Journal of Applied Horticulture, 16(1): 50-53, 2014

Canopy management in mango (*Mangifera indica* L.) cv. Alphonso with reference to flowering, yield and quality characters under ultra high density planting

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Abstract

An experiment was conducted to study the effect of different pruning levels on flowering, yield and quality characters in Alphonso mango under Ultra High Density Planting from 2010-2011 at Jain Irrigation Systems Pvt. Limited (JISL) Farms, Udumalpet, Tripur District, Tamil Nadu. The treatments included control, light pruning, moderate pruning, heavy pruning, 50 per cent removal of past season growth and total removal of past season growth and imposed on five-year-old uniform sized Alphonso trees grown under a close spacing of 3 x 2 m. The minimum number of days taken for first flowering and 50 per cent flowering were recorded by the control. The highest number of panicles per tree and the maximum number of panicles produced per sq.m canopy area were recorded in the control. However, highest percentage of hermaphrodite flower per panicle and per cent fruit set were found in the treatment T_5 (50 per cent removal of past season's growth and tipping). Fruit and yield characters were influenced by different pruning levels. Treatment T_2 (light pruning) recorded the highest mean fruit weight, fruit length, fruit volume, fruit pulp weight and stone weight. However, treatment T_3 (moderate pruning) registered highest fruit circumference. Highest pulp to stone ratio was observed in T_4 (Heavy pruning) followed by T_2 (light pruning). Highest number of fruits per tree and yield per tree were observed in control. Highest total soluble solids, total sugars and non reducing sugars of the fruit were observed in T_6 (total removal of past season's growth). The maximum acidity and ascorbic acid content were observed in control. Maximum total carotenoid content was recorded in T_3 (moderate pruning) and reducing sugars in T_4 (heavy pruning).

Key words: Mango pruning, flowering, fruit set, fruit yield and quality.

Introduction

Mango (*Mangifera indica* L.) is one of the most important tropical fruits of the world and is commonly known as the 'King of fruits'. Besides delicious taste and excellent flavour, mango is rich in vitamins and minerals. Though many reasons are attributed for low productivity, poor canopy management is considered as one of the major limiting factors in mango production. Being an evergreen tree, mango is seldom pruned in India, which leads to over-crowding of branches resulting in poor penetration of sunlight causing low productivity coupled with inferior quality fruits (Rathore, 2009). There are several reasons for pruning perennial fruit trees and if done drastically may influence several physiological processes directly or indirectly. These effects result from alteration in biochemical system within the tree and also helps to restore the balance between root system and the above ground parts. These operations are followed for maintaining tree height, canopy spread and density which is required for effective spraying which results in better fruit quantity and quality (Singh *et al.*, 2010c).

In general, management of canopy architecture deals with positioning and maintenance of trees frame work in relation to optimum productivity of quality fruits (Pathak, 2009). Charnvichit *et al.* (1994) reported that, pruning operations to control tree size are scarce and studies are mainly targeted to obtain early flowering and good fruit quality as well as to rehabilitate mature trees (Medina-Urrutia and Nunez-Elisea, 1997). Yeshitela *et al.* (2003) studied that pruning at the point of apical bud attachment induced re-flowering, more rapid fruit development and more fruits per panicle. For inducing flowering on old Alphonso mango trees, severe pruning was more effective than mild pruning (Srihari and Rao, 1998). On the other hand, Chen *et al.* (1996) observed that heavily pruned trees of mango resulted in delayed flowering than those of severely pruned ones. Davenport (2006) reported that the main advantage of annual tip pruning was to provide reliable synchronized flowering year after year in trees thus making them to remain in the same size for many years. Waghmare and Joshig (2008) made a study to regulate the vegetative flush for induction of uniform flowering in 'Alphonso' mango and reported that the sex ratio was maximum in 2.5 cm pruning immediately after harvesting. Singh *et al.* (2010b) found that the pruning intensity at moderate level took the least days to 50 per cent flowering. In mango cv. Amrapali, the size of the fruits was improved with the severity of pruning treatments (Pratap *et al.,* 2003). Rao and Shanmugavelu (1976) reported that the Mulgoa trees not yielding for many years, yielded exceeding well after sever pruning. Singh *et al.* (2010c) reported that TSS was the highest in the severely pruned trees, while TSS: acid ratio were higher in the lightly pruned trees. Keeping in view of above mentioned facts, the present investigation was carried out to study how flowering,

yield and quality characters are changed after pruning in mango cv. Alphonso under Ultra High Density Planting.

