

# Differences in the Effect of Various Packline Fungicidal Treatments on the Manifestation of Disease in Mango

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## ABSTRACT

Zill and Kent mangoes predisposed to anthracnose (*Colletotrichum gloeosporioides*) infection were exposed to various packline fungicidal treatments either incorporating benomyl or prochloraz. Following treatment, the fruit were placed in cold-storage at 12.5°C for 28 days. After cold-storage, disease incidence and severity as well as various fruit quality attributes were assessed.

All of the treatments incorporating prochloraz showed superior anthracnose control directly after cold-storage. On ripening, hot water dip at 50°C for 5 minutes; prochloraz added to the hot water bath (180 ml Omega/100 l H<sub>2</sub>O), was the only treatment of those evaluated to result in a significant and marked reduction in disease in both cultivars. This treatment increased surface scald and internal breakdown in Zill, but not in Kent. In Kent, it increased ground skin colouration and total soluble solids content. Hot benomyl treatment (5 mins. at 50°C; 200 g Benlate/100 l H<sub>2</sub>O) was as effective in controlling anthracnose as was hot water treatment alone (5 mins. at 50°C).

## INTRODUCTION

Although hot water dip at 50°C for 5 minutes followed by 20 second dip in prochloraz (180 ml Omega/100 l H<sub>2</sub>O) is the standard packline fungicidal treatment for mangoes grown in South Africa, certain variations of this treatment are adopted by packhouses. The aim of the present study was to evaluate some variations of this treatment.

## MATERIALS AND METHODS

Two identical but separate experiments were performed. Zill mangoes were used in one experiment and Kent mangoes were used in the other. The mangoes were harvested from trees in the Tzaneen/Letsitele Valley region during the 1996/97 season. They were predisposed to anthracnose (*Colletotrichum gloeosporioides* [*Glomerella cingulata*]) infection due to heavy rain and the general inability of the growers having provided the fruit to spray adequately.

The following treatments were applied after the mangoes were washed in a 1% soap solution (Bi-Prox) and prior to hand waxing with TAG.

- Hot water dip at 50°C for 5 minutes (HW)
- Hot water dip at 50°C for 5 minutes; benomyl added to the hot water bath (200 g Benlate/100 l H<sub>2</sub>O) (HW+B)
- Hot water dip at 50°C for 5 minutes; prochloraz added to the hot water bath (180 ml Omega/100 l H<sub>2</sub>O) (HW+O)
- Hot water dip at 50°C for 5 minutes followed by 20 second 50°C dip in prochloraz (180 ml Omega/100 l H<sub>2</sub>O) (HW—HO)
- Hot water dip at 50°C for 5 minutes followed by 20 second 50°C dip in benomyl (200 g Benlate/100 l H<sub>2</sub>O) (HW—HB)

- Hot water dip at 50°C for 5 minutes followed by 20 second dip at ambient temperature in prochloraz (180 ml Omega/100 l H<sub>2</sub>O) (HW—CO)
- Hot water dip at 50°C for 5 minutes followed by 20 second dip at ambient temperature in benomyl (200 g Benlate/100 l H<sub>2</sub>O) (HW—CB)

Following treatment, the fruits were placed in cold-storage at 12.5°C (±0.5°C) for 28 days. Harvesting, treatment and placement in cold-storage were all carried out on the same day. After cold-storage, the fruit were placed in a well ventilated laboratory at 20°C (±1°C). On removal of the fruits from cold-storage, disease incidence and severity were assessed, after which the ripeness of each fruit was monitored daily with a densimeter (Heinrich Bareiss, Oberdischingen, Germany). Each fruit was re-evaluated for disease when it was firm-ripe (densimeter reading of less than 60 and greater than 40 from a non-diseased portion of the fruit). The assessment of various quality attributes was included at this stage.

## Fruit quality evaluation

Fruit evaluation on ripening comprised the following:

Skin colour in each fruit was rated. A rating of "0" was given when signs of skin colouration were absent, a rating of "1" if a transition to a lighter green was apparent, a rating of "2" if regions of the skin had become yellow but the total area which was yellow was less than the total area which was green, a rating of "3" if regions of the skin had become yellow and the total area which was yellow exceeded the total area which was green, or a rating of "4" if the skin was completely yellow. The skin area covered with red-blush was not considered.

