Effect of Spray Application of KNO$_3$, Urea and Growth Regulators on the Yield of Tommy Atkins Mango

S.A. Oosthuysie

Merensky Technological Services, P.O. Box 14, Duivelskloof 0835

ABSTRACT

The effects of foliar spray application of KNO$_3$, low biuret urea, GA$_3$ (a gibberellin), CPPU (a synthetic cytokinin) and NAA (a synthetic auxin) on fruit retention, average fruit weight and yield at harvest, and monetary return taking currently obtained prices into account were evaluated. Applications were made while the trees were in flower or subsequently, just prior to the commencement of fruit drop. The effect of a foliar application of Wuxal$^+$-boron at flowering and of panicle pruning were additionally evaluated. Of the treatments applied during flowering, KNO$_3$ application was the only treatment to noticeably increase fruit retention, average fruit mass, yield and monetary return. Of the treatments applied after flowering, application of CPPU + GA$_3$, NAA, or NAA + GA$_3$ noticeably increased fruit retention, yield and monetary return. Increases in return realized were in the order of 19 to 33%.

INTRODUCTION

Trees of the mango cultivars Zill, Tommy Atkins, Haden, Kent, and Heidi notably retain less than one fruit on average per panicle, despite sufficient irrigation and fertilization and adequate control of panicle diseases. After the respective events of flowering, fruit set and initial fruit drop, a large proportion of the panicles on the upper portion of the canopy can be observed to be devoid of fruit. In view of the high percentage of fruitless panicles, especially on a particular portion of the canopy, it would appear that the cultivars in question crop beneath capacity, at least under local conditions.

Wolstenholme and Robert (1991) reviewed the mango yield problem, concluding that the tree carbohydrate status, and moisture deficits that cannot be met by soil moisture and arising due to the advent of hot and dry conditions, are the major yield constraints in existing mango fruitlets. The present study was initiated to evaluate the effect of foliar spray application of KNO$_3$, low biuret urea, GA$_3$ (a gibberellin), CPPU (a synthetic cytokinin) or NAA (a synthetic auxin) reported to advance and increase the density of flowering (Bonnad and Linsangan, 1979; Nunez-Elisea, 1985), and pre-flowering urea spray application was reported to be effective in increasing the number of leafy inflorescences produced by Washington navel orange trees (Lovatt, 1990).

Boron deficiency has been implicated as a factor limiting fruit retention in mango in view of a particular need for boron for efficient fertilization (Robbertse, et al. 1988). Boron applied as a spray to Tommy Atkins mango trees in flower was reported to increase yield (Robbertse, et al. 1990; Coetzee et al. 1991). The panicles of mango trees are seen as being a drain on reserves and currently produced assimilates (Wolstenholme and Cutting, 1991). By pruning the panicles during the early stages of their development, and thereby markedly limiting the extent of their development, a reduction in the drain on reserves would be anticipated, and consequently, the availability of assimilates to young fruitlets after flowering would be expected to be greater. Chacko (1984) concluded from investigations made of the pattern of movement and distribution of $^{14}$C-photosynthates in mango at various stages of flowering and fruit development, that the heavy drop of mango fruitlets soon after flowering is primarily due to the competition between them for a limited supply of assimilates. An increase in fruit retention might thus occur in response to panicle pruning. The present study was initiated to evaluate the effect of foliar spray application of KNO$_3$, low biuret urea, GA$_3$ (a gibberellin), CPPU (a synthetic cytokinin) or NAA (a synthetic auxin) on mango yield.
In view of the probable withdrawal of Chemox® for commercial use, future trials will incorporate other prospective chemical deblossoming agents. Ethrel® sprayed on trees at concentrations of greater than 1200 ppm (a.i.) may prove to be effective.

Gibberellin (GA3) applied as a spray before the flowering period was reported to be effective in delaying and synchronizing flowering of Keitt mango (Nunez-Elisea and Davenport, 1991). In an experiment recently performed by the author, spray application of GA3 at 200 ppm approximately three weeks before flowering, markedly delayed budbreak and gave rise to shoot as opposed to panicle development. Failure to obtain the desired response may have been related to the time or dose of the application. This option is to receive further investigation.

ACKNOWLEDGEMENTS

Thanks are due to Gustav van Veijeren of Constantia for his generosity in making trees available for this study, and to Wynand Saaiman of Merensky Technological Services for abstract translation.

LITERATURE CITED


synthetic auxin) on fruit retention, average fruit weight and yield at harvest, and monetary return taking currently obtained prices into account. Composite application was evaluated in most instances. Applications were made while the trees were in flower (Experiment I), and subsequently, just prior to the commencement of fruit drop (Experiment II). In Experiment I, the effect of a foliar application of Wuxal®-boron, a nutrient formulation rich in boron, and the effect of panicle pruning were additionally evaluated.

