Flowering Synchronization of Sensation Mango Trees by Chemical Inflorescence Removal

S.A. Oosthuyse and G. Jacobs
Horticultural Science, University of Stellenbosch, Stellenbosch 7600

Abstract
Sensation mango trees grown in the Northern and Mpumalanga Provinces of South Africa flower unevenly. Flowering synchronization can be achieved in Sensation by removing the inflorescences by hand during the normal flowering period. In the present study, chemical inflorescence removal as a means of synchronizing flowering in Sensation was evaluated.
The inflorescences on Sensation mango trees were removed chemically ('chemical pruning') by a spray of dinoseb acetate (1062 ppm) in early July and in early August. Comparisons were made with untreated trees, and trees whose apical buds and inflorescences were removed by hand in early July. Chemical pruning was effective in synchronizing flowering, but was slightly less so than hand pruning. Tree flowering duration was shortest and flowering most delayed in the chemically pruned trees. Flowering intensity was highest in the hand pruned trees and lowest in the untreated trees. Post-flowering fruit drop was positively related to flowering intensity. Differences in tree yield were unapparent, however, due to compensatory increases in fruit size in the chemically and hand pruned trees. These results show that chemical inflorescence removal can be employed as a measure to synchronize flowering in Sensation without areduction in yield.

INTRODUCTION

In mango, the removal of the apical bud or inflorescence on terminal shoots just prior to or during the flowering period ('winter pruning') results in the development of normally inhibited axillary buds adjacent to the point of cutting (Reece *et al.*, 1946). These buds usually develop as inflorescences, particularly if pruning is performed shortly before or after the start of normal flowering (Issarakraisila and Considine, 1991; Singh *et al.*, 1974). If inflorescences do develop, a delay in flowering of four to eight weeks is effected (Reece *et al.*, 1946; Singh *et al.*, 1974; Gazit, 1975), which gives rise to a delay in harvest (Issarakraisila and Considine, 1991; Oosthuyse, 1995).

Sensation mango trees grown in the Northern and Mpumalanga Provinces of South Africa flower unevenly. Differences in stage of flowering between trees as well as individual branches in the same tree are encountered. Uneven flowering has also been reported to occur in other mango cultivars (Reece *et al.*, 1949; Lin and Chen, 1981).

Flowering synchronization can be achieved in Sensation by winter pruning (Oosthuyse, 1995). Moreover, reduced flowering variability was associated with reduced variation in the stage of fruit growth and development prior to harvest, in the stage of fruit maturation at harvest, and in the rate of ripening after harvest. Fruit retention was reduced by winter pruning, although yield was unaffected in trees pruned when in a positive phase of alternation owing to a compensatory increase in fruit size.

The removal of the inflorescences and apical buds on entire trees by hand is laborious and time consuming, particularly if the trees are large. Mechanical pruning may result in a marked reduction in yield, in view of the additional removal of leaves being inevitable (Oosthuyse, 1995). Inflorescence removal by chemical means ('chemical pruning') may thus be the most practicable alternative.

Cycloheximide (Pal and Chadha, 1982; Shu, 1993), dinoseb phenol (Gazit, 1975; Mullins, 1987; Shu, 1993), dinoseb acetate (Mullins, 1987), pentochloro-phenol monohydrate sodium salt (Shu, 1993), and ethephon (Chadha *et al.*, 1979; Galan Sauco *et al.*, 1993) have been used at various geographical locations to de-blossom mango trees with the aim of delaying flowering to a period when conditions are warmer, and therefore more favourable for inflorescence development and fruit retention. Chemical pruning has not been formerly evaluated as a measure to synchronize the flowering of mango trees.

The aim of the present study was to evaluate chemical pruning in relation to hand pruning as a measure to synchronize flowering in Sensation. The effect of chemical or hand pruning on the time and intensity of flowering, fruit growth and retention, and fruit size and tree yield at harvest was also assessed.

MATERIALS AND METHODS

Thirty, two-year-old Sensation mango trees of similar canopy dimensions and in their first cropping year were selected in a commercial orchard at Constantia (latitude: $23^0$40'S; longitude: $30^0$40'E; elevation: 457 m) in early June 1992. Eight terminal shoots, chosen so as to be well distributed on the canopy periphery, were tagged per tree prior to the general start of flowering as indicated by visible signs of inflorescence development (mid-June). On July 3 1992, when the advanced inflorescences were in full-bloom, 10 trees were sprayed to run-off with dinoseb acetate at 1062 ppm (300 ml Chemox®/100 l H_2O). On the same day, the

terminal shoots on another 10 trees were hand pruned at the site of inflorescence or apical bud attachment. The chemically treated trees were re-sprayed with dinoseb acetate (1062 ppm) on Aug. 1 1992, to remove the inflorescences which only began to actively extend after July 3 1992. The remaining 10 trees were controls. Single trees served as plots in a randomized complete blocks design comprising ten blocks.

