Effect of KNO_3 Spray to Flowering Mango Trees on Fruit Retention, Fruit Size, Tree Yield, and Fruit Quality.

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ABSTRACT

In South Africa, the mango cultivars 'Tommy Atkins,' 'Kent,' and 'Heidi' retain few fruit relative to the cultivars 'Sensation,' 'Irwin,' and 'Keitt.' In the present study, the effect on fruit retention, fruit size, tree yield, and fruit quality of inflorescence applications of KNO_3 to trees of the former cultivars was investigated.

A KNO_3 spray at 2 or 4% was administered either once during the flowering period, i.e., when the inflorescences were in full-bloom, or twice during this period, i.e., when the inflorescences were actively developing and subsequently when they were in bloom. In 'Tommy Atkins', the greatest increase in fruit number occurred following the single application at 4%. In 'Heidi', two applications at 4% each gave rise to the greatest increase, and in 'Kent', two applications at 2% each gave rise to the greatest increase. In each cultivar, slight reductions in average fruit weight were associated with the increases in fruit retention found. In every cultivar, increases in yield occurred. The greatest increases corresponded with the greatest increases in fruit retention found. There was no apparent effect of the KNO_3 sprays on fruit quality (ground skin colouration, total soluble solids content, pH, or taste on ripening).

INTRODUCTION

In South Africa, 'Tommy Atkins,' 'Kent,' and 'Heidi,' mango trees retain few fruit relative to 'Sensation,' 'Irwin' and 'Keitt' mango trees. KNO_3 foliar applications have been found to enhance flowering in mango, and thereby enhance tree yield (Barba, 1974; Bondad and Linsangan, 1979). It is noteworthy that climatic conditions in the regions of the world where KNO_3 is effective in promoting flowering, often do not become adequately inductive for flowering during the year. In subtropical regions, i.e., where winter conditions are sufficiently inductive, flowering enhancement by KNO_3 has not been reported.

Aerial applications of nutrients to mango trees have been found to be ineffective in increasing leaf nutrient status (McKenzie, 1995a). This is probably due to the low absorptive capacity of the leaves. Nutrient application when inflorescences are present may be effective in increasing the nutrient status of a tree, as the inflorescences may be more capable of nutrient uptake.

KNO_3 spray application to 'Tommy Atkins' mango trees whilst the inflorescences were in full-bloom was previously found to increase fruit retention, to reduce fruit size, and to increase tree yield and tree revenue (Oosthuyse, 1993a). In the present study, the results of further experiments evaluating KNO_3 aerial application to flowering mango trees are presented.

MATERIALS AND METHODS

Experiment I (1992)

In early August, 33 adjacent mango trees were selected in an eight-year-old 'Tommy Atkins' orchard at Constantia in the Northern Province (latitude: 23°40'S; longitude: 30°40'E; elevation: 457 m; semi-arid and subtropical). Twenty two of the trees were sprayed to run-off with KNO_3 at 2 or 4 % when the inflorescences were in full-bloom (Aug. 22). Supafilm (15 ml/100 l; Plaaskem, South Africa) was added to the spray mix. At harvest in late December 1992, the fruits on each tree were individually weighed.

There were 11 single tree replicates of three treatments (incl. control) in a complete randomized blocks design. The data (tree totals or averages) were subjected to analysis of variance. In each analysis, the treatment sums of squares was subdivided for linear and quadratic components.

The trees were flood-irrigated every 21 days commencing in late January 1992, each tree was fertilized with 1 kg of limestone ammonium nitrate, broadcast monthly in three equal applications, and 1 kg of potassium chloride, broadcast monthly in two equal applications. Systemic fungicides were sprayed on the trees during flowering every 14 days to control inflorescence diseases, and copper-oxychloride was sprayed on the trees during the fruit develop-

ment period every 21 days to limit disease infection. Insecticides were applied when required.

Experiment II (1993)

In mid-June 1993, 60 two- to three-year-old mango trees of uniform size and stage of flowering were selected in each of three cultivar blocks at Mariepskop Estate in the Northern Province (latitude: 24°25'S; longitude: 30°52'E; elevation: 550 m; semi-arid and subtropical). The trees comprised the cultivars 'Tommy Atkins', 'Heidi', and 'Kent'.

Irrigation was scheduled, and water-stress was not imposed at any stage. Five hundred grams of composted chicken manure supplemented with guano (10%) and dried kelp (5%), and 30 g of limestone ammonium nitrate (28% N), were applied monthly to each tree. Fungicides and insecticides were administered regularly to control harmful insects and pathogens.

