The Effect of Calcium and Magnesium Chelate Sprays at Flowering on Fruit Quality and Physiological Disorders in Mango

S.A. Oosthuyse
HortResearch SA, P.O. Box 3849, Tzaneen 0850

ABSTRACT

Two sprays of either Calcimax, Magmax or a mixture of Calcimax and Magmax (1.5 *l* of each product/100 *l* H_2O) were applied to Sensation or Tommy Atkins mango trees whilst they were flowering. Yield or fruit size was not affected. Calcimax increased internal breakdown in Tommy Atkins and bacterial black spot in Sensation. Differences in disease incidence (besides bacterial black spot), lenticel damage, ground skin colouration, total soluble solids content, or pH in relation to treatment were not apparent in either cultivar. In Tommy Atkins, Magmax apparently enhanced taste, and Calcimax lessened taste appeal. The inability of Calcimax to reduce internal breakdown was ascribed to a distortion of the nutrient balance within the fruit. Further research is required to ascertain the tree nutrient conditions for which calcium applications will reduce the incidence of physiological disorders in mango.

INTRODUCTION

Physiological disorders characterized by internal breakdown (jelly-seed or soft-nose), and those relating to fruit development abnormalities (cavity formation which may be accompanied by tissue breakdown) are often encountered in Sensation and Tommy Atkins mangoes, respectively (Oosthuyse, 1993). Soft-nose development, evidenced by marked cell separation and cell wall degeneration, has been associated with a lack of calcium and magnesium at the site in the fruit where this disorder occurs (Burdon *et al.*, 1991; 1992). Leaf magnesium levels have been found to negatively correlate with spontaneous fruit ripening (tree ripening and fruit drop as mangoes advance in stage of maturation) (do, unpublished data). Mangoes ripening spontaneously long before harvest often exhibit some form of internal disorder (pers. obs.).

Foliar calcium application [$Ca(NO_3)_2$] has not been found to be effective in increasing leaf calcium levels (McKenzie, 1996). It has been suggested that nutrient application at flowering may result in better uptake due to the greater absorptive ability of developing inflorescences (Oosthuyse, 1996).

The aim of the present study was to assess the effect of Calcimax (Plaaskem, South Africa) and/or and Magmax (Plaaskem, South Africa) aerial applications to flowering Sensation and Tommy Atkins mango trees on the incidence of physiological disorders. A growing site where these mango varieties are particularly prone to disorder development was chosen. The effect of these sprays on various other fruit quality attributes, and on yield and fruit size was also determined.

MATERIALS AND METHODS

Forty Sensation and 40 Tommy Atkins trees (three to five years in age) were selected in two separate cultivar blocks at a mango estate in the Hoedspruit region. Identical procedures were followed in each cultivar. The procedure is described in what follows:

Two sprays were applied, the first when the inflorescences were rapidly extending, and the second when the inflorescences were in full-bloom. A factorial treatment arrangement was adopted were the factors were application or non-application of Calcimax and application or non-application of Magmax. The treatment combinations were as follows:

+ Calcimax; + Magmax (mixture of Calcimax and Magmax)
+ Calcimax; - Magmax (Calcimax alone)
- Calcimax; + Magmax (Magmax alone)
- Calcimax; - Magmax (neither Calcimax nor Magmax)

There were 10 single tree replicates of four treatments. Treatment allocation was done according to the randomized complete blocks design.

Calcimax or Magmax were applied at a concentration of 1.5 l per 100 l H_2O. Agral 90 (6 ml/100*l* H_2O) was added to the spray solutions.

The number of fruits per tree was counted prior to harvest in early December, 1996. At harvest, 10 to 20 randomly selected fruits were removed per tree. The weight of each fruit was ascertained to assess average fruit weight and tree yield. Immediately after harvest (within 24 hours), the sampled fruit were placed in a laboratory maintained at 20°C (± 2°C). In each fruit, degree of softening was determined daily with a densimeter (Heinrich Bareiss, Oberdischingen, Germany). Each fruit was evaluated for quality when it was firm-ripe (densimeter reading of less than 60 and greater than 40 from a non-diseased portion of the fruit). Quality evaluation was performed as follows:

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 (besides bacterial black spot) in each fruit was rated according 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.

In Sensation, the number of fruit of those sampled per tree showing signs of bacterial black spot infection was counted.

Lenticel damage was 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 in each fruit, each 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.

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.

RESULTS

Interaction was always found to be non-significant. The main effect means are therefore presented.

Calcimax increased the incidence of physiological disorders in Tommy Atkins, but not in Sensation (Fig. 1). The increase found here was the result of an increase in the incidence of internal breakdown (“jelly-seed”) (Fig. 2). Differences in physiological disorder incidence resulting from Magmax application were not apparent (Figs. 1 and 2).

