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Canopy Management in Mango (*Mangifera indica* L.) cv. Alphonso with reference to Growth and Physiological Characters under Ultra High Density Planting

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A field experiment was conducted to find out the effect of different pruning levels on growth and physiological characters in mango (*Mangifera indica* L.) cv. Alphonso under ultra high density planting during 2010-2011 at Jain Irrigation Systems Limited (JISL) Farms, in Tamil Nadu. The treatments *viz*., control, light pruning, moderate pruning, heavy pruning, 50 per cent removal of past season growth and total removal of past season growth were imposed on five-year-old uniform sized Alphonso trees grown under spacing of 3 x 2 m. The highest fresh weight of pruned branches and maximum number of new flushes after pruning were registered in T_6 (total removal of past season's growth). The same treatment recorded the maximum C: N ratio in leaves and shoots during harvesting stage. The highest tree height and canopy diameter (EW and NS) were recorded in T_1 (control). The treatment T_4 (heavy pruning) registered the maximum number of new shoots (8.20) emerged from pruned branch after pruning. The highest number of new shoots per plant was registered in control (T_1). The pruning treatments also influenced total chlorophyll contents. Control trees recorded the highest leaf area index in all months of observation compared to other treatments. The treatment T_5 (50 per cent removal of past season's growth and tipping) recorded the highest light transmission ratio among the treatments.

Key words: Mango pruning, Growth characters, Chlorophyll, LAI and C: N Ratio.

Mango (*Mangifera indica* L.) is one of the most important tropical fruit crops, 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 (Rathore, 2009). There are several reasons for pruning the perennial fruit trees and if done drastically may influence several physiological processes directly or indirectly. These effects have alteration in biochemical system within the tree and also help 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 are required for effective spraying and it results in better fruit quantity and quality (Singh *et al*., 2010).

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). 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 (Charnvichit *et al* ., 1994; Medina-Urrutia and Nunez-Elisea, 1997). In the tropics, the age of the last flush is the dominant factor regulating flowering of mango (Davenport, 2003). The light penetration and rate of photosynthesis increased with the extent of pruning in mango (Pratap *et al*., 2003; Sharma and Singh, 2006). Leaf chlorophyll content was higher in the control, which decreased as the extent of pruning increased (Sharma and Singh, 2006). Therefore, growth and physiological characters of tree may play an important role in such context. Keeping in view of above mentioned facts, the present investigation was carried out to study how growth and physiological characters are influenced after pruning in mango cv. Alphonso under Ultra High Density Planting.

Materials and Methods

An investigation on "Canopy Management in Mango (*Mangifera indica* L.) cv. Alphonso under Ultra High Density Planting" was undertaken at Jain Irrigation Systems Limited Farms, Elayamuthur, Udumalpet during 2010-2011. The experiment was laid out in a randomized block design with six treatments and four replications. The trial was laid

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out in 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 pruning intensities were T_1 (control), T_2 (Light pruning: retention of 70 cm flush from the base of the past season's growth), T_3 (Moderate pruning: retention of 60 cm flush from the base of the past season's growth), T_4 (Heavy pruning: retention of 50 cm flush from the base of the past season's growth), T_5 (50 per cent removal of past season's growth and tipping) and T_6 (Total removal of past season's growth). Pruning was done using secateurs after the harvesting of fruits. After pruning, number of new shoots emerged from pruned plants, which were thinned (10 % of the total new shoots in the centre portion of the plant) to open up the canopy to facilitate the penetration of sunlight as well as aeration.

Observation on growth characters such as fresh weight of pruned branches, tree height and canopy spread (east-west and north-south) were recorded after pruning and number of new shoots emerged from pruned branches, average number of new shoots per plant, average number of new flushes emerged after pruning till flowering and shoot length were recorded during flowering. Physiological parameters such as total chlorophyll and Leaf Area Index (LAI) were recorded at monthly interval from 12.00 noon to 1.00 p.m on bright sunny day using sun scan canopy analysis system type SS1. Light transmission ratio was recorded during 12.00 noon to 1.00 p.m on bright sunny day using lux meter and calculated by using the formula

$$\text{Light transmission ratio} = \frac{I_1 \text{ (Light intensity at the ground surface)}}{I_0 \text{ (Light intensity above the Canopy)}} \times 100$$

Nitrogen content in leaf and shoot samples was estimated by Micro -Kjeldhal method, total carbohydrate content in leaves and shoot was estimated by the method suggested by Somogyi (1952) and C : N ratio was determined by dividing the total carbohydrates content with total nitrogen content. Data collected on growth and physiological characters were subjected to statistical scrutiny as per the methods suggested by Panse and Sukhatme (1985).

Results and Discussion

Pruning always results in loss of biomass in plant system. The treatment T_6 recorded the highest fresh weight of pruned branches (7.86 kg per plant) followed by T_4 (5.33 kg per plant), while, the treatment T_1 (control) registered the lowest fresh weight of pruned branches (0.87 kg per plant) (Table.1).

