Pruning of Mango Trees: An Update

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ABSTRACT

The growth responses to the pruning practices being carried out by a number of mango growers have led to some interesting insights and have shown some pit-falls. It is intended that the `wrongs' and `rights' of pruning be highlighted in this paper. Some principles relating to pruning, and the correct practices of pruning mango trees are disclosed and detailed here. Considered are management procedures after planting, shoot tipping to encourage branching in young trees, pruning to stimulate flushing in young-bearing trees, and size maintenance pruning in fully-grown trees.

UITTREKSEL

Die groei reaksie teenoor die snoeipraktyke wat uitgevoer word deur 'n aantal mango kwekers het gelei tot iteressante insigte en het ook 'n paar haakplekke uitgewys. Hierdie artikel is bedoel om die verkeerde en regte aksies van snoei uit te lig. Sommige aspekte verwant aan snoei en die praktyke van snoei van mango bome word aan die lig gebring en gedetaileer. Punte wat in aanmerking geneem word is bestuurspraktyke na aanplanting, tip van jong lote om vertakking in jong boome aan te moedig, snoei om groeistuwings aan te moedig in jong draende bome en snoei vir instandhouding van boomgrootte by volgroeide bome.

INTRODUCTION

The growth responses to the pruning practices being carried out by a number of mango growers have led to some interesting insights. Some pit-falls have also come to light. It is intended that the `wrongs' and `rights' of pruning be highlighted in this paper.

It is appropriate at this stage to define a number of pruning cuts. By **heading** we mean the cutting of a shoot or branch to remove a portion of the shoot or branch (Fig. 1). Thus a portion of the shoot or branch will remain, and a portion will be removed. By **tip-pruning** we mean light heading (Fig. 2). Here, only a small piece of the top end of the shoot or branch is removed. By **tipping** we mean the removal of only the apical bud (Fig. 3). In tipping or tip-pruning we are actually performing heading cuts. By **thinning** we mean the removal of an entire branch (Fig. 4). Here, a cut is made flush with the adjoining branch.

Thinning cuts in mango are performed to remove dead branches, branches which have grown in an undesirable direction, and branches which are too low. Branches may also be thinned to allow for better spray penetration into the canopy. In thinning, productive wood is removed, and hence, branch-thinning should only be performed when it is absolutely necessary. Pruning of mango trees mainly comprises heading cuts.

In pruning mango trees, one should have only two essential goals. Firstly, one should aim at encouraging branching in young trees, particularly in those cultivars which do not branch readily on their own, e.g., Tommy Atkins and Keitt. Secondly, one should aim at maintaining tree or tree-hedge size once the desired canopy dimensions have been attained. Pruning may also prove to be useful in stimulating the development of new shoots (flushing).

Flushing is important because new mango leaves are efficient producers of carbohydrates, the tree's building materials. Certain data expressly indicate that new mango shoots play an important role in replenishing carbohydrate reserves (Davie *et al.*, 1995).

Carbohydrates produced by the leaves are either stored in the form of reserve starch or are used directly for growth — extension and expansion of roots, branches and leaves, and growth and development of the reproductive structures like the fruit. Growing mango fruits place a great demand on the pool of available carbohydrates (Chacko *et al.*, 1982). It is important to note that the quantity of carbohydrate that a tree can produce is directly related to the number of leaves that the tree possesses. Thus, in removing leaves, "say" by pruning, one is in fact reducing the tree's capacity to produce carbohydrates.

Since only those leaves which are exposed to sufficient sunlight are productive (exporters of carbohydrate), size maintenance pruning makes good sense if it ensures that most of the leaves in an orchard receive enough light. The size of trees or tree-hedges needs to be maintained due to their continued growth.

