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REDUCING POSTHARVEST DISEASES OF MANGO FRUIT USING NATURAL DEFENCE MECHANISMS

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INTRODUCTION

In the Sri Lankan market, mango is one of the most popular of fruits along with banana and pineapple. In 2004 the area under mango cultivation was 27, 846 hectares and the total mango production was approximately 72,696 metric tons (Medagoda, 2006). However, postharvest losses account for around 41% of the total produce. A large percentage of these losses are due to the postharvest diseases Anthracnose (caused by *Colletotrichum gloeosporioides*) and Stem-end rot (*Botryodiplodia theobromae*). Both these diseases originate in the field; from different types of fungi, but symptoms appear only at the postharvest stage along with ripening. The current practice is to apply fungicides to minimize or control these two diseases. Due to the increasing public concern over food safety, alternative methods for crop protection are being investigated. Manipulation of a plant's natural defence system has proved to be an attractive alternative in recent years.

The mango fruit peel and latex both contain compounds that impart natural resistance to the fruit. The mango fruit peel is reported to have antifungal compounds in the form of Resorcinols (Droby *et al.*, 1986) and gallotannins (Adikaram *et al.*, 2010). Mango latex contains Resorcinols (Hassan *et al.*, 2009), and chitinase (Adikaram *et al.*, 2010).

The present study looked into the possibility of utilizing natural preformed defences and using defence elicitors such as Salicylic acid and Bion to induce defences, thereby to reduce the development of postharvest fungal diseases in mango.

METHODOLOGY

Effect of latex on postharvest disease development - Fruits of cultivars '*Karutha Colomban*' and '*Willard*' were hand picked with 5 cm long pedicels. In each cultivar, in one set of fruits (30) the latex was drained off soon after harvest. In another set of fruits (30), the stalks were left intact, for 24 hours then trimmed approximately 3 mm above the abscission zone. Fifteen fruits of each set were inoculated using a suspension of conidia of *Colletotrichum gloeosporioides* (10^5 conidia /ml) and arranged randomly in moist chambers. Once lesions appeared, diameter was measured on two axes and lesion area was calculated. Another experiment was performed on natural disease development. For this, another 15 fruits from each of the above sets were selected, randomly arranged in trays and kept under ambient conditions and disease development was assessed. Disease area was measured by tracing the diseased area onto transparent graph papers with 1 mm^2 squares. The experiment was performed three times; data were pooled and analyzed as a two sample T-test at the 5 % probability level using Minitab 11 for windows 6.1.

Postharvest Elicitor sprays – Healthy, unripe mango fruits (cultivar '*Rata*') were sprayed with selected concentrations of elicitor solutions, Salicylic acid (sodium salt, SIGMA) (SA) and Bion. The concentrations of SA used were, 0 (control), 100, 500, 1000 and 1600 ppm and the concentrations of Bion® (Acibenzolar-s-methyl, 500 WG, SYNGENTA) used were, 0 (control) 25, 50, 100 and 200 ppm. Each elicitor concentration was prepared to contain 50 ml of solution and 10 µl Tween 20 (Sigma ®) was added to each elicitor solution. The solutions were evenly sprayed on to the surface of each fruit, until finely misted, using an atomizer. Sprayed fruits were randomly arranged and maintained in moist chambers at 28 °C and under100 % relative humidity. After 72 hours the inoculating surface of each fruit was wiped with sterile distilled water moistened cotton wool. The fruits were inoculated with a suspension of conidia of *C. gloeosporioides*, maintained in moist chambers and disease area was assessed as stated above. Eight replicate fruits were used per treatment and three trials were performed. Data were analyzed with SAS computer software (ver 6.12) at the 5 % probability level. The effectiveness of the optimum concentrations was then tested on cultivars *'Karutha colomban'* and *'Willard'*.

RESULTS AND DISCUSSION

Effect of latex - Anthracnose lesion area in inoculated sites was greater in fruit from which latex was drained as opposed to those from which latex was not drained. This was significant in cultivar *'Willard'* (Fig. 1) but not in *'Karutha colomban'*. The spread of anthracnose (in inoculated fruits) was reduced by 20 to 36 percent by retaining latex in cultivar *'Karutha Colomban'* and by 25 to 40 percent in cultivar *'Willard'*.

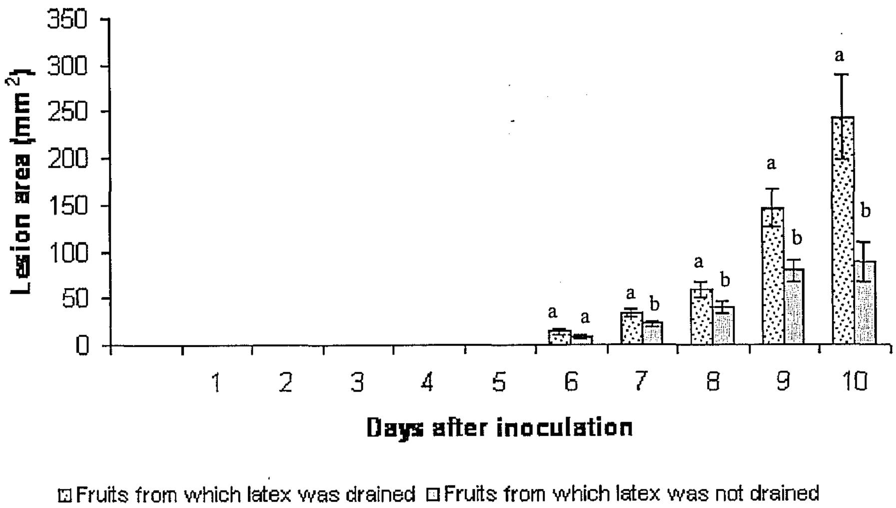

Figure 1. Progress of anthracnose, after inoculation, in fruits from which latex was drained and those from which latex was not drained in cultivar 'W*illard*'.

