Ideas on pruning of mango trees

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ABSTRACT

The objectives of maintaining tree size, and improving yield by reducing the time from planting until young trees can bear their first crop and increasing the degree of peripheral branching of bearing trees, are attainable by pruning. By heading flush growth of trees in their pre-bearing phase of growth, the number of new shoots produced is increased, and as a consequence, growth rate, tree sturdiness and number of flowering points are enhanced. By heading postharvest flush growth, the number of terminal shoots and thus flowering points in the outer canopy is increased. The size of trees having filled their space in the orchard row can be maintained by heading branches back shortly after harvest and behind the site where lateral buds first broke and grew after the previous harvest. Mechanical hedging shortly after harvest can also be adopted to maintain size. In view of these observations, procedures of pruning mango trees are proposed.

INTRODUCTION

The orchard practice of improving yield per unit area of land utilized through increasing the planting density is associated with the objectives of having trees fill their space in the orchard row in as short a period as possible, and maintaining size once the inter-row space has been filled. Mango trees, if left to grow unchecked, become exceedingly large, and for this reason, are traditionally grown at wide spacings. The ability to maintain tree size without adversely affecting productivity will enable mango growers to successfully adopt high density planting.

Irrespective of planting density, the growth rate of fruit trees during the pre-bearing period is positively related to the level of production once cropping commences. It is thus important to ensure maximal growth during this period.

Mango shoots grow without branching unless the growing point is removed, damaged or becomes floral. Branching occurs naturally after senescence or abscission of the primary panicle axis, whereupon lateral buds adjacent to the point of panicle attachment break and grow. Branching also occurs naturally at the crest of branches bent over under the weight of fruit.

In South Africa, mango trees enter a prolonged state of quiescent dormancy during the months of April, May and June. This state occurs due to the onset of winter-cold. Panicle development and flower anthesis, collectively referred to as flowering, subsequently occur during July, August and September. Inductive stimuli (low temperatures) for flowering experienced shortly before and during winter budbreak are strong enough for floral development of every apical bud, with the result that the events of flowering and fruiting generally occur in the absence of vegetative growth. Trees in the Transvaal are mainly harvested from December until March. Once harvested, they grow vegetatively by flushing repetitively from apical buds until late autumn or early winter, the number of flushes produced depending on the time available before the onset of winter-cold.

As flower panicles develop from the apex of terminal shoots, the number of panicles produced by a tree, being commensurate with cropping ability, is directly related to the number of terminal shoots present.

In pruning, a number of cut-types can be performed. A heading cut is a pruning cut made in such a way that a portion of a shoot or branch is removed and a portion is left from which new growth can develop. A tipping cut is a heading cut made a short distance from the growing point with the specific objective of removing the growing point. Heading cuts are particularly useful in manipulating young trees to thicken limbs, to develop laterals where they are needed, and to balance the branches. A thinning cut is performed when a whole shoot or branch is removed, the cut being made flush with the branch from which the specific branch or shoot to be removed arises. This type of cut becomes more important as the tree ages in order to improve light and spray distribution within the canopy.

Terminal mango shoots, tipped once fully elongated and apical buds have set, will branch as a consequence of break and growth of two or more axillary buds close to each cut. A greater number of new shoots and leaves will exist once branching has occurred than would have existed had the shoots been left, and only the apical buds broken and a single new shoot arisen from each terminal shoot. Since the degree to which shoots thicken is directly related to the number of new shoots developing from them, tipping enhances the degree of shoot thickening. Similarly, the degree of thickening of the trunk or a proximally situated branch section is directly related to the number of branches and shoots that distally adjoin the trunk or branch section.

By tipping new flush growth of young mango trees during their pre-bearing phase of growth, the number of terminal shoots is increased. Due to a greater abundance of growing points and leaves, growth rate and sturdiness are enhanced, and as a consequence, the time until the trees are of a sufficient stature to support a first crop is reduced. Further, cropping potential is increased once the trees come into bearing due to a greater abundance of terminal shoots.

The degree of peripheral ramification and number of flowering points of bearing trees can be increased by tipping new flush growth arising after harvest.