In young mango trees, where the problem of mutual shading does not exist, the removal of leaves represents a cost to the tree. In encouraging branching by **tipping**, one hopes to enable the tree to produce more new shoots (and thus leaves) during each flushing cycle than it normally would. Stated differently, one aims to increase the rate of the increase in leaf number associated with canopy development. Implicitly, the benefit, which relates to the extra number of new leaves produced, should exceed the cost, which relates to the number of leaves removed when pruning. To benefit maximally, the cost in terms of the number of leaves removed must be minimized. The effect of tipping on canopy development, and on tree structural strength and cropping ability has been previously quantified (Oosthuyse, 1995a).

Fig. 5 shows a mango terminal shoot. Most of the leaves are clustered at the apex due the internodes being very short in this region. By pruning away only a small part of the top end of the shoot (± 5 cm), one will in fact be removing a large

Fig. 1 *By heading we mean cutting of a shoot or branch to remove a portion of the shoot or branch.*

Fig. 2 *By tip-pruning we mean light heading.*

Fig. 3 *By tipping we mean removal of only the apical bud.*

Fig. 4 *By thinning we mean removal of an entire branch.*

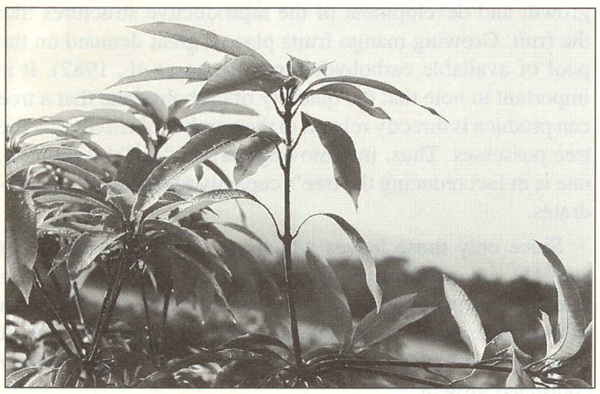

Fig. 5 *A mango terminal shoot. Most of the leaves are clustered at the apex.*

Fig. 6 *Incorrect pruning (as shown here) limits thickening of the lower branches and of the shoot itself.*

Fig. 7 *Trees can flop over themselves if tipping is not performed correctly.*

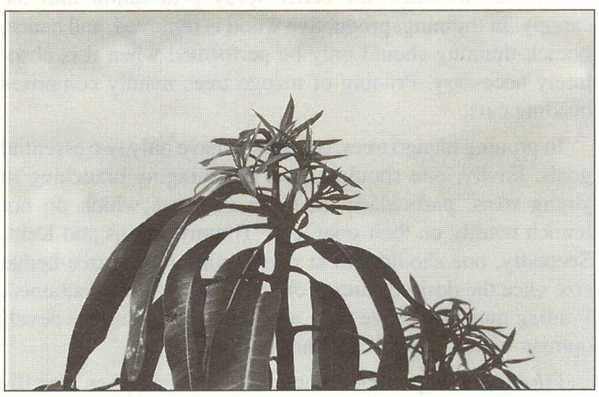

Fig. 8 *Branching naturally occurs at the end of branches were the internodes are very short.*

proportion of the leaves on the shoot, and the cost, in terms of the number of leaves removed, will be high. Tip-pruning of terminal shoots after each flushing cycle (Fig. 6) has been observed to limit thickening of the lower branches and of the pruned shoots themselves. There may thus not be a benefit of an enhancement in tree structural strength. In extreme cases, it has been observed that trees literally flop over themselves (Fig. 7).

In mango, branching naturally occurs where the internodes are very short (at the ends of the branches) (Fig. 8). Consequently, the new laterals are closely spaced. Close branching in mango **does not** give rise to weak crotches as it does in some other tree crops like peach. It is quite common to observe in mature trees that the major scaffold branches arise from a single point (Fig. 9). Splitting of such a junction or any other such junction in the tree canopy under the weight of branch tissue or fruit is very rarely observed, if at all. It might thus be concluded that one should not be concerned about the closeness of branching in mango.

