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 T6 (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 T1 (control). The treatment T4 (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 (T1). The pruning treatments also influenced total chlorophyll contents. Control trees 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, Elayamuthu, Udumalpet during 2010-2011. The experiment was laid out in a randomized block design with six treatments and four replications. The trial was laid...
out in five-year-old orchard having one hundred and forty four uniform sized trees spaced at 3 x 2 m. Each
treatment 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<sub>1</sub>
(control), T<sub>2</sub> (Light pruning: retention of 70 cm flush
from the base of the past season’s growth), T<sub>3</sub>
(Moderate pruning: retention of 60 cm flush from the
base of the past season’s growth), T<sub>4</sub> (Heavy pruning:
retention of 50 cm flush from the base of the past
season’s growth), T<sub>5</sub> (50 per cent removal of past
season’s growth and tipping) and T<sub>6</sub> (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

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

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fresh weight of pruned branches (kg/plant)</th>
<th>Tree height (m)</th>
<th>Canopy diameter (EW)</th>
<th>Canopy diameter (NS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>After pruning</td>
<td>At harvest</td>
<td>After pruning</td>
<td>At harvest</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>0.87</td>
<td>2.93</td>
<td>3.11</td>
<td>2.69</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
<td>3.69</td>
<td>2.40</td>
<td>2.72</td>
<td>2.23</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>4.46</td>
<td>2.31</td>
<td>2.66</td>
<td>2.07</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;</td>
<td>5.33</td>
<td>2.19</td>
<td>2.68</td>
<td>1.94</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt;</td>
<td>4.33</td>
<td>2.81</td>
<td>3.03</td>
<td>2.45</td>
</tr>
<tr>
<td>T&lt;sub&gt;6&lt;/sub&gt;</td>
<td>7.86</td>
<td>1.85</td>
<td>2.41</td>
<td>1.42</td>
</tr>
<tr>
<td>SEd</td>
<td>0.09</td>
<td>0.04</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>0.18</td>
<td>0.08</td>
<td>0.07</td>
<td>0.04</td>
</tr>
</tbody>
</table>

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<sub>5</sub>. The tree height was the lowest
in T<sub>6</sub> (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<sub>1</sub>) and closely followed by T<sub>5</sub>
and the lowest in T<sub>6</sub> (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

Light transmission ratio was recorded during 12.00 noon
to 1.00 p.m on bright sunny day using
top 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

\[
\text{Light transmission ratio} = \frac{I_1}{I_6} \times 100
\]

\(I_1\) (Light intensity at the
ground surface) and \(I_6\) (Light intensity above
the Canopy)

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<sub>6</sub> recorded the highest fresh
weight of pruned branches (7.86 kg per plant)
followed by T<sub>4</sub> (5.33 kg per plant), while, the treatment
T<sub>1</sub> (control) registered the lowest fresh weight of
pruned branches (0.87 kg per plant) (Table.1).
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 T6 (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 T6 recorded the highest number of two new flushes after pruning till flowering. The treatment T1

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of new shoots emerged from pruned branch</th>
<th>Average number of new shoots per plant</th>
<th>Average number of new flushes emerged after pruning till flowering</th>
<th>Shoot length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Achievement in number of new flushes was substantially reduced.</td>
<td>Production while heading back of shoots was found in T</td>
<td>[\text{T}_1]</td>
<td>[\text{T}_2]</td>
</tr>
<tr>
<td></td>
<td>[\text{CD (0.05)}]</td>
<td>[1.17]</td>
<td>[8.67]</td>
<td>[0.05]</td>
</tr>
</tbody>
</table>

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

registered the least number of new flushes emerged after pruning till flowering and was on par with T5. 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).

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 T6 and T4 (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 Dhalwal and Singh (2004).

The total chlorophyll content was more in heavy pruning treatment T4 (1.339 mg g⁻¹) at vegetative stage. Higher total chlorophyll content in leaves was found in control at flowering and at T2 (light pruning) at harvest stage respectively (Table 3.). Similar result was reported by Sharma et al. (2006) in mango.