MATERIALS AND METHODS

Experiment I

Thirty-nine, 10-year-old Tommy Atkins mango trees were selected for uniformity of size in an orchard at Constantia in the north-eastern Transvaal (grower: Gustav van Veijeren). To effect uniform flowering, the trees were deblossomed on July 17 and 19. Panicle removal was achieved by pruning the terminal shoots 5 cm beneath the point of panicle attachment, which meant additional removal of the terminal whorl of leaves. On Aug. 28, the trees had already begun to re-flower, the panicles having been at the development stage of “in shoot: 5-10 cm” (Oosthuys, 1991). To control panicle diseases, the trees were sprayed with Nustar® (5 ml/1001 H2O) every 14 days during the period of flowering. Spaying commenced on Aug. 21.

The experiment comprised of the following treatments:

1. Control: Untreated
2. Panicle pruning: Newly developing panicles were headed just above the site of the second or third primary branch from the point of panicle attachment. The remaining panicle branches were headed back severely (2/3 removed) once they had developed somewhat. Panicle pruning commenced on Aug. 28.
3. Wuxal®-boron
4. KN03 + NAA
5. Urea + NAA
6. KN03 + CPPU
7. Urea + CPPU
8. KN03 + NAA + GA3
9. Urea + NAA + GA3
10. KN03 + CPPU + GA3
11. Urea + CPPU + GA3
12. KN03
13. Urea

Concentrations and times of application:

Wuxal®-boron: 150 ml/1001 H2O; applied twice, on Aug. 28 (panicles in shoot: 3-15 cm) and on Sep. 11 (panicles 50 to 100% anthesis).

KN03: 4 kg/1001 H2O; applied twice, on Aug. 28 (panicles in shoot: 3-15 cm) and on Sep. 11 (panicles 50 to 100% anthesis).

Urea: 1 kg low biuret urea/1001 H2O; applied twice, on Aug. 28 (panicles in shoot: 3-15 cm) and on Sep. 11 (panicles 50 to 100% anthesis).

NAA: 88.9 ml Planofix®/1001 H2O (40 ppm a.i.); applied on Sep. 18 (panicles at small fruit set).

CPPU: 10 ml, 10% CPPU/1001 H2O (10 ppm a.i.); applied on Sep. 18 (panicles at small fruit set).

GA3: 138.9 ml ProGibb®/1001 H2O (40 ppm a.i.); applied on Sep. 18 (panicles at small fruit set).

When more than one growth regulator was applied (Sep. 18), the growth regulators were mixed in the same tank. In every instance, the trees were sprayed to run-off.
A completely randomized design was employed where single trees served as plots. Each treatment was applied to three trees. The fruit were individually weighed on the general harvest date, determined on the basis of the initiation of the transition in pulp colouration. Average prices received on European markets in 1992 for Tommy Atkins fruit of the various counts after deduction for packing and shipping costs were obtained from Hans Merensky Exporting Company. A price was accordingly designated to each fruit. Due to pronounced variance heterogeneity relating to treatment, analysis of variance was not performed. The data (number of fruit, average weight of fruit, and total weight of fruit per tree at harvest; and monetary return per tree) were interpreted in terms of the treatment means and their standard errors.

Experiment II
On Sep. 20, before the commencement of fruit drop and when fruitlets were generally "marble" to "goen" in size, 65 trees were selected for uniformity of size in the aforementioned orchard. Immediately after selection, the following spray applications were made:

1. Control: Untreated
2. CPPU
3. CPPU + GA3
4. CPPU + KNO3
5. CPPU + Urea
6. CPPU + GA3 + KNO3
7. CPPU + GA3 + Urea
8. NAA
9. NAA + GA3
10. NAA + KNO3
11. NAA + Urea
12. NAA + GA3 + KNO3
13. NAA + GA3 + Urea

Concentrations:
CPPU: 10 ppm CPPU (10 ml, 10% CPPU/1001 H2O)
GA3: 30 ppm GA3 (104.2 ml ProGibb®/1001 H2O)
NAA: 40 ppm NAA (88.9 ml Planofix®/1001 H2O)
KNO3: 2% (2 kg KNO3/1001 H2O)
Urea: 1% (1 kg low biuret urea/1001 H2O)

When more than one substance was applied, both were placed in the same tank. Spraying was performed to run-off.

A completely randomized design was employed where single trees served as plots, each treatment having been randomly designated to five trees. The fruit...
450: § \begin{align*} r_{\text{cor}} &= 0.95 \\ p \left(\text{sig. level}\right) &= 0.015 \\ y &= 3.26 - 0.12 \times x \end{align*}

Fig. 8 Relationship between fruit number and average fruit weight.

\[ Y = 398 - 0.12x \]

Fig. 9 Average weight of the fruit harvested per tree (vertical bars: \pm SE).

Fig. 10 Average return for the fruit harvested per tree (vertical bars: \pm SE).