The size of trees having filled their space in the orchard row can be maintained by heading back branches at the site just behind that where budbreak and shoot growth first occurred after the previous harvest, and before the time when buds first start showing signs of breaking after each harvest. Cutting in this way results in the removal of the flush growth of the previous season, the aim being for this growth to be replaced during the postharvest growth period. Mechanical hedging, although largely indiscriminate concerning the branches cut, can also be adopted to maintain size if performed shortly after harvest.

Differences relating to both cultivar and growing region exist in the relationship between stage in the phenological cycle and time of year. The duration of the postharvest growth period is of partic-

ular significance in South Africa, in the sense of trees that are harvested late in the season being restricted in the time available for vegetative growth after harvest. Consequently, the growth response to postharvest pruning or hedging to maintain size (number of flushes produced) is diminished following a late harvest.

Cultivar differences also exist concerning the growth response to tipping, certain cultivars like "Zill" requiring heading to a greater depth to induce adequate branching.

The term *tree training* refers to the establishment of a desirable tree framework during the first years of a tree's life generally by means of pruning. The proposed procedure of training that follows is directly applicable to cultivars that respond well to tipping, e.g., "Sensation," "Irwin," and "Kent".

PROPOSED PROCEDURE OF TRAINING NEWLY PLANTED MANGO TREES

Treatment after planting

After planting, trees may either be branched or unbranched (Fig. 1 A). In the case of an unbranched tree, head at a position of at least five nodes above the graft union to leave at least five axillary scion buds. Head the shoots of branched trees at positions of at least three nodes above the site of initial branching. In either case, head just above a bud and try to avoid heading at positions where the buds are clustered (Fig. 1 B).

To ensure a good branching response after heading, trees should be allowed to establish themselves after planting, and be at least 70 cm in height before initial heading.

The height of canopy development is determined by the height at which heading is first performed (Fig. 1 C). If initial heading is performed at too low a level, bending of branches under the weight of fruit may occur at a later stage to the point where fruit and branches make contact with the ground. Low branches can, however, be supported with stakes to prevent this from happening. Further, efforts to control undesired growth of weeds and grass under the tree may be hampered. A canopy that is too high is difficult to manage, particularly in relation to picking and pruning. It is recommended that initial heading be performed at a height of between 50 and 70 cm above ground level.

Lateral buds will break from beneath the site of the heading cuts (Fig. 1 D). The number of buds breaking and vigour of the new shoots that develop will be positively related to both the depth of