Table 1. Effect of pruning on fresh weight of pruned branches (kg/plant), tree height (m) and canopy diameter (m) in mango cv. Alphonso

Treatments	Fresh weight of pruned branches (kg/plant)	Tree height (m)		Canopy diameter (EW)		Canopy diameter (NS)	
		After pruning	At harvest	After pruning	At harvest	After pruning	At harvest
T_1	0.87	2.93	3.11	2.69	3.22	2.20	2.88
T_2	3.69	2.40	2.72	2.23	2.86	2.06	2.49
I_3	4.46	2.31	2.66	2.07	2.58	1.95	2.26
T_4	5.33	2.19	2.68	1.94	2.66	1.88	2.38
T_5	4.33	2.81	3.03	2.45	2.90	2.07	2.66
I_6	7.86	1.85	2.41	1.42	2.24	1.59	2.20
SEd	0.09	0.04	0.03	0.02	0.05	0.02	0.03
CD (0.05)	0.18	0.08	0.07	0.04	0.10	0.05	0.07

Increase in weight of pruned shoot with increase in severity of pruning was reported by Saini *et al*. (1994). Bajwa *et al.* (1986) also pointed out that the pruned wood weight was the highest in severely pruned tree. But, the total vegetative growth attained by an unpruned tree is always greater than that of the pruned tree.

Commercial orchards must have control over both on tree size and orchard productivity in order to remain productive for long time (Davenport, 2006). In the present study, the tree height after the pruning treatment and at the time of harvest was the highest in control followed by T_5. The tree height was the lowest in T_6 (severe pruning) (Table.1). This indicated that the pruning had a suppressive effect on plant height in mango. Similar findings were reported by Singh *et al*. (2009) in mango; Kumar and Rattanpal, 2010; Pilania *et al.* (2010) in guava. Pruning results in new flushes and leads to larger canopy in tropical areas however, mango trees require different strategies to keep them highly productive for many years. In the present investigation, the canopy diameter after pruning and at time of harvest were found to be the highest in control (T_1) and closely followed by T_5 and the lowest in T_6 (Table.1). It might be due to the fact that pruned trees were unable to make up the loss of growth caused by severe pruning in this short period. Similar findings were reported by Lal and Mishra (2008) in mango; Kumar and Rattanpal, 2010; Pilania *et al.* (2010) in guava.

Consequent to pruning of branches, new shoots

Table 2. Effect of pruning on vegetative parameters in mango cv. Alphonso

Treatments	Number of new shoots emerged from pruned branch	Average number of new shoots per plant	Average number of new flushes emerged after pruning till flowering	Shoot length (cm)	
				3rd month	6th month
T_1	4.20	272.38	1.00	18.10	20.11
T_2	6.30	213.50	1.27	28.75	32.69
T_3	7.03	134.65	1.77	33.38	37.80
T_4	8.20	155.33	1.88	49.80	53.41
T_5	6.03	198.83	1.00	23.15	25.34
T_6	5.30	128.00	2.00	51.03	57.09
SEd	0.08	4.07	0.02	0.37	0.61
CD (0.05)	0.17	8.67	0.05	0.78	1.30

are expected to grow as the results of removal of apical dominance. In the present study, it was observed that heavier the pruning, more was the number of new shoots emerged per branch, highlighting the effect of apical dominance as expected in any other plants (Table 2.). More number of laterals were produced while heading back of shoots in mango was done (Suresh Kumar *et al*., 2003). In the present experiment, control was found significantly superior to all the treatments in respect of average number of new shoots per plant. The lowest number of new shoots per plant was found in T_6 (Table 2.). The possible reason is that, in the severely pruned plant, lesser number of new shoots were produced as older branches had lesser tendency to put forth new shoots. In severely pruned branches, the number of new shoots was substantially reduced. Similar findings were reported by Dalal *et al*. (2002) in guava; Banker *et al*. (2000); Gupta and Singh (1977) in ber.

In the tropics, the age of the last flush is the dominant factor regulating the flowering of mango (Davenport, 2003). In general, the treatment T_6 recorded the highest number of two new flushes after pruning till flowering. The treatment T_1 registered the least number of new flushes emerged after pruning till flowering and was on par with T_5. So, in severe pruning treatment there was an increase in new flush production (Table 2.). It might be due to the poor assimilates especially the carbohydrates due to severe pruning. It promotes frequent flushes of vegetative growth to make up the loss of growth caused by severe pruning in this short period. Similar observation due to pruning of mango was reported by Suresh Kumar *et al.* (2003).