Disease manifestation in each fruit was rated according to its severeness. A rating of "0" was given if a fruit was disease free, a rating of "1" if symptoms were present but

were localized to a small portion of the fruit's surface, a rating of "2" if approximately 1/3 of the fruit's surface showed symptoms, a rating of "3" if 2/3 of the fruit's surface was affected, or a rating of "4" if the entire fruit's surface was visibly diseased. The diseases occurring were also identified.

Lenticel damage, blotch (green patchiness of skin), pitted spot or surface scald were rated by approximating the percentage of the skin surface over which symptoms could be seen. The percentages designated were either 0, 25, 50, 75 or 100.

To assess internal quality, each fruit was first cut through twice; 'longitudinally' along the flattened margins of the seed. In each fruit, juice from the 'cheeks' thus obtained was evaluated by measuring its pH (Mettler Toledo 120 pH meter) and total soluble solids content (Euromex RF 0232 hand held refractometer), and by assessing its taste.

Taste was rated. A rating of "1" was given if taste was deemed appealing, a rating of "0" if taste was deemed satisfactory but not appealing, or a rating of "-1" if taste was deemed unsatisfactory.

Mesocarp colour, i.e., the degree of colour intensification of the mesocarp from white to the yellow/orange colour normally seen in a fully ripe Zill or Kent mango, was estimated with the 'Zill' colour chart.

Physiological disorder manifestation in each fruit was rated as was disease manifestation, except that the degree to which the mesocarp as opposed to the exocarp (skin) was affected, was taken into account. The disorders occurring were also identified.

In each experiment, there were five single carton (4 kg carton) replicates of seven treatments. The cartons were arranged in accordance with the randomized complete blocks design, when in cold-storage and subsequently. Carton averages were subjected to analysis of variance incorporating multiple range testing (5% LSD).

**RESULTS**

**Diseases present**

Symptoms of anthracnose were prevalent. Those of soft-brown rot (*Nattrassia mangiferae*) and stem-end rot (unknown) were less obvious.

**Disease incidence**

Directly after cold-storage, all of the treatments incorporating prochloraz (Omega) showed superior disease control in both Zill and Kent (Figs. 1 and 2). On ripening, Treatment 3 (HW+O) [hot water dip at 50°C for 5 minutes; Omega added to the hot water bath (180 ml Omega/100 l H<sub>2</sub>O)] was the only treatment to result in a significant and marked reduction in disease in both cultivars (Figs. 1 and 2).

**Fruit quality attributes in Zill**

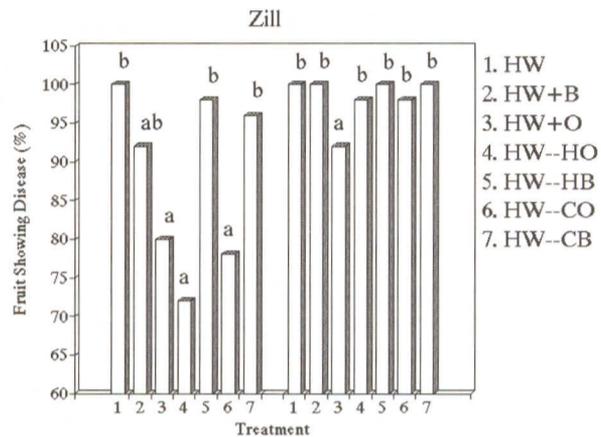
As a result of the high incidence of disease, only Treatments 2, 3, 4, 6 and 7 could be properly evaluated in terms of their effect on fruit quality.

Surface scald development was most pronounced following Treatment 3 (W+O) (Fig. 3). Surface scald was also evident in the remaining treatments (Treatments 2, 4, 6 and 7). It is noteworthy that Zill mangoes are particularly prone to surface scald.

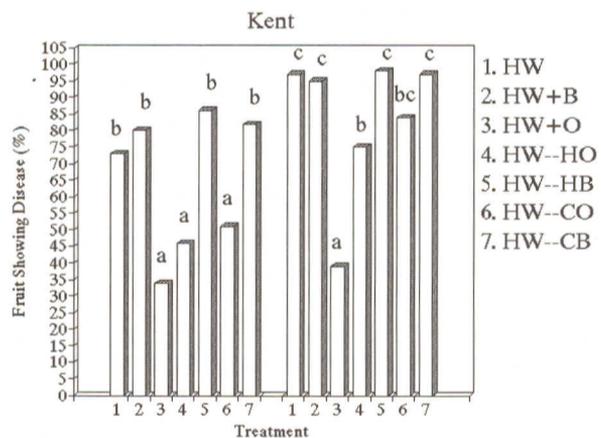
Treatment 3 (W+O) gave rise to the greatest occurrence of internal breakdown (breakdown of the inner mesocarp) (Fig. 4). Internal breakdown also occurred in the fruits of the remaining treatments (Treatments 2, 4, 6).