During flowering of the control trees and reflowering of the pruned trees, the development of the most distal inflorescence on each of the tagged shoots was monitored weekly, and the dates on which each of these inflorescences attained the stages of 'pre-shoot' (about to enter the rapid phase of primary axis elongation) and 'bare panicle' (just completed the phase of shedding flowers and panicle axes) were recorded. In each tree, the duration of flowering was determined as the difference between the average dates on which each of these stages was attained.

Once the inflorescences on the tagged shoots were fully extended, their lengths and number were recorded. After flowering, the growth of the largest fruit on each of the tagged shoots was monitored weekly. Fruit size was expressed as the average of two circumference measurements per fruit, one taken longitudinally, from and back to the point of pedicel attachment, and the other equatorially. At harvest in late January 1993, the fruits on each tree were individually weighed.

A Stevenson screen was setup in the orchard to record temperature prior to and during the flowering and fruit growth periods. Insect pests, inflorescence diseases and fruit diseases were effectively controlled by regular sprays of insecticides and fungicides. Commercial fertilization recommendations were followed. Tensiometer stations, each consisting of two tensiometers (Irrometer, model R) inserted to depths of 30 and 60 cm, were used to schedule irrigation, the pressure deficit never being allowed to exceed an average of 50 kpa.

RESULTS

The minimum temperatures during the weeks preceding the flowering (control trees) or reflowering (pruned trees) periods of each group of equally treated trees generally fell to below 10^0C (Fig. 1). These temperatures were sufficiently inductive, since flowering in the control and pruned trees was profuse and was not accompanied by new shoot development. Maximum temperatures during these periods generally exceeded 20^0C, and were often greater than 25^0C.

Dinoseb acetate was effective in causing inflorescence die-back or abscission within three weeks of being sprayed. Dormant buds and newly developing inflorescences or portions thereof that were protected by bud scales or bracts, were unaffected by the spray. It was therefore necessary to apply a second spray once inflorescence development had proceeded further. The rate of inflorescence die-back was noted to be negatively related to the extent of inflorescence development at the time of spraying. Rapidly growing inflorescences were highly susceptible. The primary axis of inflorescences sprayed when in full-bloom remained alive, although its abscission did occur after two to three weeks from spraying. Signs of leaf phytotoxicity were absent. It is

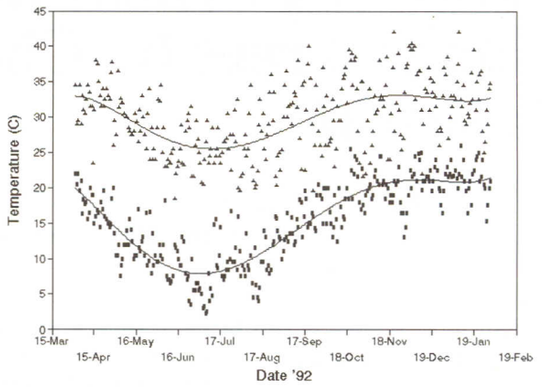

Fig. 1 *Daily maximum and minimum temperatures before and during flowering, and during the fruit growth period.*

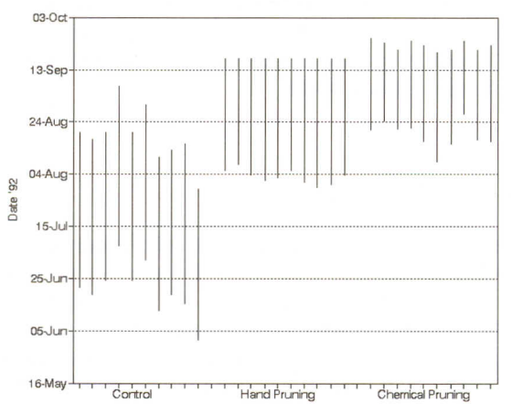

Fig. 2 *Time and duration of flowering of each tree.*

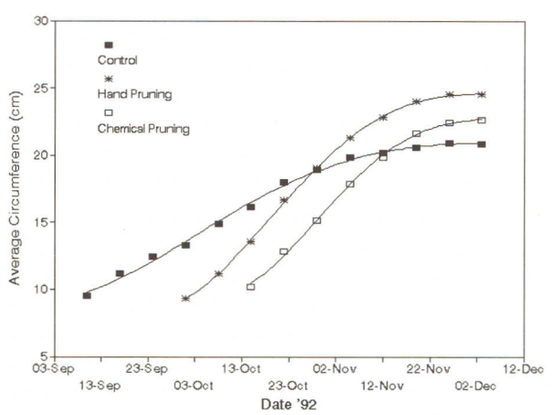

Fig. 3 *Average increase in size of the largest fruit on the tagged termianl shoots on each group of equally treated trees.*