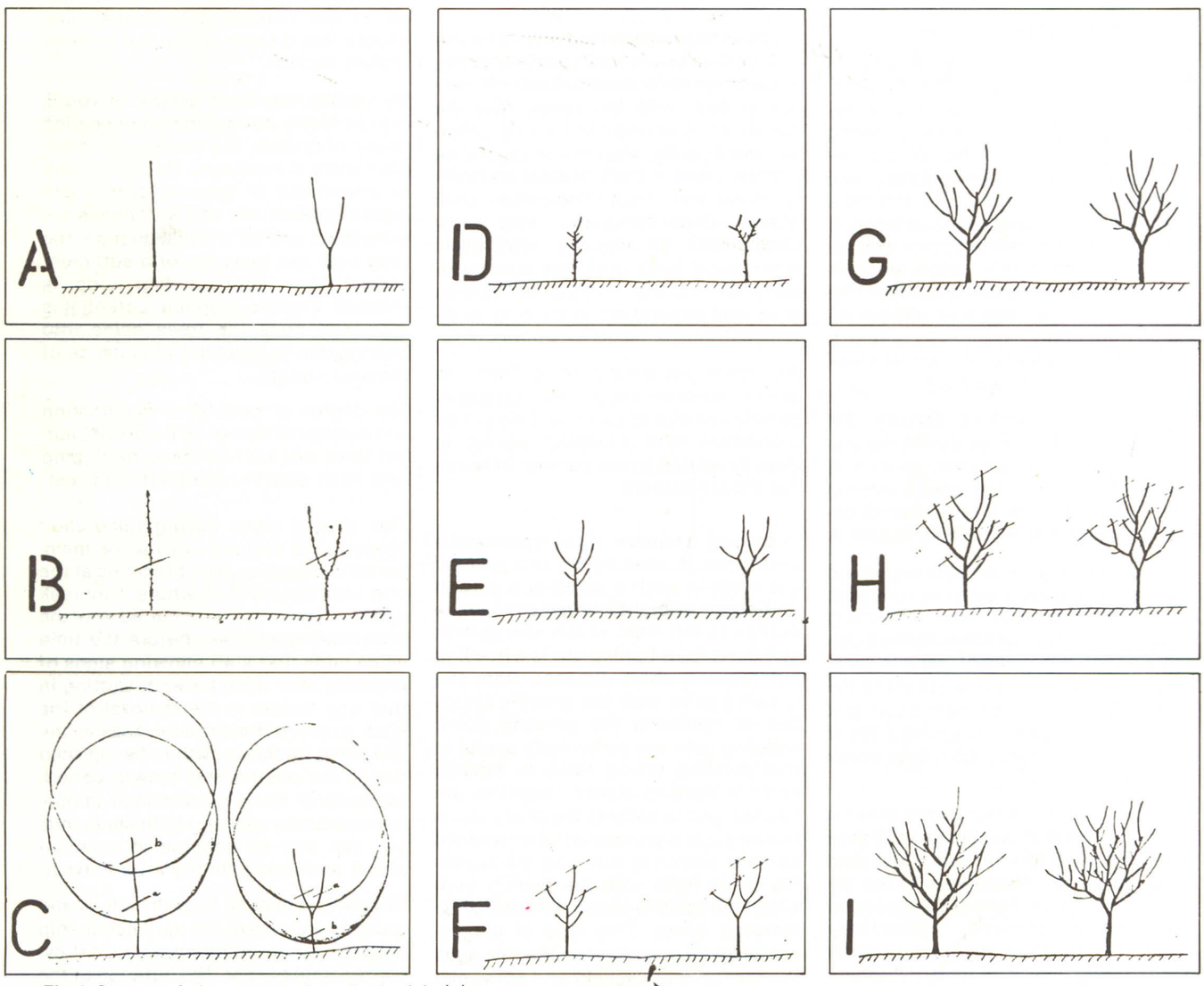


Fig 1 Stages of the proposed method of training young mango trees.

heading and the extent of tree growth before heading.

If heading is performed at a position where the buds are clustered, new shoots will develop in close proximity to one another. As some, if not all, of the first laterals will be selected to become the primary scaffold branches, which will bear the weight of the tree canopy and crop, this is undesirable since closely spaced branches give rise to weak crotches.

Selection of primary scaffold branches

In the case of an unbranched tree, select three to five new shoots well positioned around and down the main stem (scion) soon after the new shoots begin developing. In the case of a branched tree, a greater number of new shoots can be selected, the emphasis of selection being a good spatial arrangement or balance of the future scaffolds around the tree's central axis. Unwanted laterals can be broken out by hand.

Selection should be done at an early stage to restrict the period during which the limited supply of tree reserves are used to fuel growth of unwanted shoots.

Initial tipping to induce lateral branching

Once the shoots selected have fully extended (Fig. 1 E), to encourage branching, remove the apical bud of those having grown out strongly by tipping (Fig. 1 F). Tip directly above an axillary bud and just beyond the region close to the shoot apex where the axillary buds are very closely spaced.

By tipping beyond the sub-apical region where the internodes are extremely short, the new shoots that subsequently develop will not be too closely spaced. Tipping should always be performed with this in mind. As weak shoots branch poorly and produce weak laterals in response to tipping, they should be left to grow to an acceptable length before being tipped.

Further tipping until the time of first bearing

Once the second flush of new shoots has fully extended and apical buds have set (Fig. 1 G), tip the shoots which have grown out strongly as well as those that were not tipped previously that have attained a reasonable length (Fig. 1 H). Fig. 1 I illustrates the degree of branching after the third flush of new shoots has fully extended.

The procedure of tipping vigorous new shoots and allowing the less vigorous ones to flush more than once before being tipped, should continue until the trees are of a sufficient stature to bear a first crop. To benefit maximally from the proposed method of training, it is important that trees grow vigorously, and not be restrained in their growth by inadequate irrigation or fertilization, or physical damage caused by wild animals or insects.