The number of new shoots which will develop from a terminal shoot after it has been tipped is directly related to the terminal shoot's thickness (vigour). Adequate branching (the development of more than one vigorous new shoot) is usually encountered after removing the apical bud on pencil thick or thicker terminal shoots which are mature (have dark green leaves). Adequate branching in thinner shoots may not occur, particularly in cultivars that exhibit strong apical dominance like Zill, Tommy Atkins and Keitt. **It is advised that only pencil thick and thicker terminal shoot be tipped after each flushing cycle to encourage branching.** Thinner terminal shoots, particularly those that are short, should be left alone.

In Heidi, where apical dominance is relatively weak, there is no real need to encourage branching by tipping, since the apical and upper axillary buds usually develop in the absence of pruning (Fig. 10). Tipping may in fact be detrimental, since by tipping the terminal shoots, one may prevent the additional development of the apical buds (central shoots) (Fig. 11).

Short terminal shoots (Fig. 12) have leaves which contribute to growth and the replenishment of tree reserves, however small their contribution may be. It is therefore unwise to remove these shoots.

Fruit on mango trees are generally retained lower down on the canopy (Fig. 13), and new shoots are generally produced on the upper reaches of the canopy during the fruit growth and development period. This is because buds in the vicinity of fruit are inhibited from developing. Figs. 14 shows the relationship between the number of new shoots developing during the fruit growth and development period and the number fruit in three-year-old Sensation and Tommy Atkins mango trees. The relationships clearly show that the greater the number of fruit retained by a mango tree, the lower the number of new shoots that will develop on the tree during the fruit growth and development period (and vise versa).

Pruning may be performed for the sole purpose of stimulating bud development and thus flushing. In trees bearing adequately large crops (ideally, adequately large crops will be borne year after year), flushing usually occurs only once after harvest. By heading branches just behind the point of inflorescence (fruit stalk) attachment at (harvest pruning) or shortly after harvest (postharvest pruning) (Fig. 15), postharvest flushing can be hastened and made to occur uniformly (Fig. 16). This may effect earlier and more complete reserve replenishment (Oosthuyse, 1994; Davie *et al.*, 1995), and reduce flowering variation (Oosthuyse 1994).

In what follows, training and pruning of young and fully-grown mango trees is described.

Tree Training and Pruning in Young Trees

Procedure after planting

Maintain your grafted tree as a single stemmed whip (Fig. 17). Allow the tree to attain a height of more than 1 m before permitting any branching to occur. Lateral shoots should be removed (thinned) by hand (pinching) soon after they begin developing (Fig. 18).

First pruning

Once the trees (single stemmed whips) have attained a height of more than 1 m, head each tree at a height of 0.8 to 1 m (higher first-heading-heights may be considered to effect adequate canopy clearance from the ground) (Fig. 19).

The length of a tree's trunk (as it will be for the rest of the tree's life) is equal the height at which the tree was first headed. A trunk of sufficient height is required to ensure that fruit will not come to rest on the orchard floor due to branch bending (Fig. 20).

Heading to initiate branching should not be performed during the months of April, May, June, July, August or September. If the trees are headed during these months, axillary inflorescences as opposed to new shoots may develop (Fig. 21). This is undesirable, as the unwanted inflorescences will place a demand on the supply of carbohydrates, and the upper tree-section from which the axillary inflorescences arise will have to be removed. The probability of inflorescences as opposed to new shoots developing is negatively related to temperature (night temperatures), which means that the lower the night temperatures, the more likely inflorescences as opposed to new shoots will develop.

Development of the first laterals

After pruning, the first lateral shoots will develop (Fig. 22). Some of these shoots will become the main scaffold branches of the tree. Allow all of the laterals which emerge from beneath the heading cut (the first pruning cut made) to develop to maturity.

Shoot tipping to encourage branching

Terminal shoot tipping is important during the pre-bearing years of a tree's life. Only mature terminal shoots that are pencil-thick or thicker (preferably) should be tipped. **By tipping we expressly mean the removal of only the apical bud** (Fig. 23). In tipping, remove as fewer leaves as is practically possible.