Surprisingly, Calcimax increased the incidence of bacterial black spot (*Xanthomonas campestris* pv. *mangiferae-indicae*) in Sensation (Fig. 3). Here, a positive relationship was found to exist between bacterial black spot incidence and the incidence of jelly seed (Fig. 4). This indicates that the internal breakdown observed in Sensation was partly the result of microbial action. Black spot lesions on the skin would have exposed the pulp to infection.

Differences in disease incidence (diseases other than bacterial black spot), lenticel damage, ground skin colouration, total soluble solids content, and pH in relation to treatment were not apparent (Figs. 5, 6, 7, 8, and 9).

Taste in Sensation was not affected by treatment. However, in Tommy Atkins, Magmax apparently enhanced taste, and Calcimax apparently lessened taste appeal (Fig. 10).

DISCUSSION AND CONCLUSION

Calcimax aparrently increased the incidence of internal breakdown. It also increased the incidence of bacterial back spot. These results were not expected.

The inability of Calcimax to reduce internal breakdown might be described in terms of nutrient balances within the fruit. Calcium application may not be effective in reducing internal breakdown, if an increase of calcium does not effect a fruit nutrient balance which is unfavourable for the development of internal breakdown.

An increase in bacterial black spot infection in response to calcium application has not been reported before to the knowledge of the author. Pre-harvest application of calcium compounds has been reported to predispose mango fruit to *Diplodia* stem-end rot (caused by *Diplodia natalensis* [*Botryodiplodia theobromae*]) (Ray, *et al.*, 1993). Calcium nitrate or calcium chloride application was found to significantly increase the incidence of disease. Disease incidence increased with application rate. Moreover, spraying twice was more effective than spraying once. Calcium nitrate or calcium chloride was also found to increase linear growth of *Botryodiplodia theobromae* on potato dextrose agar.

Pre-harvest calcium application has been reported to enhance fruit quality attributes in mango. Singh *et al.* (1993) reported that fruits harvested from Dashehari mango trees sprayed with $Ca(NO_3)_2$ (1 or 2% Ca_2^{+}) or $CaCl_2$ (0.6 or 1.2% Ca_2^{+}) 20 or 10 days before harvest were of an improved quality and ripened more slowly than fruits harvested from untreated trees. The relative earliness of Calcimax application in the present study may have been such that the likelihood of an effect on fruit quality arising was small.

The fact that tree yield was not affected might be seen to indicate that the tree calcium levels were not deficient. Fruit size should have been affected if yield was affected.

The effect of Magmax and Calcimax on taste is difficult to explain. Other, research relating taste to fruit calcium or magnesium levels in mango is unavailable to the knowledge of the author.

Further research is required to ascertain the tree nutrient conditions under which calcium applications well reduce the incidence of physiological disorders in mango.

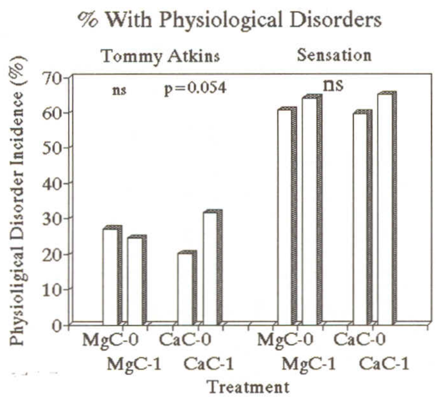

Fig. 1 *Main effect means for percentage of fruit showing signs of physiological disorders. MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

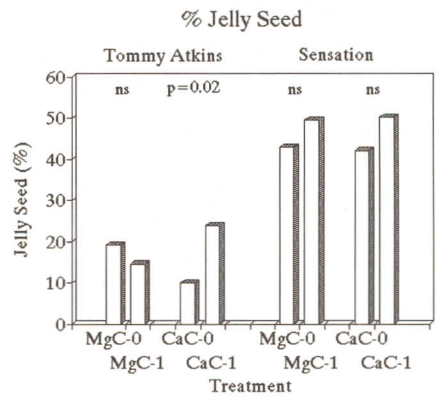

Fig. 2 *Main effect means for percentage of fruit showing signs of internal breakdown ("jelly seed"). MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

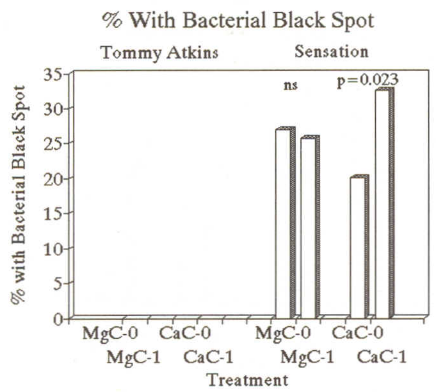

Fig. 3 *Main effect means for percentage of fruit showing signs of bacterial black spot (bacterial black spot incidence was not recorded in Tommy Atkins). MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

