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Original Research Paper

Impact of pruning on growth, yield and quality of mango cv. Dashehari

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ABSTRACT

An experiment was carried out to study the impact of pruning on growth, yield and quality of mango cv. Dashehari. Ten treatments consisted of heading back of terminal shoots at two different levels *viz.,* M_1: 10 cm & M_2: 20 cm, with two level of frequency i.e., F_1: annually & F_2: biennially and at two different timings i.e., T_1: immediately after fruit harvest (June-July) & T_2: during rest period before the emergence of new growth (floral and vegetative) including control as $M_0F_0T_0$ with and without Paclobutazol (PBZ), were imposed on the trees. The trial was laid out in Randomized block design replicated thrice and single tree served as treatment unit. On the basis of 6 years (2009-2014) pooled data, it was observed that the vigorous growth in terms of tree height (4.56 m), trunk circumference (43.56 cm) and tree spread (3.03 m) were observed in the trees under control ($M_0F_0T_0$ without PBZ), whereas the trees which were pruned annually by heading back of 20 cm of terminal shoots during rest period before emergence of new growth along with paclabutrazol application ($M_2F_1T_2$) showed less growth in terms of tree height (3.30 m) and spread (2.21 m). The annual pruning of tree by heading back of 10 cm of terminal shoots immediately after fruit harvest along with paclobutrazol application ($M_1F_1T_1$) proved effective for increasing the number of fruits per tree (51.31), yield (9.09 kg/tree and 15.14 t/ha), B: C ratio (4.04), maintaining fruit quality and for having the appropriate dwarfing effect on the tree.

Keywords: Mango, pruning, vegetative growth, yield, fruit quality, paclobutrazole.

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'. The poor productivity of orchard can be attributed to wide tree spacing, lack of canopy architecture and long juvenile phase. In India, mango occupies 20.7 % production share with an area of 2.21 million hectares and annual production of 18.50 million tonnes having productivity of 8.34 metric tonnes per hectare (Anon, 2015). In order to meet the challenges of high productivity, optimization of growth parameters and minimization of the unproductive components of trees without sacrificing the overall health of the tree and quality of the product are of paramount importance. Suitable levels, frequency and time of pruning play an important role in deciding the quality and yield of the crop. Fruit plants attain tall and huge structure as they are not regulated by proper pruning and training from initial stage, leads to higher orchard management cost and it becomes quite cumbersome as well as expensive to restructure the canopy of the trees (Rathore, 2009). There are several reasons for pruning perennial fruit trees and if done drastically may influences several physiological processes directly or indirectly. These effects result from alteration in biochemical system within the tree. It also helps to restore the balance between root system and the above ground parts, followed maintaining height, canopy spread and density required for effective spraying with better fruit yield and quality. In general, management of canopy architecture deals with positioning and maintenance of plant's frame work in relation to optimum productivity and quality fruits (Davenport, 2006). Presently, the high density planting in mango is gaining momentum wherein, planting at a closer spacing is being adopted, which is capable of enhancing productivity

and ensuring continuous cropping of mango trees besides getting good quality mangoes. Thus, keeping in view the importance of pruning and use of paclabutrazol the experiment was undertaken to see its impact on vegetative growth (to find out relevancy for high density planting), yield and quality of mango cv. Dashehari.

MATERIAL AND METHODS

The experiment was conducted at Horticulture Research Centre, Patharchatta, GBPUA&T, Pantnagar at an altitude of 29 ºN latitude & 79.3 ° E longitudes and at 243.84 meters above mean sea level during the year 2009-2014 in Dashehari mango orchard planted at the distance of 3×2 meter. The trial was started in the year 2009 on 8 years old Dashehari mango and continuously conducted for six years and thus at the end of the experimentation the age of the trees were 13 years. In total, 10 treatments consisted of heading back of terminal shoots at two different levels *viz.,* M_1: 10cm & M_2: 20 cm, with two level of frequency i.e., F_1: annually & F_2: biennially and at two different timings i.e., T_1: immediately after fruit harvest (June-July) & T_2: during rest period before the emergence of new growth (floral and vegetative) including control as $M_0F_0T_0$ and $M_0F_0T_0$ without Paclobutazol (PBZ) were imposed. The paclobutrazol @ 1.0 ml a.i per meter canopy spread was applied in September through Trunk Soil Line Pour-TSLP method (application of aqueous solution of PBZ in trench near to collar of trunk) uniformly to all trees under the treatments except absolute control (i.e., $M_0F_0T_0$ without PBZ). The trial was laid out in randomized block design, replicated thrice and single tree served as treatment unit. The uniform cultural practices were adopted for all the trees of mango under the experimentation. The vegetative performance of trees under different treatments was studied on the basis of tree height, trunk circumference and tree spread. The data on number of fruit per plant and yield were recorded at the time of fruit harvesting. The average fruit weight and fruit size (length and width) were recorded with the help of digital balance and vernier calliper, respectively. The total soluble solids (TSS) of the fruits were measured with hand refractrometer (ERMA) and expressed in degree Brix (^{0}B). The acidity was estimated by the standard method of AOAC, 1980. The B:C ratio was calculated by dividing the gross income with the total cost incurred. The data were statistically analysed by using the standard procedure as suggested by Cochran and Cox, 1963.