Once the first lateral shoots to develop have matured, tip those shoots that are pencil-thick or thicker. It is desirable for the purpose of balance that as many shoots are tipped on one side of the tree as on any other. One should expect to tip from three to five shoots. Leave the weak shoots alone.

Subsequently, after each period of flushing, tip the pencil-thick or thicker terminal shoots once they have matured (the leaves can be seen to be dark green). Do not tip terminal shoots during the months of April, May, June, July, August or September.

In October, remove any inflorescences that have developed by hand. Soft new shoots arising from pencil-thick or thicker terminal shoots at this time can be removed in the same way. In addition, tip the pencil thick or thicker terminal shoots that

Fig. 9 *The main scaffold branches of a mango tree often arise from a single point.*

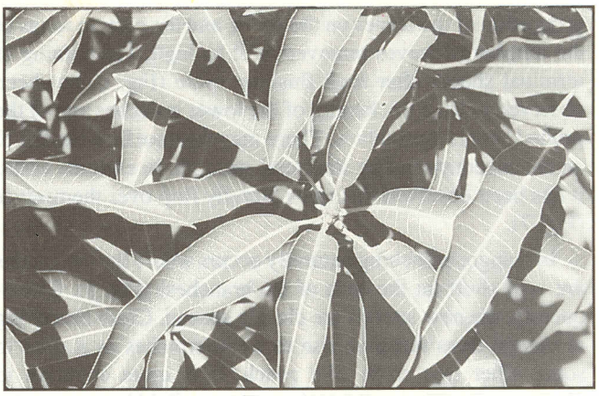

Fig. 10 *In Heidi, the upper axillary and apical buds often develop naturally.*

Fig. 11 *Development of the central shoot when tipping is not performed in Heidi.*

Fig. 12 *Short shoots have leaves which contribute to growth and the replenishment of carbohydrate reserves.*

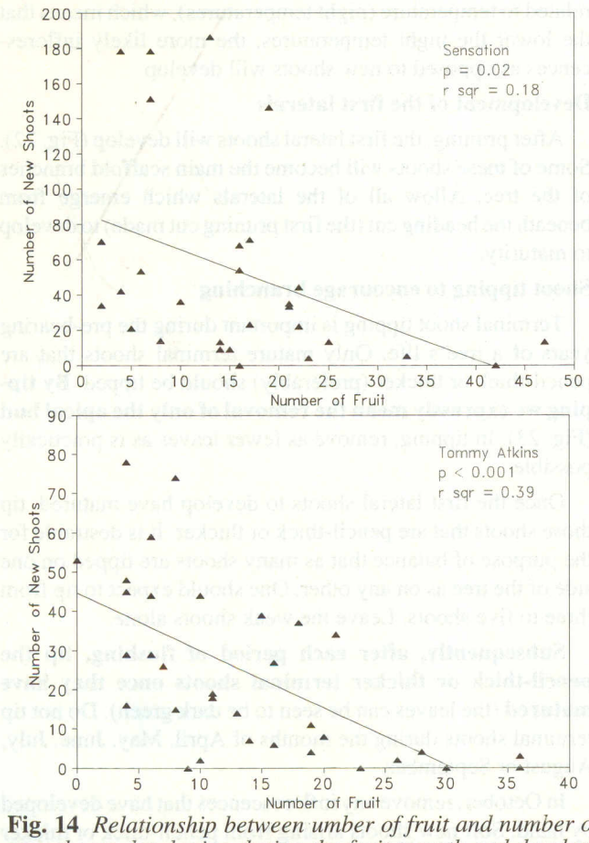

Fig. 14 *Relationship between umber of fruit and number of new shoots developing during the fruit growth and development period in Sensation (above) and Tommy Atkins (below).*