In each cultivar block, KNO_3 was sprayed on trees at 2 or 4%, and one or two applications were made. Single trees served as plots. There were four treatment combinations in a complete randomized blocks design comprising 10 blocks with five trees in each. One unsprayed tree in each block served as a control. Spraying took place when the inflorescences were actively extending and subsequently when the inflorescences were at 50 to 100% bloom when two applications were made. When one application was made, the inflorescences were sprayed when at 50 to 100% bloom. Agral 60 was used as a wetting agent (6 ml/100 l H_2O).

After the period of fruit drop which succeeds flowering, the number of fruits on each tree was counted. At harvest, the fruits on each tree were individually weighed. Furthermore, two randomly selected fruits were taken from each tree and placed in a well ventilated laboratory (within four hours from picking), where they were allowed to ripen at 20 (±1)°C. These fruits were examined daily, and when the surface of a fruit yielded to thumb pressure, it was evaluated as follows:

Skin coloration 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 that was yellow exceeded that total area that was green, and a rating of 4 if the skin was completely yellow. The skin area covered with red-blush was not considered.

To assess internal quality, each fruit was cut through twice, i.e., longitudinally along the flattened margins of the seed. Juice form each of the cheeks thus obtained was assessed for its pH (Mettler 320 pH meter), total soluble solids content (N1, Atago hand-held refractometer), and taste.

Taste was rated. A rating of 1 was given if taste was appealing, a rating of 0 if taste was satisfactory by not appealing, and a rating of -1 if taste was unsatisfactory due to the presence of off-flavours.

The data (tree totals or averages) were subjected to

Table 1 *Means and contrast significance levels (P) for number of fruit harvested, average fruit weight, and tree yield.*

Treatment	Number of fruit harvested	Average fruit weight (g)	Tree Yield (kg)
Unsprayed	205	385	78
2% KNO_3	226	366	83
4%KNO_3	244	367	90
ANOVA results - [z]p values			
Linear	0.09	0.10	0.21
Quadratic	0.94	0.31	0.86

[z]Contrast probabilities

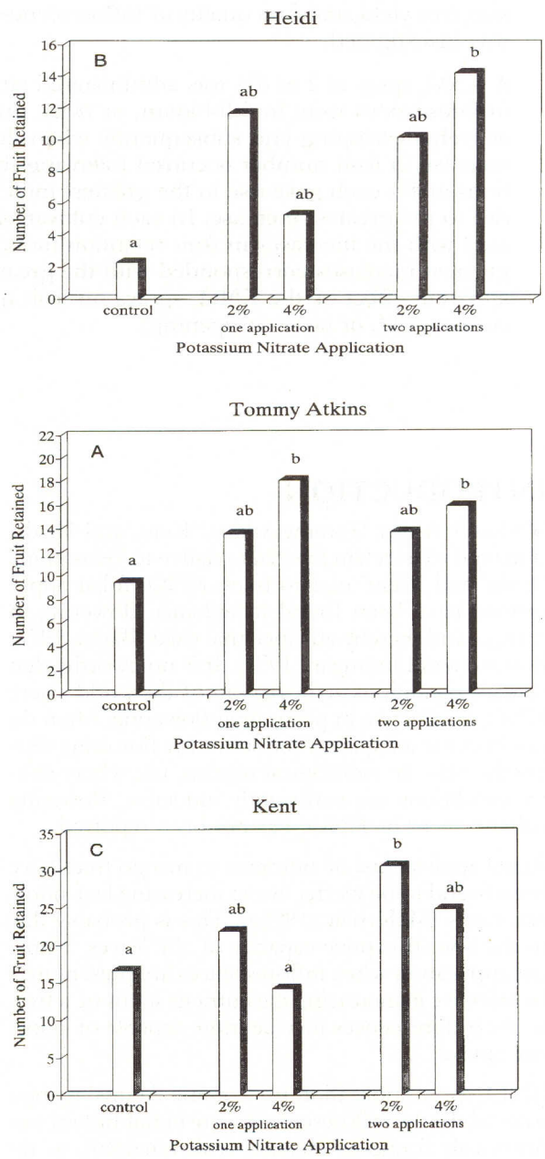

Fig. 1 *Effect of the KNO3 sprays on number of fruit retained in 'Tommy Atkins' (A), 'Heidi' (B), and 'Kent' (C). Bars with differing letters differ significantly according to LSD (5%).*