Table 1 *Means for tree flowering duration, number of buds developing per terminal shoot, and average and total length of the inflorescences developing per terminal shoot.*

Treatment	Tree flowering duration (days)	No. of buds developing per terminal shoot	Average inflorescence length (cm)	Total length of inflorescences per terminal shoot (cm)
Control	59[a]	1.3[a]	30.4[a]	38.2[a]
Hand pruning	45[b]	7.9[b]	19.6[b]	156.2[b]
Chemical pruning	34[c]	4.8[c]	21.3[b]	106.8[c]

Means within columns followed by different letters, differ significantly according to Tukey's multiple range test

Table 2 *Means for number of fruit retained per tree, average fruit weight (fruit size), and tree yield.*

Treatment	No. of fruit retained	Average fruit weight (g)	Tree yield (kg)
Control	42[a]	161[a]	6.8[a]
Hand pruning	31[b]	238[b]	7.4[a]
Chemical pruning	35[b]	185[c]	6.4[a]

Means within columns followed by different letters, differ significantly according to Tukey's multiple range test

noteworthy that only fully mature leaves were present when spraying.

Flowering was more delayed following chemical as opposed to hand pruning, and generally commenced on Aug. 2 1992 after hand pruning and on Aug. 18 1992 after chemical pruning. Both hand and chemical pruning were effective in synchronizing flowering. However, the degree of synchronization achieved was slightly reduced after chemical inflorescence removal (Fig. 2). Collectively, the control trees flowered over a period of 97 days, whereas the hand and chemically pruned trees took 49 and 47 days to flower, respectively. Tree flowering duration was markedly reduced following hand and chemical pruning, the reduction being greatest in the chemically pruned trees (Table 1).

The number of axillary buds developing, and the average and total length of the inflorescences on the tagged terminal shoots is shown in Table 1. A greater number of axillary buds developed on the hand pruned than on the chemically pruned trees. The inflorescences on the hand and chemically pruned trees were approximately 10 cm shorter than those on the control trees. Flowering intensity, as indicated by the total length of the inflorescences on each of the tagged shoots, was greatly enhanced in the hand and chemically pruned trees, the extent of the enhancement being greatest in the hand pruned trees.

Growth rate of the fruit on the chemically and hand pruned trees was enhanced. Moreover, the fruit on these trees attained a greater size than those on the control trees (Fig. 3, Table 2). The fruit on the hand pruned trees became largest. The control trees retained more fruit than the hand or chemically pruned trees, the hand pruned trees apparently retaining the least number of fruit (Table 2). Due to compensatory increases in fruit size in the hand and chemically pruned trees, differences in tree yield relating to treatment were not apparent.

DISCUSSION AND CONCLUSION

Chemical pruning was effective in synchronizing flowering. Flowering was more delayed and slightly less uniform after chemical pruning than after hand pruning. These differences might reasonably be ascribed to the more delayed and non-instantaneous disappearance of the inhibitive effect of the terminal inflorescences on the axillary buds in the chemically pruned trees.

In the hand and chemically pruned trees, tree flowering duration and time of flowering were negatively related. This might be expected, since flowering occurred over a period of increasing temperature. It might thus be considered that the effect of temperature on the rate of inflorescence development may have contributed to the reduction in flowering variability observed in the hand and chemically pruned trees.

The reduced number of axillary buds developing in the chemically pruned as opposed to the hand pruned trees, may also relate to the non-instantaneous disappearance of the inhibitive effect of the terminal inflorescences on axillary bud development in the chemically pruned trees. Partial growth inhibition of axillary buds, imposed by inflorescences that were in the process of dying back, or by inflorescences whose primary axis remained attached for a period of time before abscising, would be expected to result in fewer buds developing initially. The inflorescences arising first would in turn limit further axillary bud development.

The results concerning fruit retention, fruit size and yield, and the relationship between flowering intensity and fruit retention, and between fruit retention and fruit size, are entirely consistent with those found previously (Oosthuyse, 1995). They support the view conveyed that the extent of fruit drop after flowering is directly related to flowering intensity due to the drain on available assimilates by developing inflorescences. Moreover, the outcome of increased fruit size giving rise to the absence of a difference in yield

between pruned and unpruned trees, was attributed to the recovery of the level of available assimilates at some stage after flowering.

The results of the present study show that the removal of inflorescences by chemical means can be employed as a measure to synchronize flowering in Sensation without there being a reduction in yield. The use of the dinoseb acetate for this purpose may be considered objectionable in view of its relative toxicity. The use of ethephon would seem to be the most acceptable alternative.

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