Dealing with flowering during the period of training

Developing panicles are a drain on tree reserves, and in general, trees in flower do not grow vegetatively. From the viewpoint of wanting trees to "size-up" quickly and reserves to be utilized for growth of new shoots, roots and the tree framework during the period of training, flowering during this growth phase is undesirable.

As grafted mango trees commonly flower during the first years after planting, the last growth flush produced during a season should only be tipped once flowering has already occurred and night temperatures are no longer inductive for flowering. If terminal shoots are tipped before flowering, the trees will flower more intensely due to floral development of more than one axillary bud beneath each cut (Fig. 2). Further, if flowers are removed by tipping terminal shoots when conditions are still inductive for flowering, the trees will respond by re-flowering from axillary buds beneath the pruning cuts. Both of these actions increase the drain on reserves due to flowering.

By pruning the newly developing panicles themselves, the extent of their development, and hence the drain on reserves, can be curtailed.

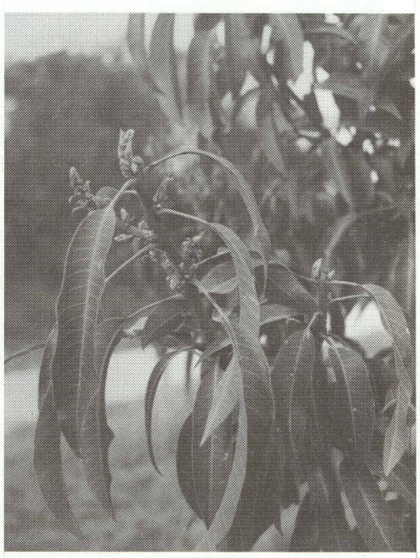


Fig 2 Floral development of axillary buds on a terminal shoot tipped before the period of flowering.

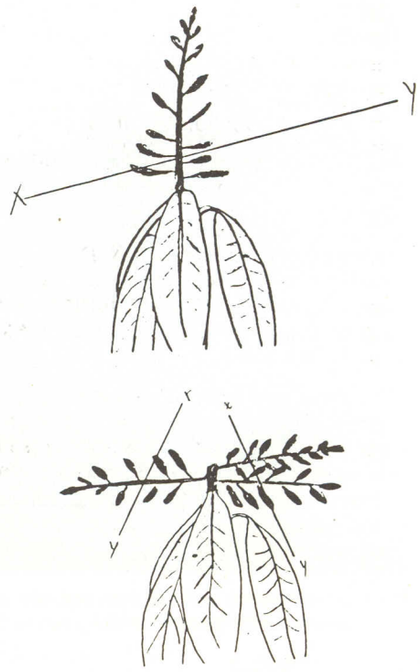


Fig 3 Pruning of the panicle to limit the extent of its development (above). Pruning primary panicle branches to further limit the extent of panicle development (below).

Prune the primary axis of the flower panicles soon after budbreak when the panicles are in their early stages of development, and above the site of emergence of the second or third primary branch. Prune the remaining primary branches once they have developed somewhat (Fig. 3). Remove the entire panicles by tipping the panicle-bearing terminal shoots when inductive conditions no longer prevail.

Pruning of the primary branches is advocated in view of their enhanced ability to grow following pruning of the primary axis.

In a recent study by the author, Gibberellin (GA_3 at 250 ppm a.i.) sprayed on "Kent" trees two to three weeks before normal flowering, inhibited flowering, delayed budbreak and gave rise to break of more than one bud at the shoot apex (Fig. 4). Seen in the context of tree training, this result is beneficial, since shoot development occurred instead of flowering, and the nature of the regrowth response was such that it obviated the need for tipping. The effect of gibberellin sprayed at the same time and concentration on the remaining cultivars grown locally has still to be ascertained, however.

Fig 4 Development of more than one new shoot from the terminal shoots of a "Kent" tree sprayed with gibberellin (GA_3) two to three weeks before the normal time of flowering.