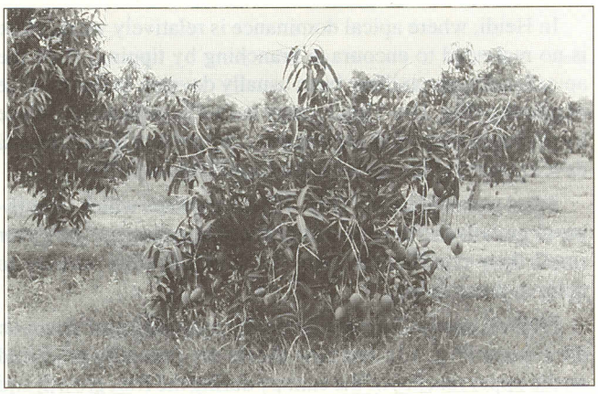

Fig. 13 *The fruit on mango trees are retained lower down on the canopy.*

Fig. 15 *Heading branches just behind the point of inflorescence attachment to hasten postharvest flushing.*

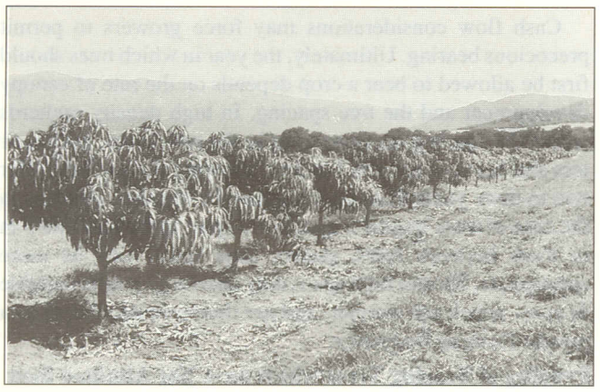

Fig. 16 *Uniform postharvest flushing in Tommy Atkins effected by heading cuts made after harvest.*

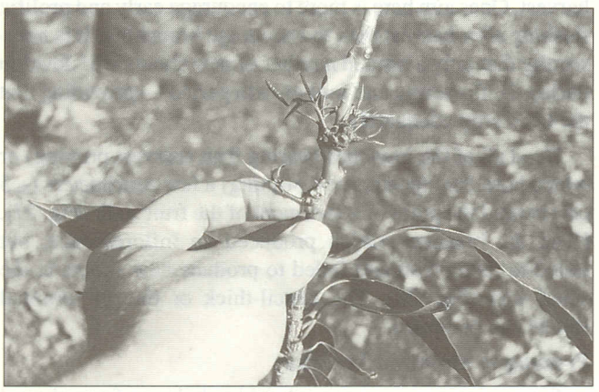

Fig. 18 *Pinch out laterals by hand when they are still soft.*

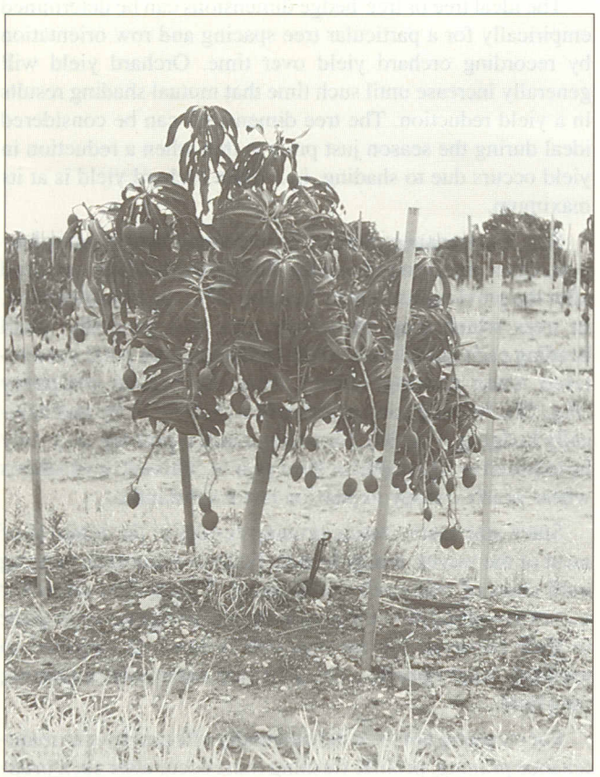

Fig. 20 *A trunk of sufficient height will ensure that fruit do not come to rest on the orchard floor due to branch bending.*