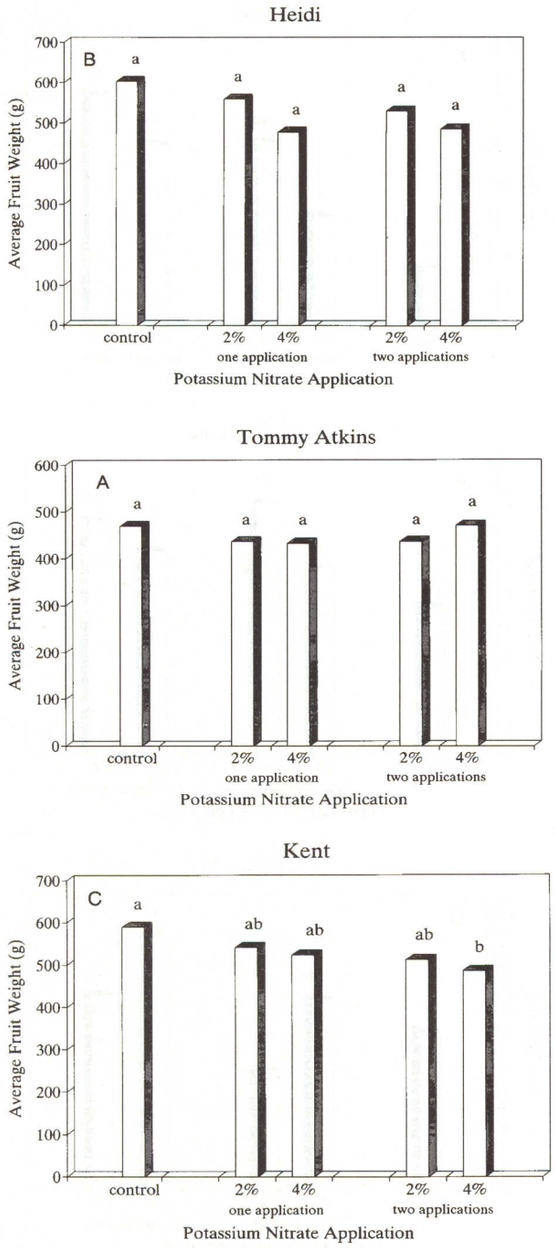

Fig. 2 *Effect of the KNO3 sprays on average fruit weight (fruit size) in 'Tommy Atkins' (A), 'Heidi' (B), and 'Kent' (C). Bars with differing letters differ significantly according to LSD (5%).*

analysis of variance, and transformed when such transformation was deemed necessary.

RESULTS

Experiment I (1992)

KNO_3 application, especially at 4%, was slightly phytotoxic to the leaves and inflorescences. The distal margins of some to the leaves and the extremities of some the inflorescence branches became necrotic.

Means and significance levels for number of fruit retained, average fruit weight, and tree yield are shown in Table 1. Linear increases in number of fruit retained and tree yield were apparently associated with the increase in concentration of KNO_3 applied. Moreover, these increases were apparently associated a linear reduction in average fruit weight.

Table 2 *Ground skin colouration, total soluble solids content, pH, and taste of the sampled 'Tommy Atkins' fruit once they were ripe.*

Treatment	Ground skin colouration index	TSS (% brix)	pH	Taste index
Unsprayed	3.5	15.4	4.8	0.7
Single application				
2% KNO_3	3.7	14.7	4.9	0.7
4%KNO_3	3.4	14.9	4.8	0.7
Double application				
2% KNO_3	3.5	15.0	4.9	0.9
4%KNO_3	3.7	15.2	4.9	0.9

Within columns, all differences were non-significant according to LSD (5%)

Experiment II (1993)

Slight phytotoxicity was observed as in Experiment I. The effect of the KNO_3 sprays on number of fruit retained is shown in Fig. 1. In each cultivar, increases were found. In 'Tommy Atkins', the greatest increase occurred following the single application at 4%. In 'Heidi', two applications at 4% each gave rise to the greatest increase, and in 'Kent', two applications at 2% each gave rise to the greatest increase.

Slight reductions in average fruit weight were apparently associated with the increases in fruit retention found (Fig. 2). However, only in 'Kent' was there a significant reduction in average fruit weight, which followed the two KNO_3 applications at 4% each.

The effect of the KNO_3 sprays on tree yield is shown in Fig. 3. In each cultivar, increases occurred. Moreover, the greatest increases corresponded with the greatest increases in fruit retention found.

There was no apparent effect of the KNO_3 sprays on ground skin colouration, total soluble solids content, pH, or taste on fruit ripening in any of the cultivars (Tables 2, 3 and 4).

DISCUSSION AND CONCLUSION

Increases in fruit retention and tree yield occurred despite all the trees having received adequate fertilizer and water (via the soil). As stated previously, KNO_3 foliar application induces flowering in mango. KNO_3 may thus be considered to have growth regulatory properties in this tree crop (Bondad and Linsangan, 1979). Foliar application of growth promoters has also been found to increase fruit retention in mango (Chen, 1983; Oosthuyse, 1995a).