Appearance of tipped mango trees two years from planting

Fig. 5 A shows a two-year-old "Sensation" tree whose terminal shoots were tipped during its development. Fig. 5 B shows points of branching within the canopy. The tree in question and its similarly treated neighbours were planted in April 1990 and allowed to crop for the first time during 1992. Fig. 5 C shows the tree in late September, 1992.

INCREASING THE DEGREE OF PERIPHERAL BRANCHING OF BEARING TREES

During the period of flowering and fruit growth, axillary buds are inhibited from breaking (Fig. 6 A). After harvest, branching occurs naturally as a result of the development of buds in the vicinity of the point of attachment of the panicle axes (Fig. 6 B). Budbreak may additionally occur at other locations on the tree frame-

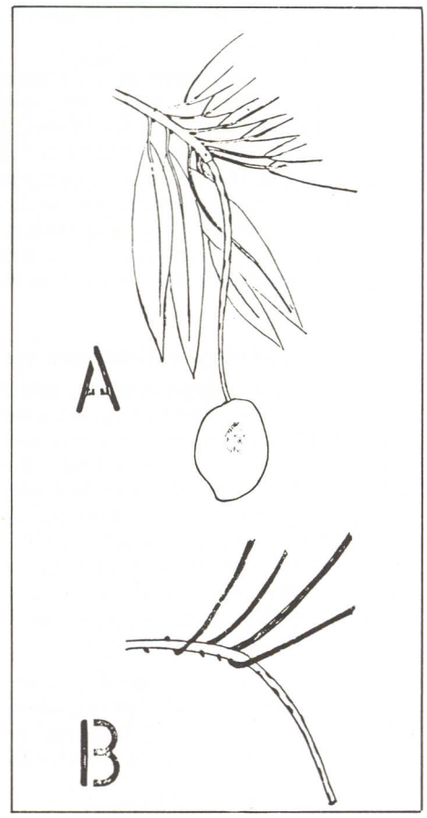
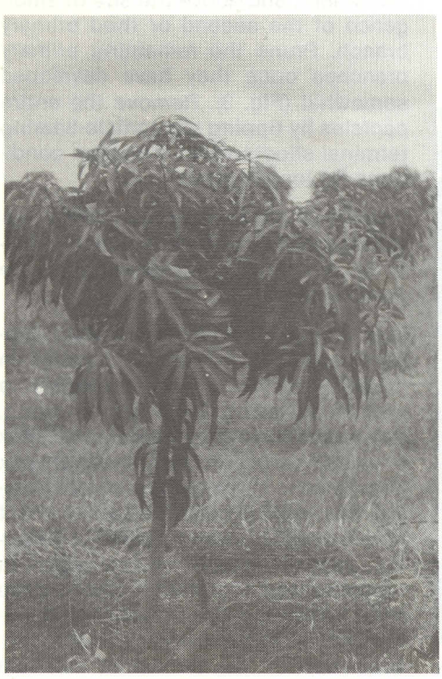


Fig 6 Axillary buds are inhibited from breaking during the period of flowering and fruit growth (A). After harvest, branching occurs naturally close to the sites of panicle attachment (B).

A



B

C

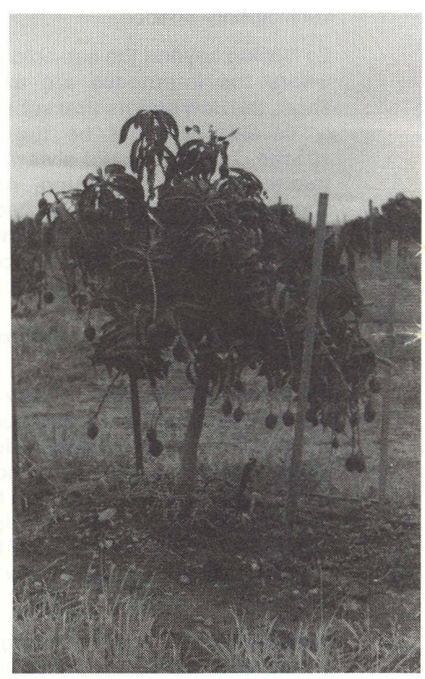


Fig 5 A two-year old "Sensation" mango tree whose terminal shoots were tipped during its development. A: External appearance in early April; B: View of branching from above; C: External appearance in late September.

work, particularly at the crest of branches bent over under the weight of fruit.