Fig. 17 *Mango trees should be maintained as single stemmed whips until they have gained sufficient height.*

Fig. 19 *Head the single stemmed trees at least 80 cm above ground level.*

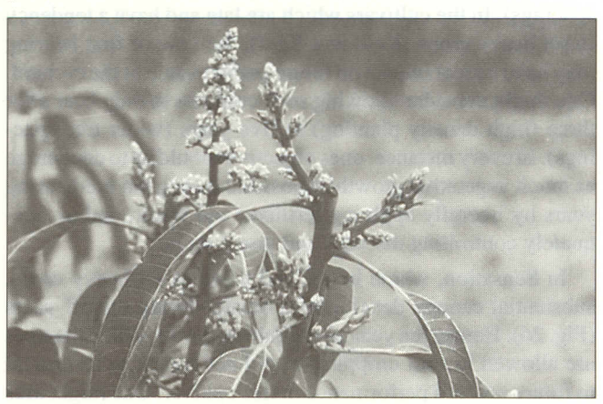

Fig. 21 *Development of axillary inflorescences due to heading at the wrong time.*

are not showing signs of growth or are just starting to show signs of bud development.

Gibberellin application to limit or prevent flowering (optional)

A gibberellin spray (ProGibb®, 100 ppm a.i.) can be administered to in early to mid-June in Sensation, Kent, Keitt and Heidi, or in late July in Tommy Atkins and Zill (Oosthuyse, 1995b). On the date of spraying, all of the dormant terminal shoots **must be tip-pruned** (removal of ± 2 cm of the upper-portion of the shoots), and any inflorescences that are present must be removed by tip pruning in the same way. Soft new shoots arising from pencil-thick or thicker terminal shoots must also be removed by tip-pruning. Soft new shoots arising from thinner shoots should be left to develop fully. Treatment of mango trees as stated here is generally effective in preventing further flowering. Flowering may still occur if the winter is exceptionally cool or is prolonged.

Age to Allow Trees to Bear a First Crop

The cropping potential of a mango tree is directly related the size of its canopy (Oosthuyse, 1995a). The rate at which the canopy increases in size thus determines the rate at which tree yield increases over time. Moreover, the size of the canopy when the tree is first allowed to bear determines how large the first crop will be.

In bearing mango trees, the extent to which tree growth occurs prior to harvest depends on the crop load (Fig. 14). The extent to which mango trees grow after harvest depends on the time of harvest and the crop load.

Postharvest flushing in trees having borne a heavy crop may be delayed and may occur unevenly. In Sensation, it is often observed that trees or branches having cropped heavily flush as late as the flowering period or shortly thereafter. When this happens, entire trees or branches fail to crop.

In the important late cultivars (Heidi, Sensation, Keitt and Kent), the time available for new shoot development after harvest and before cool temperatures set in is shorter (four to 10 weeks) than that for the early cultivars (Irwin, Tommy Atkins and Zill) (± 12 weeks). A reduction in the time available for growth after harvest may reduce a mango tree's capacity to increase in size.

In the cultivars which have a tendency to produce new shoots during the fruit growth and development period (Zill, Heidi), the year after planting during which the trees are first allowed to carry a crop may not be critical to future orchard performance. One might consider allowing such cultivars to bear after two (high density planting) to four years (wider tree spacings). In the cultivars which are late and have a tendency to set heavy crops (Keitt and Kent), the time of first bearing may have a great impact on future performance of the orchard. One might consider allowing such cultivars to only bear after three (high density planting) to five years (wider tree spacings). In every instance, ones objective should be to encourage as much vegetative growth as possible during the pre-bearing years by liberally applying fertilizer and water, and by adequately controlling diseases and insect pests.

