at 5,5 °C for 28 days to simulate export conditions. After removal from commercial cold storage, fruit was allowed to ripen at 21 °C, 90 % RH. Fruit was evaluated at the ready to eat stage for symptom development. Evaluations for SE severity were done on a 0-10 scale according to Bezuidenhout & Kuschke (1982), where 0 = healthy fruit and 10 = totally affected fruit. The wounded inoculations were evaluated on a 0-3 scale (0 = no infection; 1 = little infection; 2 = infection clearly visible; 3 = severe infection).

Statistical analysis was done using Duncan's multiple range test.

RESULTS AND DISCUSSION

Infections through wounds by *N. mangiferae* and by *P. perseae* were effectively controlled by SU319, Terminator and by the fungicidal (PTB) treatments (Table 1). SU319 effectively controlled wounded inoculations of *P. versicolor,* but Terminator and the fungicidal treatment only performed better compared to the water-treated control. The fungicidal treatment (PTB) was the only treatment which effectively controlled wounded inoculations of *C. gloeosporioides,* but SU319 also performed well compared to the water treated control. None of the treatments could reduce the incidence of wounded inoculations of *T. pseudotrichia* on either the water-treated or the untreated controls.

Table 1
Effect of disinfectants on wounded inoculations of post-harvest pathogens Fuerte avocado fruit[1]

Treatments	*Pathogen inoculations*				
	Nattrassia mangiferae	Phomopsis perseae	Pestalotiopsis versicolor	Colletotrichum gloeosporioides	Thyronectria pseudotrichia
1. Su319	0,58bc	0,39a	0,17a	0,36b	0,90b
2. Terminator	0,35a	0,70b	0,20ab	0,53bc	0,87b
3. SU393	0,65c	0,88c	0,34c	0,69c	0,66a
4. PTB	0,43ab	0,37a	0,20ab	0,14a	0,68a
5. Water control	0,68c	0,94c	0,40c	0,40b	0,80ab
5. Untreated control	0,55c	0,95c	0,32bc	0,65c	0,75ab

[1]PTB = Prochloraz, Benlate and Tecto (Fungicidal treatment)
Values followed by the same letter do not differ significantly according to Duncan's multiple range test (P = 0,05). Values indicate mean disease severity
Fruit were evaluated at a 0 –3 scale, 0 being healthy and 3 indicating completely affected

PTB was the only treatment that effectively controlled SE inoculations of *C. gloeosporioides* (table 2). SU393 performed better than the untreated control of SE inoculations of *T. pseudotrichia.* Generally none of the pathogens showed increased disease severity more than any of the controls. However, SU393, significantly increased severity of SE inoculations of *N. mangiferae* compared to both controls and Terminator increased severity of SE inoculations of *P. perseae* compared to untreated control. The only inoculation that showed significantly more disease with water treatments was the SE inoculation with *C. gloeosporioides.*

Table 2
Effect of disinfectants on stemend inoculations after pedicel has been removed[1]

Treatments	*Pathogen inoculations*				
	Nattrassia mangiferae	Phomopsis perseae	Pestalotiopsis versicolor	Colletotrichum gloeosporioides	Thyronectria pseudotrichia
1. Su319	2,10ab	6,00a	0,75a	2,15b	6,30c
2. Terminator	1,40ab	8,35b	0,85a	2,35b	5,25abc
3. SU393	3,55c	4,10a	1,75ab	0,65ab	3,15a
4. PTB	1,75ab	4,15a	1,35ab	0,00a	4,50abc
5. Water control	1,00a	6,30ab	2,05b	4,65c	4,05ab
5. Untreated control	2,80ab	4,65a	1,20ab	0,85ab	5,85bc

[1]PTB = Prochloraz, Benlate and Tecto (Fungicidal treatment)
Values followed by the same letter do not differ significantly according to Duncan's multiple range test (P = 0,05). Values indicate mean disease severity
Fruit were evaluated at a 0 –10 scale, 0 being healthy and 10 indicating completely affected (Bezuidenhout & Kuschke, 1982)

Evaluation of products other than fungicides for the reduction of post-harvest fruit diseases has been reported for chlorine (Bartz, 1988), antioxidants (Prusky, 1988) and calcium (Conwey *et al.,1992).* Bartz (1988) demonstrated that the incidence of disease associated with the infiltration of tomato fruit with water was reduced but not eliminated by adding 50-1000 p.p.m. chlorine per litre of water and that disease incidence increased as chlorine concentration decreased. However, according to Bartz (1988) chlorination increased the potential for water infiltration, and water-infiltrated fruits were likely to become diseased. Boshoff *et al.,* (1995) reported that chlorine increased certain diseases, but a high (900 p.p.m.) chlorine concentration significantly reduced anthracnose. Management input is therefore very important when chlorine baths are to be used in packhouses.

Other than for sanitizing empty storage bins in lemon packhouses (Bancroft *et al.,* 1984) quartenary ammonium compounds (QACs) have not previously been used as post-harvest fruit treatments. In this study, wounded inoculations on the surface of Fuerte were readily controlled by QACs — more so than SE inoculations.

An observation of this study was the improved appearance of fruit washed in disinfectant solutions. Products such as SU319 and Terminator can be incorporated in water baths in packhouses prior to grading and waxing. However, a rapid drying process before waxing is needed. The possibility of using these disinfectants in combinations with other control measures should be evaluated further.

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