Materials and methods

The study was undertaken at Jain Irrigation Systems Pvt. Limited Farms, Elayamuthur, Udumalpet during 2010-2011. The experiment was laid out in a randomized block design having six treatments and four replications. The trial was laid out in a five-year-old orchard having one hundred and forty four uniform sized trees spaced at 3 x 2 m. Each treatmental unit consisted of six trees. The trees were maintained under uniform cultural practices during the investigation period. The pruning was done in last week of June 2010 and the pruning intensities were: T_1 (control: tipping of previous season's growth), T_2 (light pruning: retention of 70 cm from the base of the past season's growth), T_3 (moderate pruning: retention of 60 cm from the base of the past season's growth), T_4 (heavy pruning: retention of 50 cm from the base of the past season's growth), T_5 (severe pruning: 50 per cent removal of past season's growth and tipping) and T_6 (very severe pruning: total removal of past season's growth). Pruning was done by using shears after the harvesting of fruits. Data were recorded on days taken for first flowering and 50 per cent flowering, number of panicles produced per sq.m canopy area, number of panicles per tree and percentage of hermaphrodite flowers was calculated by using the given formula:

$$\text{Hermaphrodite flowers (\%)} = \frac{\text{Number of hermaphrodite flowers per panicle}}{\text{Total number of flowers per panicle}} \times 100$$

The percentage of fruit set was calculated at pea size stage as follows:

$$\text{Fruit set (\%)} = \frac{\text{Number of fruits at pea size}}{\text{Number of flowers per panicle}} \times 100$$

The fruit physical parameters such as mean fruit weight, fruit length, fruit circumference, fruit volume, pulp weight, stone weight, pulp to stone ratio were recorded. Yield data was recorded at the time of harvesting. Fruit quality parameters such as total soluble solids was determined by using hand refractometer, titrable acidity and ascorbic acid as per the method of AOAC (1975), total carotenoids by the method suggested by Roy (1973), total sugars by the method suggested by Hedge and Horreiter (1962), reducing sugars was estimated as per Somogyi (1952) and non-reducing sugars was calculated as the difference between the estimated total and reducing sugars. Data collected on flower, yield and quality attributes were subjected to statistical analysis as per the methods suggested by Panse and Sukhatme (1985).

Results and discussion

Evergreens, unlike deciduous trees, do not normally store large reserves of manufactured foods and the growth is more closely related to currently available leaf surface obtained after pruning. In the present investigation, severity of pruning delayed the flowering. The control, T_5 (50 per cent removal of past season's growth and tipping) and T_2 (light pruning) recorded early flowering and 50 per cent flowering while it was delayed in severely pruned treatments (Table.1). Thus, the shoots with desired maturity gave rise to early flowering. The late commencement of flowering in severely pruned trees than the unpruned ones may be explained on the basis that pruned trees put forth new vegetative growth immediately after pruning and almost the entire amount of carbohydrates which otherwise favour the flower bud formation/initiation, might have been utilized in the vegetative growth of the tree, thereby delaying the flowering. Similar results were obtained by Jannoyer (2009) in mango.

In an evergreen tree like mango, proper canopy management is essential to encourage sufficient number of panicles per sq.m of canopy area and number of panicles per tree, so that the higher productivity could be achieved. In the present study, the number of panicles per sq.m canopy area and number of panicles per tree were higher in control (Table.1). Gopikrishna (1979) reported that the reduction in number of flowers in severely pruned branches might be due to loss of potential bearing wood of the tree. The severely pruned trees showed lesser number of panicles per sq.m canopy area as well as per tree due to heavy vegetative growth. This was expected because of lesser number of shoots observed with higher pruning level when compared to control (T_1) and light pruning treatments. Similar results were recorded by Singh *et al.* (2009) in mango.