In Sensation, which is late and tends to set heavy crops, substantial canopy development occurs during the off-years (Fig. 26). Hence, the year after planting during which the trees are allowed to start cropping would not appear to be critical to future orchard performance in this cultivar. One might thus consider allowing Sensation to bear after two (high density planting) to four years (wider tree spacings).

Cash flow considerations may force growers to permit precocious bearing. Ultimately, the year in which trees should first be allowed to bear a crop depends on the rate of canopy development and the tree spacing. In high density orchards where the spacing between trees in the row is two metres or less and between rows is 3 to 5 m, allowing trees to bear after two to three years from planting may be feasible, whereas in the case of trees spaced 3 m or more apart in the row and 5 m or more between rows, greater time spans may be more appropriate. Shorter time spans may also be generally suitable in areas which are warmer, and are therefore conducive to a greater flushing frequency.

Pruning of Bearing Trees which have Not Attained their Final Size

In such trees, it is only necessary to prune at or shortly after harvest. Ones aim here is more to encourage early and prolific flushing after harvest than to encourage branching. It is noteworthy that only a limited number of new shoots will develop during the flowering and fruit growth period — providing that the trees crop adequately.

Head all of the branches bearing fruit (harvest pruning) or which bore fruit (postharvest pruning) a few centimeters (± 5 cm) behind the point of attachment of the fruit stalk (Fig. 27). Head the branches which produced an inflorescence, but failed to retain fruit and failed to produce new shoots in the same way (Fig. 28). The pencil-thick or thicker terminal shoots can be tipped.

Pruning to Maintain Tree Size

Size maintenance pruning should only be performed once the trees or tree-hedges have attained the dimensions which one wishes them to have. In theory, one should only maintain tree size once mutual shading between the trees or tree-hedges effects a reduction in orchard yield.

The ideal tree or tree-hedge dimensions can be determined empirically for a particular tree spacing and row orientation by recording orchard yield over time. Orchard yield will generally increase until such time that mutual shading results in a yield reduction. The tree dimensions can be considered ideal during the season just prior to that when a reduction in yield occurs due to shading, i.e., when orchard yield is at its maximum.

Size maintenance pruning is performed shortly after harvest. Ones aim is to remove the flush growth which occurred after the previous harvest by heading all of the branches back. In trees which crop adequately, this will generally entail heading each branch behind the first branching point encountered when moving inward from the branch periphery (Fig. 29). Pruning can be performed by hand or by mechanically hedging (Fig. 30). Size maintenance pruning may only be required every second or third year in cultivars or situations where yearly canopy expansion is not substantial.

Since size maintenance pruning results in the removal of most of the leaves, it may be beneficial to delay such pruning until signs of bud swell are apparent. This should allow for leaves to contribute to the replenishment of tree reserves prior to their removal. Further research is however required to establish what benefit a delay in size maintenance pruning may hold.

For cropping not to be detrimentally affected by size maintenance pruning, prolific flushing must occur after such pruning. It is therefore important that conditions after harvest be favourable for shoot growth. Water and nutrients should not

Fig. 22 *Development of the first lateral shoots after heading for the first time.*