Most of the fruits were fully yellow on ripening (Fig. 5). Ground skin colouration was apparently reduced by Treatment 7 (HW—CB).

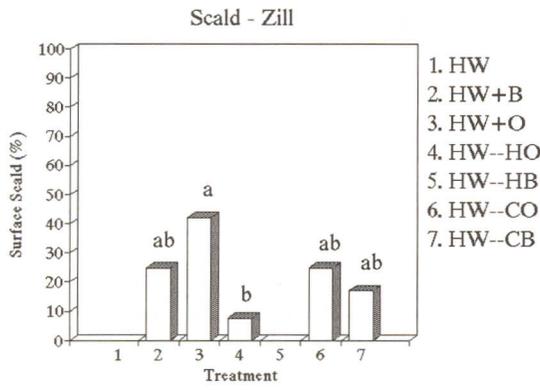
Differences in lenticel damage, blotch, pitted spot, total soluble solids content, pH, taste, or pulp colouration relating to treatment were not apparent (data not shown). Spongy



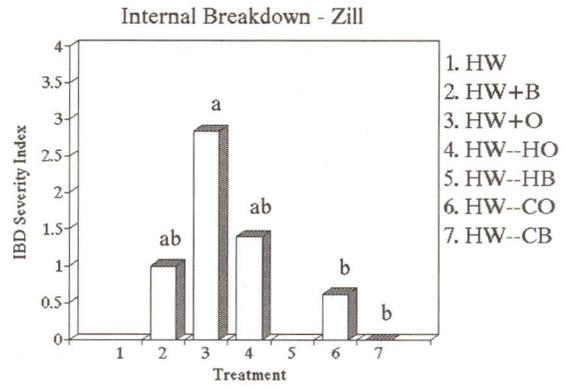
**Fig. 1** Disease incidence directly after cold-storage (left) and on ripening (right) in Zill. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).



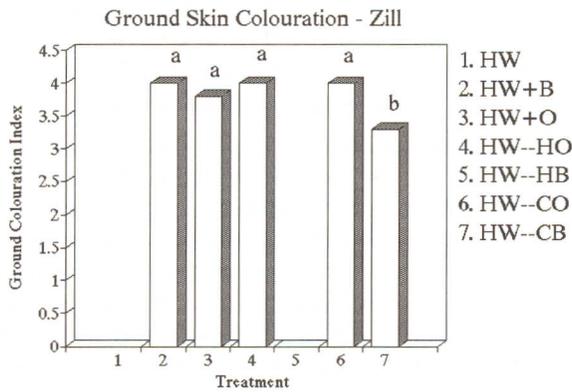
**Fig. 2** Disease incidence directly after cold-storage (left) and on ripening (right) in Kent. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).



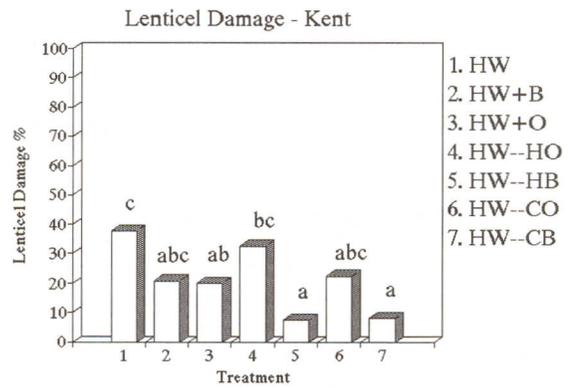
**Fig. 3** Surface scald severity in Zill on ripening. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).



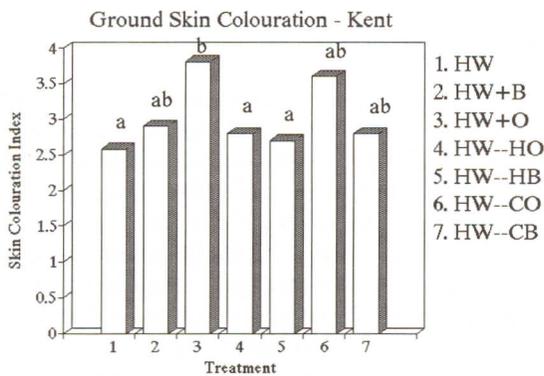
**Fig. 4** Internal breakdown severity in Zill on ripening. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).