RESULTS AND DISCUSSION

Impact on vegetative growth and yield

The data pertaining to effect of pruning and paclobutrazol on vegetative growth and yield on mango cv. Dashehari showed significant difference among the treatments **(Table 1)**. On the basis of 6 years (2009-2014) pooled data, the minimum tree height was noticed with $M_2F_1T_2$ (3.30 m), followed **by** $M_1F_1T_2$ **(3.33 m),** $M_2F_1T_1$ **(3.34 m),** $M_1F_2T_2$ **(3.52 m), which were found statistically *at par* with each other,** whereas, maximum tree height (4.56 m) was observed under the control ($M_0F_0T_0$ without PBZ). The higher tree circumference was noticed in $M_0F_0T_0$ without PBZ (43.56 cm) followed by $M_2F_2T_1$ (42.21 cm), whereas the lower circumference was observed in $M_0F_0T_0$ (33.23). The tree spread was observed maximum in $M_0F_0T_0$ without PBZ (3.03 m), $M_2F_2T_1$ (3.00 m), $M_2F_2T_2$ (2.95 m), $M_1F_1T_1$ (2.95 m) and $M_1F_2T_1$ (2.94 m), which were found statistically *at par* with each other, whereas, it was minimum in $M_2F_1T_2$ (2.21 cm). In the un-pruned trees ($M_0F_0T_0$ without PBZ), the maximum height may be due to uninterrupted growth. As the treatment $M_2F_1T_2$ with PBZ showed that this was very effective for development of dwarfed tree (3.03 m) but at the same time the yield (5.11 t/ha) was reduced at a greater extent and it is certainly due to more heavy pruning during the rest period. Pruning effect on the tree architecture in the present study is in support with the findings of Ram *et al.,* 1997 in mango. The tree subjected to annual pruning coupled with heading back during rest period with paclobutrazol application had registered lower height which may be due to increased tree structural strength in proportion to the number of terminal shoots tipped during the period of canopy development. These effects are especially relevant to high density orchards. Shading within the canopy reduces photo-saturation of leaves and the conversion of light energy to carbohydrates for growth and cropping. In dense mango canopies many leaves are in total shade and heavy shading eventually results in poor canopy regeneration, lower floral initiation (Dambreville *et al.,* 2013), fruit set and yield (Sharma *et al.,* 2006).

Table 1. Effect of pruning on vegetative growth and yield in mango cv. Dashehari (based on 6 years pooled data: 2009-2014)

		Vegetative growth			Yield	
S. No.	**Treatments #**	**Tree height (m)**	**Tree Circumference (m)**	**Tree spread (m)**	**Number of fruits**	**Yield per tree (kg)**
1.	$M_1F_1T_1$	4.11	0.37	2.95	51.31	9.09
2.	$M_1F_2T_1$	3.67	0.37	2.94	51.16	7.70
3.	$M_1F_1T_2$	3.33	0.36	2.39	30.86	4.30
4.	$M_1F_2T_2$	3.52	0.38	2.78	26.92	4.83
5.	$M_2F_1T_1$	3.34	0.37	2.51	40.77	6.62
6.	$M_2F_2T_1$	3.55	0.42	3.00	29.74	5.43
7.	$M_2F_1T_2$	3.30	0.36	2.21	19.46	3.07
8.	$M_2F_2T_2$	4.11	0.41	2.95	31.83	6.12
9.	$M_0F_0T_0$	3.62	0.33	2.64	33.93	6.87
10.	$M_0F_0T_0$(without PBZ)	4.56	0.43	3.03	20.59	3.68
SEM±		**0.92**	**0.47**	**0.52**	**6.50**	**1.01**
C.D *(P= 0.05)*		**0.26**	**1.36**	**0.15**	**18.52**	**2.90**
C.V		**6.06**	**3.04**	**4.71**	**47.25**	**43.17**