The number of flushes produced after harvest depends on the time available for growth before the onset of cold temperatures. Canopy expansion is thus more pronounced for the cultivars harvested early as opposed to those harvested late in the season. As flush growth does not normally branch, the density of the outer canopy declines during the postharvest growth period. By tipping new flush growth, the degree of ramification of the outer canopy can be enhanced, and consequently, the number of flowering points increased.

Postharvest tipping may also be performed selectively for the purpose of filling unproductive "space" in the outer canopy arising due to insufficient branching within the canopy.

The last flush produced in the season should not be tipped. If tipped, branching will not occur, but instead, the trees will flower more intensely due to floral development of more than one axillary bud beneath each heading cut at the time of flowering. A reduction in fruit retention has been found to be associated with an increase in flowering intensity as a direct consequence of tipping the last growth flush produced (unpublished data).

Postharvest tipping to increase the degree of ramification of the outer canopy is not appropriate for the late cultivars which, due to the time of harvest, generally flush only once after harvest and before flowering.

TREATMENT OF CULTIVARS THAT RESPOND POORLY TO TIPPING

The degree to which a shoot will branch after being headed is positively related to the girth of the shoot at the site of heading. The cultivars that respond poorly to tipping, e.g. "Keitt," "Zill," and "Tommy Atkins," require more severe heading to induce adequate branching. Allowing flushing to occur more than once, and heading into wood of the second most recent growth flush, is recommended for these cultivars.

INTER-BRANCH LENGTH AS IT RELATES TO CANOPY SPREAD

The length of the branch sections between successive branching points, the *inter-branch length,* is under the control of the grower, and is determined by the lengths of the branch portions remaining after heading is performed. The vigour of new shoots, the depth of heading and the number of times shoots are permitted to flush before being headed, all have a bearing on the inter-branch length.

If the branch portions left are long, the canopy will develop in a spreading manner, whereas if the branch portions left are short, canopy development will be compact.

In considering the situation of a narrow inter-row space ($\leq$ 2 m) to be filled by the tree canopy due to high density planting, it would be preferable to head in such a way as to encourage the development of a sturdy canopy that is highly ramified. Conversely, if the inter-row space to be filled is wide ($\geq$ 3 m), it would be desirable to head in such a way as to allow trees to grow in a spreading manner initially to enable the inter-row space to be filled more quickly.

METHODS TO MAINTAIN TREE SIZE

Once trees have filled their space in the orchard row, the emphasis of pruning changes from that of increasing complexity (degree of ramification) to that of maintaining size. The methods described entail pruning soon after harvest to remove the branches that grew after the previous harvest, the objective being for this growth to be replaced during the ensuing postharvest growth period.

Proposed method of hand pruning

After harvest, head branches back behind the site where buds first broke and grew after the previous harvest (Fig. 7). Head just above a lateral bud. Buds will subsequently break from behind the heading cuts, and from these regions, the outer branches that will bear the following seasons crop will grow (Fig. 8).

As the length of the branch sections to be headed each season is limited, heading in this manner cannot be performed continually without having to head beyond the following branching points.

Fig 7 Heading of a branch behind the site where buds first broke and grew after the previous harvest.

Fig 8 Panicle-bearing shoots which arose from branches headed after harvest.

This problem can be overcome by pruning each branch to leave a portion of one of the previous season's branches for the purpose of renewing buds for the replacement growth desired (Fig. 9).

The number of new shoots developing after postharvest pruning can, in fact, be influenced by altering the number of branch portions left, the greater their number, the greater the number of new shoots arising after pruning. Fig. 10 shows a branch pruned in such a way as to leave three branch portions. Conversely, if heading is performed beyond the following branching points, a significant reduction in the number of terminal shoots produced can be achieved.