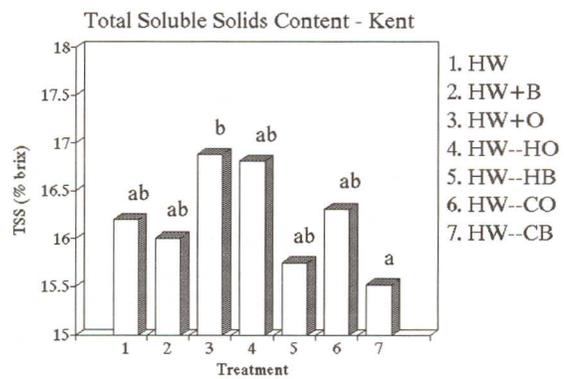
**Fig. 5** Ground skin colouration in Zill on ripening. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).



**Fig. 6** Incidence of lenticel damage in Kent on ripening. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).



**Fig. 7** Ground skin colouration in Kent on ripening. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).



**Fig. 8** Total soluble solids content in Kent on ripening. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).

tissue, cavity, peripheral browning, internal browning or vascular browning were not encountered.

### Fruit quality attributes in Kent

Irrespective of treatment, some lenticel damage was encountered (Fig. 6). The incorporation of fungicides did not increase the incidence of lenticel damage. Lenticel damage incidence was greatest following Treatment 1 (HW) and was lowest following Treatment 5 (HW—HB).

Ground skin colouration was greatest following Treatment 3 (HW+O) (Fig. 7). An increase in ground skin colouration was also apparent following Treatment 6 (HW—CO). Relative to Treatment 1 (HW), increases in ground skin colouration were not apparent following the treatments incorporating benomyl.

Total soluble solids content was greatest following Treatment 3 (HW+O) or 4 (HW—HO), and lowest following Treatment 7 (HW—CB). Both Treatments 3 and 4 incorporated hot prochloraz.

All of the treatments incorporating fungicide appeared to increase blotch (Fig. 9). Blotch severity was always low, however.

Differences in pH, pulp colouration or taste relating to treatment were not apparent. Surface scald, pitted spot, internal breakdown, spongy tissue, cavity formation, peripheral browning, internal browning or vascular browning were not encountered.

### DISCUSSION AND CONCLUSION

Directly after cold-storage, all of the treatments incorporating prochloraz were superior in both Zill and Kent. On ripening, Treatment 3 (HW+O) [hot water dip at 50°C for 5 minutes; prochloraz added to the hot water bath (180 ml Omega/100 l H<sub>2</sub>O)] was the only treatment of those evaluated to effect a significant and marked reduction in disease (mainly anthracnose) in both cultivars.

Lonsdale *et al.*, 1991 found that hot water (55°C/2 minutes) plus prochloraz at 40.5 or 81 g a.i./100l controlled anthracnose effectively and suppressed the development of soft brown rot in mangoes stored for 4 weeks at 11°C. Prochloraz was less effective in controlling soft brown rot when used at ambient temperature (Lonsdale, 1992). Saaiman and Lonsdale (1994) later noted that hot water (55°C for 2 min) containing prochloraz (81.0 or 40.5 g a.i./100l) controlled anthracnose and low levels of soft brown rot, but did not control high levels of soft brown rot.

Pelser and Lesar (1991) obtained good control of anthracnose and soft brown rot following a 30 second immersion in a mixture of imazalil and prochloraz (2500 mg/l and 2000 mg/l respectively) at ambient temperature, preceded by a 3 minute dip in hot water (53°C). McMillan *et al.* (1987) performed an experiment where unheated (26-32°C) and heated (53°C) suspensions of benomyl, imazalil or prochloraz were compared as postharvest treatments for the control of anthracnose in Tommy Atkins or Keitt mangoes. In their study, mature-green mangoes were immersed for 20 seconds in an unheated suspension or for three minutes in a heated suspension. Fruit were then held for 16 days at 13°C followed by ripening at 24°C before examination for decay.

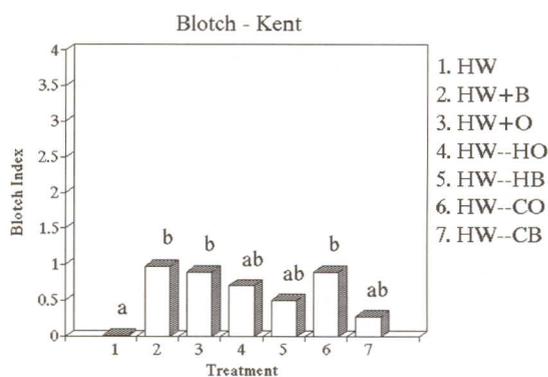


Fig. 9 Blotch severity in Kent on ripening. Bars headed by differing letters differ significantly according to LSD (5%) (see Materials and Methods for meaning of treatment abbreviations).