Percentage of hermaphrodite flowers per panicle had direct relationship with fruit set and fruit yield. The pruning intensities significantly improved the percentage of hermaphrodite flowers per panicle and the lowest percentage of hermaphrodite flowers per panicle was found in light pruned trees including control (Table.1). Waghmare and Joshi (2008) attributed that low percentage of hermaphrodite flowers is due to the development of lower temperature regime in denser canopies. The highest percentage of hermaphrodite flowers per panicle was found in T_5 (50 per cent removal of past season's growth and tipping) followed by heavy pruning (T_4). Highest percentage of hermaphrodite flower per panicle in the pruned trees might be due to removal of excess shoots, which leads to more light interception and movement of assimilates to fewer growing points. Besides in mango, the flowers arise mostly at terminals *i.e.,* very near to sink. There was every possibility of increase in drawal of more nutrients from the source towards the sink.

Mango generally produces more number of flowers in the panicles but the per cent fruit set is relatively low. Hence, knowledge on the fruit setting ability is very essential for crop management practices. The maximum per cent fruit set was noticed in T_5 (50 per cent removal of past season's growth and tipping) followed by T_1 (control). However, the per cent fruit set was the least in severely pruned treatment T_6 (total removal of past season's growth) (Table.1). Poor fruit set in severe pruned trees might be due to removal of the potential food synthesizing young shoots.

Improvement in fruit size due to pruning was observed in mango (Fivaz and Stassen, 1997). In the present study, severe pruning resulted in decrease in mean fruit weight, length, fruit circumference and fruit volume. The highest mean fruit weight, length and fruit volume were observed in the treatments with light pruning (T_2) followed by moderate pruning (T_4). It was least in severely pruned treatment T_6 (total removal of past season's growth) (Table 2). The reduction in weight, length and volume of fruit were due to the removal of biomass through severe pruning. Similar results were obtained by Pratap *et al.* (2009) in mango.

The highest fruit pulp weight, peel weight and stone weight were

Table 1. Effect of pruning on flowering characters in mango cv. Alphonso

Treatments	Days taken for first flowering	Days taken for 50 per cent flowering	Number of panicles produced per sq.m canopy area	Number of panicles per tree	Percentage of hermaphrodite flower per panicle	Fruit set (%)
T_1	168.66	190.89	26.26	160.80	6.91	0.261
T_2	172.27	192.43	24.49	124.55	5.78	0.239
T_3	188.75	204.33	19.81	85.22	12.34	0.204
T_4	192.64	211.84	18.01	73.08	14.02	0.209
T_5	171.59	192.76	25.98	140.80	16.53	0.276
T_6	197.83	208.58	15.79	54.50	12.28	0.167
LSD (P=0.05)	4.72	7.52	0.55	2.33	0.37	0.005

Table 2. Effect of pruning on fruit characters in mango cv. Alphonso

Treatments	Mean fruit weight (g)	Fruit length (cm)	Fruit circumference (cm)	Fruit volume (cc)	Fruit pulp weight (g)	Fruit peel weight (g)	Stone weight (g)	Pulp to stone ratio
T_1	217.10	8.78	21.93	207.98	139.22	34.96	35.93	0.258
T_2	252.66	9.18	22.45	243.91	160.02	42.00	46.25	0.289
T_3	241.19	8.99	22.74	232.20	157.68	38.40	41.43	0.262
T_4	226.68	8.85	21.70	218.81	140.25	40.16	45.50	0.324
T_5	231.24	8.86	21.74	222.67	146.16	36.14	33.83	0.231
T_6	201.87	8.61	20.81	195.70	126.96	37.25	36.59	0.288
LSD (P=0.05)	5.80	0.25	0.46	6.66	3.33	1.32	0.95	0.008

observed in light pruned trees. However, the pulp weight was the least in T_6 (total removal of past season's growth) and the stone weight was least in T_5 (50 per cent removal of past season's growth and tipping) (Table 2). Generally, for better sink, better source is essential which is very much ensured in light pruning than the severe pruning.