Mechanical hedging

In Puerto Rico, tree size is maintained by mechanical hedging directly after harvest (Fig. 11). The number of new

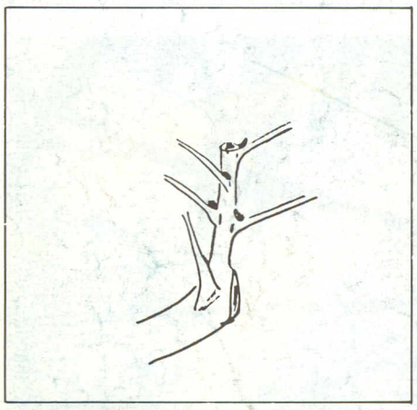


Fig 9 Pruning to leave a portion of one of the previous season's branches for the purpose of renewing buds.

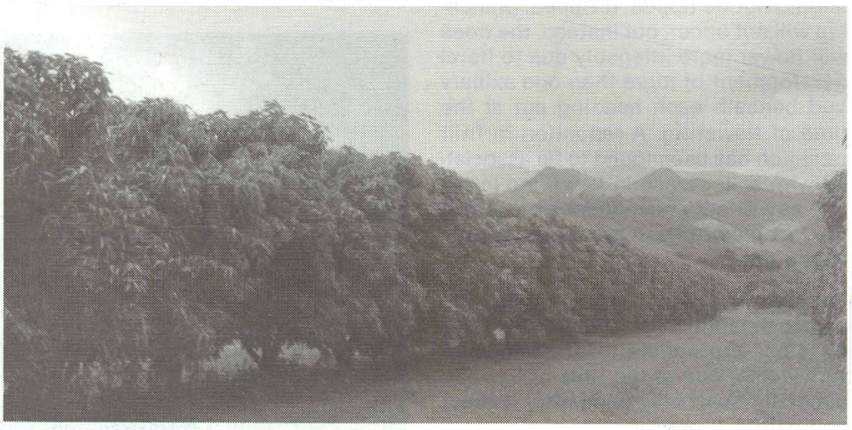


Fig 11 Hedged mango trees in Puerto Rico. The trees are shown after hedging and once growth of new shoots has occurred.

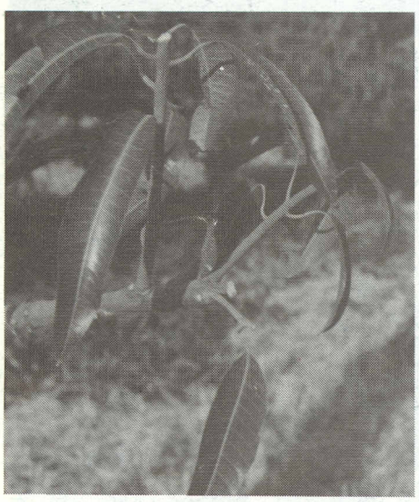


Fig 10 A branch pruned shortly after harvest in such a way as to leave three branch portions for the purpose of increasing the number of new shoots arising after postharvest pruning.

Fig 12 Sparse internal scaffolding of a mango tree. This limits flexibility in influencing the regrowth response to mechanical hedging.

shoots produced after hedging is influenced by the depth to which hedging is performed. If performed deeply as opposed to lightly, thicker and fewer branches deeper in the canopy are cut, and hence, the number of points from which branching can occur is reduced. By hedging lightly, the number of cuts made, and hence the number of points from which new shoots can develop, is far greater.

Problems in hedging may arise if the degree of internal ramification is sparse and branches within the canopy are thick (Fig. 12). In this situation, flexibility in influencing the regrowth response by varying the depth of hedging is reduced. By frequently performing heading cuts prior to the stage when trees fill their space in the orchard row, adequate internal ramification of the canopy can be ensured.

THINNING TO REDUCE THE DENSITY OF THE TREE CANOPY

An outer canopy that limits spray penetration, gives rise to shading of fruit limiting their ability to develop blush colouration, and is comprised of terminal shoots of low average length that crop inadequately, may be considered too dense. The density of the outer canopy can be reduced without diminishing canopy size by performing thinning cuts to remove entire branches. The aim should be to allow the remaining branches to have sufficient space within the canopy.

CONCLUSION

Much has still to be quantified concerning the effect of pruning on productivity; productivity being both a function of the quantity and quality of fruit produced. It is of course essential that the benefit of pruning always outweigh the additional cost incurred as a consequence for economic benefit.

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