Treatment for three minutes at 53°C in tap water, 0.2% benomyl, 0.2% imazalil, 0.2% prochloraz or 0.05% benomyl plus 0.05% prochloraz satisfactorily controlled anthracnose after 16 days of storage at 13°C. Feng (1991) found that hot water treatment (52-54°C for 8-10 minutes) or treatment with iprodione or thiabendazole (1000 ppm) was effective in controlling mango anthracnose.

During long-term storage in a controlled atmosphere (5% O<sub>2</sub>, 2% CO<sub>2</sub>, 13°C for 26 days followed by air for 11 days at 20°C) hot benomyl followed by prochloraz (45 EC, 0.55 ml/litre, 25°C, 30 seconds) provided effective control of stem end rot (*Dothiorella dominicana* or *Lasiodiplodia [Botryodiplodia] theobromae*) and anthracnose. Hot benomyl alone was ineffective (Johnson *et al.* 1990a). Johnson *et al.*, 1990b noted that hot benomyl followed by prochloraz controlled anthracnose in all cultivars in their study. Stem end rot (*Dothiorella dominicana*) was only controlled in some of the cultivars used. Dodd *et al.* (1991) found that a hot-benomyl dip (850 mg/l a.i. at 52-55°C for 10 min.) completely eradicated anthracnose on mangoes treated on the day of harvest. The hot-benomyl dip was also effective in fruits treated on the day of harvest and on the third day after harvest. There was no significant difference between hot-benomyl dips or prochloraz dips (500 mg/litre a.i. for 10 min) at ambient temperature when fruits were treated three days after harvest.

In Australia, the current recommendation for postharvest control of anthracnose in mango is a 5 minute hot (52°C) benomyl dip or a 30-second unheated overhead spray of prochloraz. Coates *et al.* (1994) found that, under long-term storage conditions (26 days in 5% O<sub>2</sub>/2% CO<sub>2</sub> at 13°C, then 11 days in air at 20°C), prochloraz or benomyl, when applied as recommended, gave **unacceptable** control of anthracnose. A dual treatment consisting of hot benomyl followed by prochloraz was shown to give superior control of anthracnose under the foregoing storage conditions. These authors found that rain on fruit at harvest increased disease severity, and resulted in a reduction in efficacy of hot benomyl treatment.

The results of the present study clearly show the superiority of prochloraz as opposed to benomyl in controlling

anthracnose, irrespective of whether prochloraz is incorporated in the hot water bath or is applied subsequently at ambient temperature. The results also indicate that the efficacy of prochloraz is greatly enhanced when it is applied in water at 50°C. The studies cited above often corroborate the results of this study, although none specifically indicate a benefit of hot prochloraz as opposed to prochloraz applied at ambient temperature.

The temperature at which benomyl was applied did not alter the effect of this fungicide. Hot benomyl is generally applied as a packline treatment worldwide. Surprisingly, hot benomyl treatment did not fare better than hot water treatment alone in controlling anthracnose.

In South Africa, the recommendation for postharvest control of anthracnose and soft-brown rot in mango is a 5 minute heated (50°C) water dip followed a 20 second dip in prochloraz (180 ml Omega/100l H<sub>2</sub>O). This treatment was not found to be the most effective treatment for the control of anthracnose in the present study. Prochloraz residue limits for fruit destined to be exported to Europe may inhibit the adoption of the treatment which gave best results.

Lonsdale (1992) noted that a 5 minute prochloraz dip at 55°, or a hot water dip at 55°C for 5 minutes followed by an ambient-temperature dip in prochloraz for 20 seconds, caused surface scald in a number of mango cultivars. He noted that a two minute dip at 55°C or a 5 minute dip at 50°C did not cause damage to the skin. In the present study, scald occurred in Zill, but not in Kent. This result indicates that cultivars differ in their sensitivity to hot water treatment or to hot prochloraz treatment.

The induction of internal breakdown by heat treatment in mango has been reported before (Mitcham and McDonald, 1993; Esquerra and Lizada, 1990; Esquerra *et al.*, 1990). In the present study internal breakdown occurred in Zill, but not in Kent. It might thus be said that mango cultivars differ in their sensitivity to hot water treatment or to hot prochloraz treatment with regard to the induction of internal breakdown.