 # Method: M_1-10 cm heading back of terminal shoots, M_2-20 cm heading back of terminal shoots, **Frequency:** F_1- Annually, F_2-Biennially, **Time:** T_1-Immediately after fruit harvest (June-July), T_2-During rest period before the emergence of new growth (floral and vegetative) and with standard dose of paclobutrazole.

Based on the 6 years (2009-2014) pooled data related to impact of pruning and paclobutrazol on mango cv. Dashehari, it was observed that number of fruits per tree **(Table. 1)** were higher with $M_1F_1T_1$ (51.31), $M_1F_2T_1$ (51.16), $M_2F_1T_1$ (40.77) and $M_0F_0T_0$ (33.93), whereas it was lower in $M_2F_1T_2$ (19.46), $M_0F_0T_0$ (20.59) without paclobutrazol. The yield per hectare **(Fig.1)** was found higher with the treatment of $M_1F_1T_1$ (15.14 t/ha), $M_1F_2T_1$ (12.82 t/ha), $M_0F_0T_0$ (11.44 t/ha), $M_2F_1T_1$ (11.02 t/ha) and those were statistically *at par* with each other, whereas lower yield with $M_2F_1T_2$ (5.11 t/ha), $M_0F_0T_0$ (6.13 t/ha) without paclobutrazol, $M_1F_1T_2$ (7.16 t/ha), $M_1F_2T_2$ (8.04 t/ha) and $M_2F_2T_1$ (5.43). It is also depicted from the **Fig.1** that the higher B:C ratio (4.04) was observed with the treatment of $M_1F_1T_1$, followed by $M_1F_2T_1$ (3.85) whereas, the lower B:C ratio with $M_2F_1T_2$ (1.36), followed by $M_1F_1T_2$ (1.91). The overall yield was found comparatively lower under all the treatments which are certainly because of younger age of the trees. The yield parameters have clearly shown that in north India the pruning during rest period has no significance; rather it reduces the yield drastically. Therefore, the pruning operation in mango must be adopted immediately after the harvesting of the fruits. The data have also shown that yield was found more in those plants which were treated with paclobutrazol coupled with pruning. Thus, it had also indicated that the treatment of Paclobutrazol or pruning alone is not effective for regular bearing and good yield in mango cv. Dashehari. The pruning would have initiated higher number of lateral shoots,

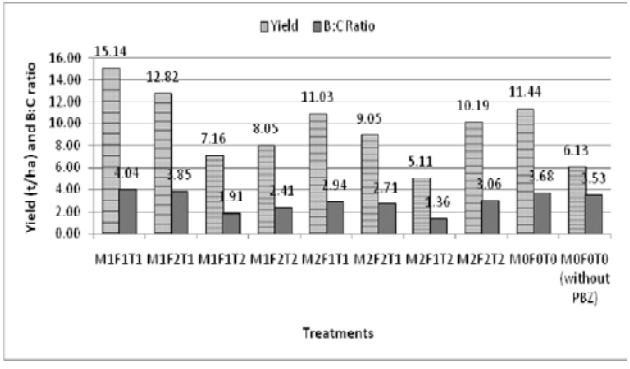

Fig. 1. Effect of pruning on yield (t/ha) and B:C ratio in mango cv. Dashehari.

which leads to increase in the number of fruiting branches. These results are in confirmatory with the findings of Davenport, 2006 and Uddin *et al.,* 2014, who have reported that pruning stimulates development of more laterals and thus resulted in increased potential for yield in mango. Pruning and thinning operations lead to increase in yield (Singh *et al.,* 2010 and Ram *et al.,* 1997) because they are effective in diverting nutrients and water taken by the tree to productive branches in mango.