Table 3. Effect of pruning on total chlorophyll content, light transmission ratio (LTR) and C: N ratio (leaves and shoot) in mango cv. Alphonso

Treatments	Total chlorophyll			Light Transmission Ratio (LTR)	C: N ratio			
					Leaf			Shoot
	Vegetative stage	At flowering stage	At harvest stage		Vegetative stage	At flowering stage	At harvest stage	At harvest stage
T_1	0.774	0.948	1.905	3.58	25.77	31.90	27.25	23.56
T_2	0.667	0.386	2.297	3.81	24.90	21.03	16.57	19.86
T_3	1.113	0.721	1.846	4.69	19.59	24.63	16.99	18.58
T_4	1.339	0.946	2.050	4.22	21.36	24.44	24.58	27.44
T_5	0.866	0.605	1.957	12.06	17.14	21.63	17.72	20.05
T_6	1.006	0.640	0.733	4.26	23.09	25.30	29.23	29.91
SEd	0.02	0.01	0.04	0.07	0.35	0.27	0.28	0.28
CD (0.05)	0.04	0.02	0.08	0.14	0.75	0.58	0.60	0.60

The length of new shoot in 3rd and 6th month after pruning showed significant differences among the treatments. With the increase in severity of pruning, there was an increase in length of shoot. More vigorous growth was found in T_6 and T_4 (Table 2.). It might be due to less number of growing points and more supply of nutrients and water compared to other treatments. Similar trend was observed in mango by Ervin (1979). While in control trees, there were a number of growing points and all of them showed a slow rate of growth which resulted in the least increase in shoot length. This might be due to more competition for nutrients among the existing shoots as numerous shoots were present on control trees. Similar observation due to pruning in guava was reported by Dhaliwal and Singh (2004).

The total chlorophyll content was more in heavy pruning treatment T_4 (1.339 mg g^{-1}) at vegetative stage. Higher total chlorophyll content in leaves was found in control at flowering and at T_2 (light pruning) at harvest stage respectively (Table 3.). Similar result was reported by Sharma *et al*. (2006) in mango.

Table 4. Effect of pruning on leaf area index in mango cv. Alphonso

Treatment	Leaf Area Index									
	July 2010	Aug 2010	Sep 2010	Oct 2010	Dec 2010	Jan 2011	Feb 2011	March 2011	April 2011	May 2011
T_1	3.21	3.48	5.93	4.83	5.12	5.30	5.63	5.50	5.07	5.60
T_2	2.10	3.17	5.52	3.91	4.57	4.68	4.97	5.18	5.02	5.55
T_3	1.41	1.81	4.83	2.81	3.40	4.08	4.21	4.55	4.73	4.57
I_4	1.15	2.03	5.03	3.51	4.50	4.20	4.65	5.16	5.65	4.75
T_5	1.60	2.23	4.27	3.17	3.98	4.30	4.02	3.83	4.07	3.52
T_6	0.70	1.40	3.95	3.11	3.43	3.98	4.24	4.55	5.12	4.70
SEd	0.04	0.03	0.07	0.04	0.05	0.04	0.04	0.08	0.05	0.06
CD (0.05)	0.08	0.07	0.15	0.09	0.11	0.09	0.10	0.17	0.11	0.13

The C : N ratio is very important factor in many fruit crops, when ratio is higher better would be the fruit bud initiation and differentiation leading to higher yield (Oliveria and Priestley, 1988). However in the present study, distinct difference was noticed in leaf and shoot C : N ratio among the treatments due to pruning. The control (T_1) and light pruning (T_2) recorded comparatively higher C: N ratios than the other treatments (Table 3.). The higher C: N ratio in control plants at vegetative and flowering stage favoured better panicle production. However in the harvest stage, T_6 recorded the highest C: N ratio in leaves and shoots. The results clearly indicated that higher C: N ratios at vegetative and flowering stages influenced the flowering and finally the yield positively. Similar findings were reported by Sathiya (2005) in Sapota.

Leaf Area Index is one of the parameters, which indicates the vigour of the plant showing considerable variation among the treatments due to pruning. Leaf Area Index decreased as the severity of pruning increased (Table 4.). If the leaf area index is more, the harvesting of light is better that encourages higher rate of photosynthesis. However in control trees, higher leaf area index was noticed during all months of observation than the pruning treatments. The severely pruned treatment T_6 recorded the lowest leaf area index in the initial months *i.e.,* July, August, September 2010 and January 2011, however the moderately pruned trees (T_3) recorded the least leaf area index in the months, October 2010, April and May 2011. The maximum light transmission ratio (LTR) was recorded in T_5 and was lesser in rest of the treatments (Table 3.). This was expected because of 50 per cent removal of past season's growth and tipping permitting easy penetration of the light. These findings were in agreement with Jackson and Palmer (1980); Singh and Singh (2007) in guava.

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Conclusion

The present study demonstrates that, total removal of past season's growth during the last week of June has showed the significant positive effect on growth such as higher fresh weight of pruned branches and physiological characters especially higher C: N ratio at flowering stage and higher number of new flushes after pruning in mango cv. Alphonso under Ultra High Density Planting. Whereas, 50 per cent removal of past season's growth and tipping recorded the highest Light Transmission Ratio, chlorophyll content and leaf area index. Hence this study deduced that, light pruning as soon as possible after harvest preferably during last week of June is beneficial practice to maintain Ultra High Density Planting orchards in Alphonso mango for sustainable production and yield with improving growth and physiological characters.

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