Prochloraz incorporation apparently enhanced ground skin colouration and total soluble solids content. Enhancements of these attributed due to heat treatment of mangoes has been reported elsewhere (Saucedo *et al.*, 1995; Jacobi *et al.*, 1995). However, an increase of these attributes due specifically to treatment with hot prochloraz has not been reported before to the knowledge of the author. This also applies to the increase in blotch observed as a result of fungicide incorporation.

In postharvest studies evaluating the effectiveness of fungicides on mango, fruit quality evaluation is often excluded. The present study indicates an improvement in fruit quality resulting from hot prochloraz treatment. Further research is required to verify this.

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## LITERATURE CITED

- DODD, J.C., BUGANTE, R., KOOMEN, I., JEFFRIES, P., AND JEGER, M.J. 1991. Pre- and post-harvest control of mango anthracnose in the Philippines. *Plant Pathology* 40:576-583.
- ESQUERRA, E.B., BRENA, S.R., REYES, M.U., AND LIZADA, M.C.C. 1990. Physiological breakdown in vapor heat-treated "Carabao" mango. *Acta Hort.* 269:425-434.
- ESQUERRA, E.B. AND LIZADA, M.C.C. 1990. The postharvest behaviour and quality of "Carabao" mangoes subjected to vapor heat treatment. *ASEAN Food Journal* 5:6-11.
- FENG, S.Q., CHEN, Y.X., WU, H.Z., AND ZHOU, S.T. 1991. The methods for delaying ripening and controlling postharvest diseases of mango. *Acta Agriculturae Universitatis Pekinensis* 17:61-65.
- JACOBI, K., GILES, J., MACRAE, E., AND WEGRZYN, T. 1995. Conditioning 'Kensington' mango with hot air alleviates hot water disinfestation injuries. *HortScience* 30:562-565.
- JOHNSON, G.I., BOAG, T.S., COOKE, A.W., IZARD, M., PANITZ, M., AND SANGCHOTE, S. 1990. Interaction of post harvest disease control treatments and gamma irradiation on mangoes. *Annals of Applied Biology* 116:245-257.
- JOHNSON, G.I., COATES, L.M., COOKE, A.W., WELLS, I.A., JOHNSON, G.I., AND HIGHLY, E. 1994. Postharvest control of mango diseases. *ACIAR Proceedings* No. 58.
- JOHNSON, G.I., SANGCHOTE, S., AND COOKE, A.W. 1990. Control of stem end rot (*Dothiorella dominicana*) and other postharvest diseases of mangoes (cv. Kensington Pride) during short- and long-term storage. *Tropical-Agriculture* 67:183-187.
- LONSDALE, J.H., LONSDALE, J.M., GREEF, H., AND BROOKS, W. 1991. The efficacy of prochloraz, chloramizol-sulphate and quazatine on postharvest diseases of mango. *S.A. Mango Growers' Assoc. Yearbook* 11:35-38.
- LONSDALE, J.H. 1992. In search of an effective postharvest treatment for the control of postharvest diseases of mangoes. *S.A. Mango Growers' Assoc. Yearbook* 12:32-36.
- McMILLAN, R.T. JR., SPALDING, D.H., AND REEDER, W.F. 1987. Effectiveness of various postharvest treatments for mango decay control. *Proc. Florida State Hort. Soc.* 100:7-9.
- MITCHAM, E.J. AND MCDONALD, R.E. 1993. Respiration rate, internal atmosphere, and ethanol and acetaldehyde accumulation in heat-treated mango fruit. *Postharvest Biology and Technology* 3:77-86.
- PELSER, P. DU T. AND LESAR, K.H. 1991. Postharvest decay control in mangoes with combinations of prochloraz, imazalil, benomyl or TBZ. *S.A. Mango Growers' Assoc. Yearbook* 11:9-10.

SAAIMAN, W.C. AND LONSDALE, J.H. 1994. The effect of prochloraz in combination with guazatine on post harvest diseases of mangoes. *S.A. Mango Growers' Assoc. Yearbook* 14:62-64.

SAUCEDO-VELOZ, C., MENA-NEVAREZ, G., AND CHAVEZ-FRANCO, S.H. 1995. Effect of hydrothermal treatments for quarantine purpose on the physiology and quality of "Manila" mango. *Harvest and Postharvest Technologies for Fresh Fruits and Vegetables*, 1995, 276-281.

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