Fig. 11 Average percentage increases in return relative to the average return for the control trees.

were individually weighed on the general harvest date, determined on the basis of the initiation of the transition in pulp colouration. Average prices received on European markets for Tommy Atkins fruit of the various counts in 1992 after deduction for packing and shipping costs were obtained from Hans Merensky Exporting Company. A price was accordingly designated to each fruit. Due to pronounced variance heterogeneity relating to treatment, analysis of variance was not performed.

**RESULTS**

**Experiment I**

**Fruit retention**

The only treatments that resulted in a noticeable increase in the number of fruit retained were Treatment 8 (\(\text{KNO}_3 + \text{NAA} + \text{GA}_3\)) and Treatment 12 (\(\text{KNO}_3\)) (Fig. 1). Low biuret urea, when applied solely or incorporated, had a pronounced negative effect on fruit retention.

**Average fruit weight**

In general, the increases in fruit retention were each accompanied by decreases in average fruit weight, and vice versa (Fig. 2). However, in Treatment 2 (\(\text{KNO}_3\)), the effect of an increase in retention was also accompanied by an increase in average fruit weight. Panicle pruning (Treatment 2), although not having had an effect on fruit retention, resulted in a noticeable increase in average fruit weight.

**Yield**

In considering the total weight of fruit harvested per tree, the only treatment to effect a noticeable increase was Treatment 12 (\(\text{KNO}_3\)) (Fig. 3). This might have been anticipated in view of this treatment having caused an increase in fruit retention as well as an increase in average fruit weight. Although Treatment 8 (\(\text{KNO}_3 + \text{NAA} + \text{GA}_3\)) gave rise to an increase in the number of fruit retained, a resultant positive effect on yield was offset by the associated reduction in average fruit weight. The effect of panicle pruning on yield was not marked, despite the positive effect of this treatment on average fruit weight.

**Return**

In considering return based on prices received during the 1991/92 export season, Treatment 12 (\(\text{KNO}_3\)) was the only treatment that resulted in a noticeable increase in return (Fig. 4). A 33% average increase in return relative the average return for the control trees was realized (Fig. 5).

**Phytotoxicity**

The Urea and \(\text{KNO}_3\) applications were slightly phytotoxic. Burn and at the tips of the older leaves and margins
leaves on new flush growth was apparent. Curling of the young leaves was apparent, as well as blackening (necrosis) of young fruitlets on the panicles. In view of the latter effect, KN03 applications at a lower concentration of 2%, for example, may prove to be more beneficial than the 4% applications.

Experiment II

Fruit retention

The treatments that resulted in a noticeable increase in the number of fruit retained were Treatment 3 (CPPU + GA₃), Treatment 8 (NAA), and Treatment 9 (NAA + GA₃) (Fig. 6).

Average fruit weight

The increases in fruit retention were each accompanied by a decrease in average fruit weight, and vice versa (Fig. 7). In considering the relationship between average fruit weight and the number of fruit retained per tree, a significant negative relationship was found (Fig. 8). However, the relationship was weak, as indicated by the slope of the fitted line, and imprecise, as indicated by the low coefficient of correlation (r). Interestingly, this relationship suggests that, in Tommy Atkins at least, fruit size cannot be markedly influenced by fruit thinning.

Yield

In considering the total weight of fruit harvested per tree, the increases observed were a direct reflection of the effect of treatment on fruit retention (Fig. 9). Noticeable increases in yield were observed for Treatment 3 (CPPU + GA₃), Treatment 8 (NAA) and Treatment 9 (NAA + GA₃).

Return

Return, based on prices received during the 1992 export season, was commensurate with yield (Fig. 10). Noticeable increases in return were observed for Treatment 3 (CPPU + GA₃), Treatment 8 (NAA) and Treatment 9 (NAA + GA₃). An average increase in return of 26%, 29%, and 19% was observed for Treatment 3, Treatment 8, and Treatment 9, respectively, relative to the average return for the control trees (Fig. 11).

CONCLUSION

In view of the preliminary nature of the results, it was felt that a full discussion of the effects of the treatments employed is not warranted. It would appear, however, that spray applications of KN03 during the period of flowering, or spray application of CPPU + GA₃, NAA, or NAA + GA₃ just prior to the commencement of fruit drop, can be employed to improve the yield of Tommy Atkins mango. Productivity increases in terms of return realized were in the order of 19 to 33%. The foregoing treatments may also prove to be effective when applied to trees of other mango cultivars grown that retain an average of less than one fruit per panicle.

Future trials will be aimed at (1) confirming the results of the present study, (2) testing the promising spray applications on a number of the other mango cultivars grown locally for export, and (3) investigating the effect of other concentrations of the promising applications, for example, 2% applications of KN03 during the flowering period.

ACKNOWLEDGEMENTS

 Thanks are due to Gustav van Veijeren of Constantia for his generosity in making trees available for this study. Thanks are also due to Wynand Saaiman of Merensky Technological Services for abstract translation.

LITERATURE CITED


LOVATT, C.J. 1990. The role of nitrogen in citrus flowering and fruit set. Lecture presented in March 1990 at the University Cooperative Extension Class, University of California, Riverside.