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

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total chlorophyll</th>
<th>Number of new shoots emerged from pruned branch</th>
<th>Average number of new flushes emerged after pruning till flowering</th>
<th>Shoot length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Leaf</td>
<td>Shoot</td>
<td>Vegetative</td>
<td>At flowering stage</td>
</tr>
<tr>
<td>T1</td>
<td>0.774</td>
<td>0.413</td>
<td>4.20</td>
<td>272.38</td>
</tr>
<tr>
<td>T2</td>
<td>0.667</td>
<td>0.386</td>
<td>6.30</td>
<td>213.50</td>
</tr>
<tr>
<td>T3</td>
<td>1.113</td>
<td>0.721</td>
<td>7.03</td>
<td>134.65</td>
</tr>
<tr>
<td>T4</td>
<td>1.339</td>
<td>0.946</td>
<td>8.20</td>
<td>155.33</td>
</tr>
<tr>
<td>T5</td>
<td>0.866</td>
<td>0.605</td>
<td>6.03</td>
<td>198.83</td>
</tr>
<tr>
<td>T6</td>
<td>0.100</td>
<td>0.640</td>
<td>5.30</td>
<td>128.00</td>
</tr>
<tr>
<td>SED</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>4.07</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>0.17</td>
<td>8.67</td>
<td>0.05</td>
<td>0.78</td>
</tr>
</tbody>
</table>
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 (T1) and light pruning (T2) 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, T5 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 T6 recorded the lowest leaf area index in the initial months i.e., July, August, September 2010 and January 2011, however the moderately pruned trees (T3) recorded the least leaf area index in the months, October 2010, April and May 2011. The maximum light transmission ratio (LTR) was recorded in T5 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.

Acknowledgement

The first author expresses his deepest sense of gratitude and profuse thanks to M/s. Jain Irrigation Systems Limited, providing research fellowship and necessary facilities for carrying out the field experiment at Jain Irrigation Systems Limited Farms, Ellaymuthur village, Udumalpet, Tamil Nadu.

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.

References


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

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>3.21</td>
<td>3.48</td>
<td>5.93</td>
<td>4.83</td>
<td>5.12</td>
<td>5.30</td>
<td>5.63</td>
<td>5.50</td>
<td>5.07</td>
<td>5.60</td>
</tr>
<tr>
<td>T2</td>
<td>2.10</td>
<td>3.17</td>
<td>5.52</td>
<td>3.91</td>
<td>4.57</td>
<td>4.68</td>
<td>4.97</td>
<td>5.18</td>
<td>5.02</td>
<td>5.55</td>
</tr>
<tr>
<td>T3</td>
<td>1.41</td>
<td>1.81</td>
<td>4.83</td>
<td>2.81</td>
<td>3.40</td>
<td>4.08</td>
<td>4.21</td>
<td>4.55</td>
<td>4.73</td>
<td>4.57</td>
</tr>
<tr>
<td>T4</td>
<td>1.15</td>
<td>2.03</td>
<td>5.03</td>
<td>3.51</td>
<td>4.50</td>
<td>4.20</td>
<td>4.65</td>
<td>5.16</td>
<td>5.65</td>
<td>4.75</td>
</tr>
<tr>
<td>T5</td>
<td>1.60</td>
<td>2.23</td>
<td>4.27</td>
<td>3.17</td>
<td>3.98</td>
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<td>4.02</td>
<td>3.83</td>
<td>4.07</td>
<td>3.52</td>
</tr>
<tr>
<td>T6</td>
<td>0.70</td>
<td>1.40</td>
<td>3.95</td>
<td>3.11</td>
<td>3.43</td>
<td>3.98</td>
<td>4.24</td>
<td>4.55</td>
<td>5.12</td>
<td>4.70</td>
</tr>
<tr>
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<td>0.04</td>
<td>0.03</td>
<td>0.07</td>
<td>0.04</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
<td>0.08</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>0.08</td>
<td>0.07</td>
<td>0.15</td>
<td>0.09</td>
<td>0.11</td>
<td>0.09</td>
<td>0.10</td>
<td>0.17</td>
<td>0.11</td>
<td>0.13</td>
</tr>
</tbody>
</table>


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Received: March 25, 2013; Revised: July 2, 2014; Accepted: July 21, 2014