Increased nitrogen fertilization via the soil has, however, also been found to effect an increase in fruit

Table 3 *Ground skin colouration, total soluble solids content, pH, and taste of the sampled 'Heidi' fruit once they were ripe.*

Treatment	Ground skin colouration index	TSS (% brix)	pH	Taste index
Unsprayed	3.2	13.9	4.0	0.7
Single application				
2% KNO_3	3.4	14.8	4.0	0.7
4%KNO_3	3.5	14.8	4.2	0.7
Double application				
2% KNO_3	3.8	14.7	4.1	0.9
4%KNO_3	3.6	14.5	4.2	0.9

Within columns, all differences were non-significant according to LSD (5%)

Table 4 *Ground skin colouration, total soluble solids content, pH, and taste of the sampled 'Kent' fruit once they were ripe.*

Treatment	Ground skin colouration index	TSS (% brix)	pH	Taste index
Unsprayed	1.4	18.2	4.3	0.25
Single application				
2% KNO_3	1.5	18.8	4.3	0.40
4%KNO_3	1.3	18.6	4.1	0.56
Double application				
2% KNO_3	1.9	19.0	4.1	0.69
4%KNO_3	1.9	19.1	4.3	0.36

Within columns, all differences were non-significant according to LSD (5%)

retention and tree yield in mango (Smith, 1994). Hence, a 'nutritional' effect cannot be discounted.

A negative correlation has been found to exist between extent of nitrogen fertilization or leaf nitrogen status and degree of fruit de-greening on ripening (Oosthuyse, 1993b; McKenzie, 1994; 1995b). In the present study, KNO_3 application did not effect a reduction in de-greening. It might thus be considered that the effect of the KNO_3 sprays was not of sufficient impact to markedly increase the trees' nitrogen status.

The reductions in fruit size brought about by KNO_3 might be ascribed to the enhancements in fruit retention caused. A negative relationship between fruit number and size in mango has been shown previously by the author (Oosthuyse, 1995b).

The results of the present study nevertheless show that spray application of KNO_3 to 'Tommy Atkins', 'Heidi', or 'Kent' mango trees whilst they are flowering increases fruit retention and tree yield without there being a conspicuous reduction in fruit size. It is noteworthy that application of KNO_3 to 'Keitt' and also 'Zill' mango trees was not found to be beneficial (do, unpublished). This may have been the result of increased inflorescence phytotoxicity. It is

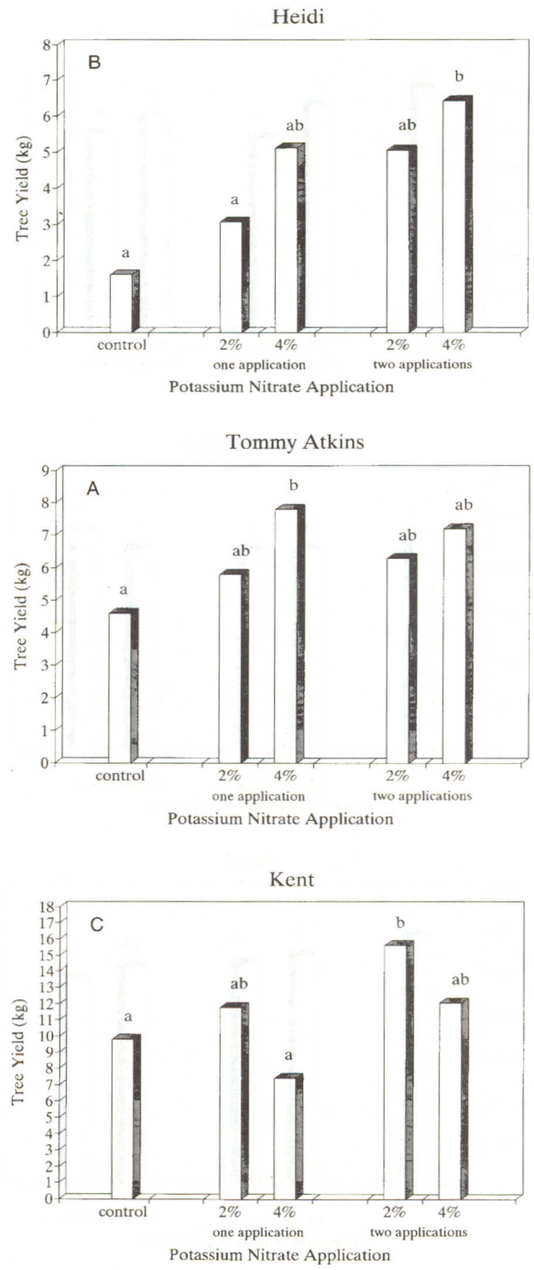

Fig. 3 *Effect of the KNO3 sprays on tree yield in 'Tommy Atkins' (A), 'Heidi' (B), and 'Kent' (C). Bars with differing letters differ significantly according to LSD (5%).*

advised that the effects of KNO_3 application be evaluated on cultivars other that those used in the present study before commercial recommendations are made for these cultivars.

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