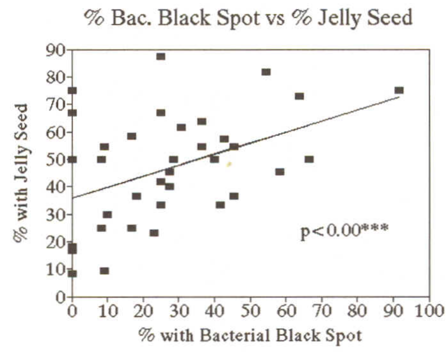

Fig. 4 *Relationship between bacterial black spot incidence and internal breakdown incidence ("jelly seed") in Sensation. *** denotes a very highly significant linear relationship.*

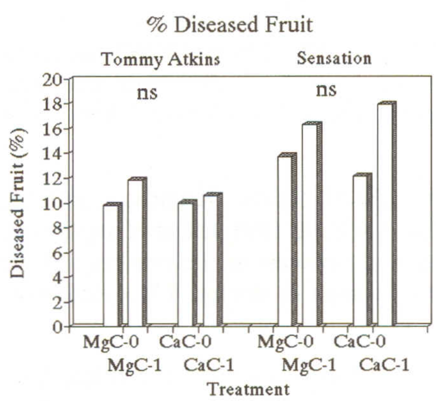

Fig. 5 *Main effect means for percentage of fruit showing signs of disease (besides bacterial black spot). MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

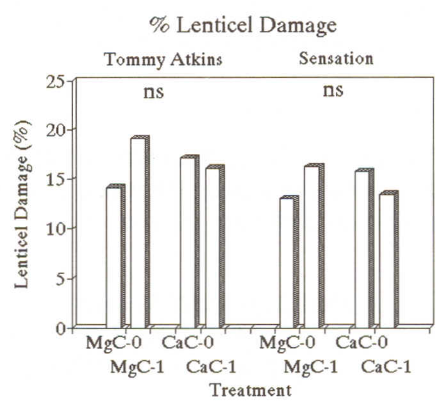

Fig. 6 *Main effect means for lenticel damage severity expressed as the percentage of the skin surface over which damaged lenticels could be seen. MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

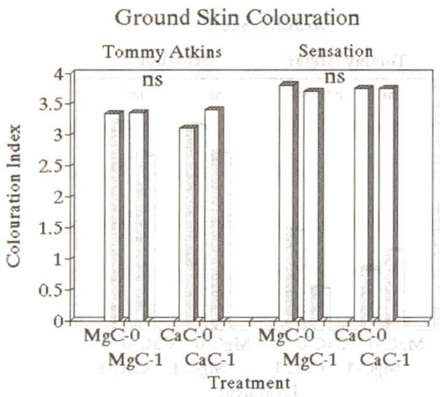

Fig. 7 *Main effect means for ground skin colouration. MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

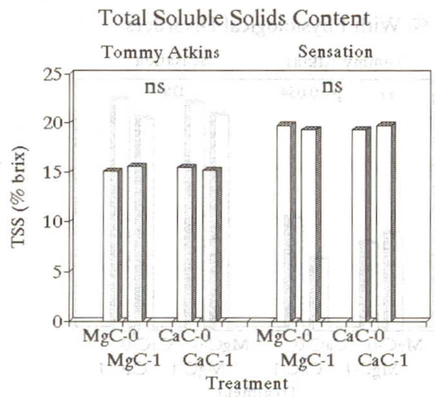

Fig. 8 *Main effect means for total soluble solids content. MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

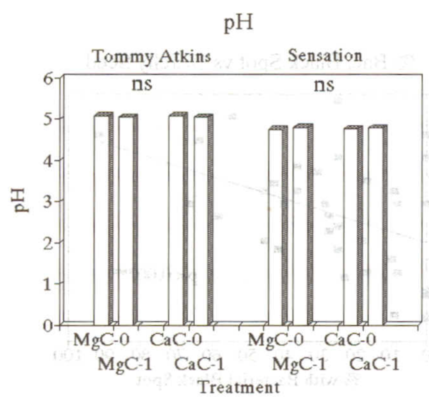

Fig. 9 *Main effect means for pH. MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

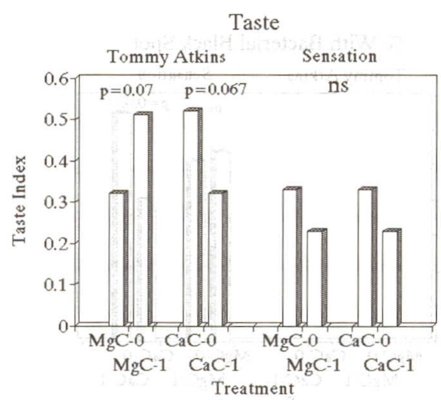

Fig. 10 *Main effect means for taste. MgC-0 = main effect for non-application of Magmax; MgC-1 = main effect for Magmax application; CaC-0 = main effect for non-application of Calcimax; CaC-1 = main effect for application of Calcimax (ns = non-significant difference (p < 0.05), otherwise significance level presented).*

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