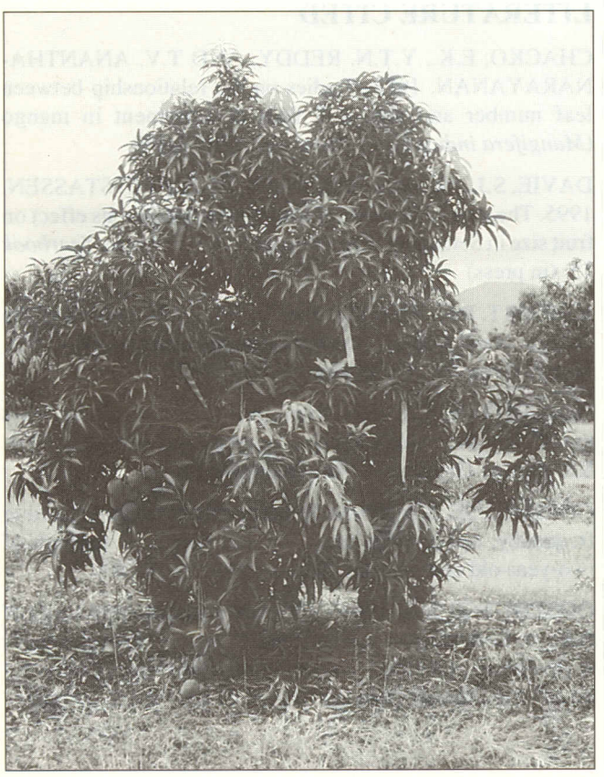

Fig. 25 *Substantial canopy development of a Sensation mango tree during an off year.*

Fig. 23 *By tipping we expressly mean only the removal of the apical bud.*

Fig. 24 *Late flushing of Sensation mango trees during their off year.*

Fig. 26 *Head fruit bearing branches to hasten postharvest flushing.*

Fig. 27 *Head all flowering branches failing to retain fruit to hasten postharvest flushing.*

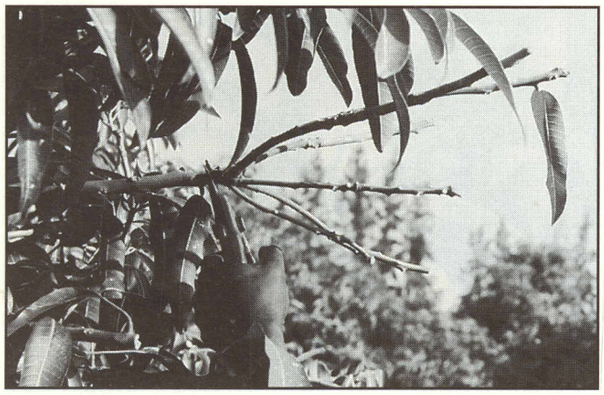

Fig. 28 *Size maintenance pruning will generally entail heading each branch behind the first branching point found.*

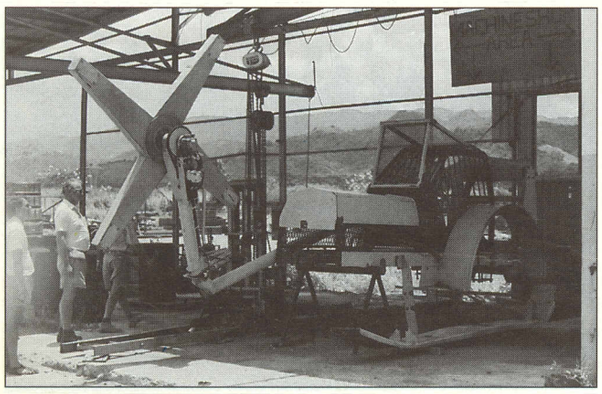

Fig. 30 *Mechanical hedger used to maintain the size of mango trees.*

Fig. 29 *Tree appearance after size maintenance pruning.*

be lacking, and temperatures should be conducive to flushing. By mid-April, the trees should show complete canopy recovery. The effect of size maintenance pruning on re-growth, shoot starch, flowering and cropping has been previously investigated (Oosthuyse, 1994).

Size maintenance pruning can greatly facilitate orchard sanitation (Kotzè, pers. comm., University of Pretoria) By removing the prunings, much of the disease inoculum and insect pests that were present in an orchard will also be removed. Moreover, the canopy interior will be exposed and therefore accessible to sprays targeted at diseases or insect pests. Mango weevils were considered to hide in branch crevices and under lose bark (Joubert and Pasques, 1994).

It is recommended that the new shoots which develop after size maintenance pruning be sprayed with a fungicide (copper) as soon as the leaves are fully expanded. This will afford protection from disease re-infection, and thus allow one to capitalize on the sanitation benefit.

It has not been found necessary by the author to protect the inner-branches from solar injury (sunburn) after size maintenance pruning. The application of a white coating (e.g. diluted PVA paint) to the upper-side of the exposed inner-branches might be considered, particularly in hot, dry areas.

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