Fruit yield in mango is mainly influenced by fruit set per cent. In the present study, the number of fruits per tree and yield per tree during the period of experiment was generally higher in the control than the trees subjected to pruning (Table 3). This clearly points that the pruning has the supressive effect on the yield. The reason for more fruit yield in control is due to the retention of more number of past season shoots as against removal of many such shoots in the pruning treatments. Singh *et al.* (2010b) in mango and Sheikh and Hulmani (1993) in guava also had similar results. Moreover, as this study was conducted on young mango trees of five years, the effect of new shoots produced consequent to pruning treatments on its flowering potential, fruit setting could not be assessed. Hence, the real effect of pruning on the yield of mango needs to be assessed by continuing the experiment for another 2 to 3 years.

Any management practice system, besides increasing the productivity, should also aim at the production of better quality fruits. This is more true in the case of canopy management practices, wherein the main objective is to permit better aeration and light for the inner parts of the trees, so that the developing

Table 3. Effect of pruning on number of fruits per tree and yield per tree (kg) in mango cv. Alphonso

Treatments	Number of fruits per tree	Yield per tree (kg)
T_1	81.62	19.96
T_2	56.55	15.09
T_3	42.37	10.30
T_4	44.61	10.35
T_5	54.33	12.36
T_6	38.50	7.50
LSD (P=0.05)	1.57	0.28

fruits attain better colour and quality. In present study, the highest total soluble solids, total sugars and non reducing sugars of the fruit were observed in T_6 (total removal of past season's growth) where the light penetration was at its maximum (Table 4). Besides, lesser number of fruits in the severe pruning, (T_6) led to less competition among the fruits, finally resulted in better fruit quality. The results confirmed the earlier reports in mango by Venkatesan (2006), Pratap *et al.* (2009) and Singh *et al.* (2010a). Similarly, lowest acidity was observed in T_5 (50 per cent removal of past season's growth and tipping), while, the highest acidity was recorded in control (Table 4). Similar result were observed in mango by Singh (2010a).

Canopy management in mango cv. Alphonso under UHDP maximized the yield and maintained the optimum canopy size without overlapping. The results indicated that control (tipping off) encouraged emergence of more flower producing shoots resulting in better yield (19.96 kg/tree). However, canopy with

Table 4. Effect of pruning on fruit quality characters in mango cv. Alphonso

Treatments	TSS (°Brix)	Titrable acidity (%)	Ascorbic acid (mg $100g^{-1}$)	Total carotenoid (mg $100\ g^{-1}$)	Total sugars (%)	Reducing sugars (%)
T_1	16.99	0.371	41.05	12.07	12.28	4.71
T_2	16.68	0.307	39.47	13.79	12.14	4.54
T_3	17.57	0.268	37.89	16.11	12.97	4.60
T_4	17.30	0.333	36.31	12.90	12.55	4.75
T_5	16.38	0.256	38.68	15.50	12.04	4.34
T_6	18.40	0.320	40.26	15.42	13.72	4.68
LSD (P=0.05)	0.40	0.009	0.83	0.34	0.39	0.16

overlapping will be of a great concern in control (T_1) to keep the tree well within the manageable limit. To achieve a targeted yield of 23-25 tonnes/ha/year, treatment T_1 (control) and T_6 (total removal of past season's growth) may be followed in alternate rows so that the yield as well as canopy spread are taken into consideration. Pandey and Singh (2008) also reported alternate pruning method for sustainable production in mango cv. Amrapali. However, one or more confirmation trials are to be taken up to arrive firm conclusion.

Acknowledgement

We thank M/s. Jain Irrigation Systems Limited, Udumalpet unit for provding facilities to conduct the experiment using Ultra High Density Planting in mango.

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Received: November, 2013; Revised: February, 2014; Accepted: March, 2014