In the fruits of cultivar *'Willard'* which were kept aside to observe natural disease development only anthracnose developed. Both the severity and incidence of natural anthracnose were higher in fruits from which latex was drained as opposed to those from which latex was not drained. Stem-end rot (SER) was the predominant natural disease in cultivar *'Karutha colomban'*. SER was greater in latex drained fruits; however, it was significant only on day seven after harvest.

Latex contains both antifungal resorcinols and the enzyme chitinase which can digest fungal cell walls. Therefore, the retention of latex would also retain these defences in the fruit. Thus latex retained fruits develop less postharvest fungal diseases compared to the latex drained fruits.

Treatment	Day 5	Day 6	Day7	Day 8	Day 9
Control	17.5 ^{a}	38.33 ^{a}	70.51^{a}	136.12 ^{a}	187.7^{a}
100 ppm	17.33 ^{a}	32.85 ^{ab}	70.37 ^{a}	115.41^{ab}	169.26 ^{a}
500 ppm	9.97 ^{b}	17.9 ^{b}	38.85 ^{b}	82.43 ^{b}	99.7 ^{a}
1000 ppm	13.79 ^{ab}	31.94 ^{ab}	59.61^{b}	114.31^{ab}	155.7 ^{a}

Table 1. Mean lesion area (mm^2) in inoculated fruits of cultivar '*Rata*' treated with varying concentrations of Salicylic acid.

Treatment	Day 5	Day 6	Day 7	Day 8	Day 9
Control	15.9 ^{a}	35.2 ^{a}	76.5 ^{a}	140.7 ^{a}	223. 9 ^{a}
25 ppm	5.3 ^{b}	13.8 ^{b}	31.7 ^{b}	43.7 ^{b}	82.1 ^{b}
50 ppm	0.8 ^{b}	4.2 ^{b}	12.2 ^{b}	46.5 ^{b}	73.8 ^{b}
100 ppm	3.2 ^{b}	17.8 ^{b}	32.4 ^{b}	67.7 ^{b}	115.3 ^{b}
200 ppm	1.7 ^{b}	5.6 ^{b}	20.1 ^{b}	50.9 ^{b}	102.4 ^{b}

Table 2. Mean lesion area (mm^2) in inoculated fruits of cultivar '*Rata*' treated with varying concentrations of Bion

Values followed by the same letter within each column of each cultivar are not significantly different at the 5 % probability level (Duncan's Multiple Range Test).

Both elicitors tested at the postharvest stage were effective in reducing postharvest anthracnose. The optimum concentration (25 ppm) of Bion was much lower than the optimum concentration of Salicylic acid (500 ppm), but the percentage reduction in lesion area by Bion was much higher when compared with that of salicylic acid.

The reduction in anthracnose development in fruits treated with salicylic acid was significant from days 5 to 8 after inoculation and the percentage reduction ranged between 39-53%. In fruits treated with Bion, the reduction in anthracnose development was again significant on all the days considered in the experiment. The percentage reduction ranged between 67-95%. The optimum concentration of SA and Bion were also effective for the cultivars 'Karutha colomban' and 'Willard'.

Unlike in a fungicide where the fungus is eradicated and the most effective in doing so would be the highest concentration, elicitors activate the plants defences to protect themselves. The most effective dose of the two elicitors salicylic acid and its functional analogue Bion was not the highest but an optimum. Yu and Zheng (2006) report similar findings. They state that salicylic acid could improve the efficacy of the bio-control agent *Cryptococcus laurentii* against the blue mould disease in apple caused by *Penicillium expansum*. The most effective concentration was 10 μg ml−1 and either higher or lower concentrations were less effective. Furthermore, fruits sprayed with high concentrations (1000 mg/l) of salicylic acid showed some phytotoxic effects. High concentrations of salicylic acid are reported to show phytotoxic effects (Lopez and Lucas, 2002). The line which separates effectiveness and phytotoxicity is very close in salicylic acid and therefore is a major factor limiting its use as an elicitor. Further, when applied exogenously, the salicylic acid mediated resistance responses are reported to be restricted to treated tissues, indicating that exogenously applied salicylic acid is not translocated efficiently (Kessmann et al., 1994). Due to these drawbacks attention was drawn to more effective synthetic analogues of salicylic acid such as Bion. Bion, applied as a pre-harvest spray, post-harvest spray or as a soil drench has proven effective in suppressing disease. Bion (acibenzolar-S-methyl), described as being probably the most potent synthetic activator discovered to date, (Kessmann, *et al.*, 1994) is a functional analogue of salicylic acid. The present study also confirms that it is much more effective at much lower concentrations in reducing postharvest disease development in mango fruit.

CONCLUSIONS/RECOMMENDATIONS

The results indicate that both preformed defence systems and induced defence systems can be used to reduce postharvest disease development in mango. Retention of latex in fruits is an effective and easy method to reduce postharvest disease development. Both SA and Bion can effectively reduce postharvest disease development. Furthermore, Bion is more efficient elicitor in comparison to SA and a small dose such as 25 ppm is sufficient to significantly reduce postharvest disease development.

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