Relevancy of pruning for high density planting

The data given in **Table 1** clearly show that the different level of pruning gives the dwarfing effect to the plants. This effect is especially relevant for the trees grown under high density planting system. The tipping and pruning operations have been also recommended in South Africa by Oosthuyse, 1992 for good branching, dwarfing effect and more yields in mango. In the present investigation, the annual pruning by heading back of 10 cm of terminal shoots immediately after fruit harvest with paclobutrazole application has been found appropriate for high density planting.

Impact on quality (physico-chemical) characteristics

The data given in **Table 2** show that the physico-chemical characteristics were also affected by pruning and use of paclobutrazol. The result showed that the trees subjected to the treatment $M_0F_0T_0$ gave higher fruit weight (206.91 g) followed by $M_2F_2T_2$ (189.12 g), $M_2F_2T_1$ (186.80 g), $M_1F_1T_1$ (184.83 g), $M_0F_0T_0$ (184.36 g) and $M_1F_2T_2$ (178.70 g). The lower fruit weight was noticed with $M_1F_1T_2$ (112.98 g), $M_2F_1T_2$ (136.00 g), $M_2F_1T_1$ (136.18 g) and $M_1F_2T_1$ (155.14 g), which were found statistically *at par* with each other. Similar to the present finding, Oosthuyse and Jacobs, (1995) have also reported that increase in number of branching points are directly associated with a reduction in the average fruit weight. The fruit length was noticed maximum in $M_0F_0T_0$ (10.47 cm) followed by $M_1F_1T_1$ (10.16 cm), $M_2F_2T_1$ (10.15 cm), $M_0F_0T_0$ (9.98 cm). The minimum length of the fruit was observed in $M_1F_1T_2$ (7.78 cm). Higher fruit diameter **(Table 2)** was reported in $M_0F_0T_0$ (5.76) , $M_0F_0T_0$ (5.55 cm) without PBZ, $M_1F_1T_1$ (5.53 cm), $M_1F_2T_1$ (5.37 cm) and $M_1F_2T_2$ (5.41 cm)

Table 2. Effect of pruning on quality characteristics of mango cv. Dashehari (based on 6 years pooled data: 2009-2014)

S. No.	Treatments #	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Pulp weight (g)	T.S.S (°B)	Acidity (%)
1.	$M_1F_1T_1$	184.83	10.16	5.53	121.61	19.06	0.27
2.	$M_1F_2T_1$	155.14	9.53	5.37	98.18	18.81	0.28
3.	$M_1F_1T_2$	112.98	7.78	4.49	82.24	15.21	0.22
4.	$M_1F_2T_2$	178.70	9.91	5.41	119.44	19.56	0.28
5.	$M_2F_1T_1$	136.18	8.01	4.33	85.61	15.63	0.23
6.	$M_2F_2T_1$	186.80	10.15	5.41	121.87	19.59	0.27
7.	$M_2F_1T_2$	136.00	8.31	4.41	88.09	15.45	0.25
8.	$M_2F_2T_2$	189.12	10.03	5.50	126.57	18.88	0.27
9.	$M_0F_0T_0$	206.91	10.47	5.76	147.93	19.85	0.26
10.	$M_0F_0T_0$ (without PBZ)	184.36	9.98	5.55	120.06	17.60	0.28
SEM ±		**17.50**	**0.89**	**0.43**	**11.60**	**1.59**	**0.28**
C.D. ***(P=0.05)***		**49.86**	**2.53**	**1.24**	**33.06**	**4.53**	**0.82**
C.V		**25.66**	**23.10**	**20.69**	**25.57**	**21.70**	**26.64**

 # Method: M_1-10 cm heading back of terminal shoots, M_2-20 cm heading back of terminal shoots, **Frequency:** F_1- Annually, F_2-Biennially,**Time:** T_1-Immediately after fruit harvest(June-July), T_2-During rest period before the emergence of new growth (floral and vegetative) and with standard dose of paclobutrazole.

and $M_2F_2T_1$ (5.41 cm), which were found statistically *at par* with each other. The lower fruit diameter was reported in $M_2F_1T_1$ (4.33 cm) followed by $M_2F_1T_2$ (4.41 cm) and $M_1F_1T_2$ (4.49 cm). An increase in fruit size has been also observed by Oosthuyse (1992) and it is possibly relates to a lesser depletion of carbohydrate and other nutrient reserves by less vegetative growth, whose development is suppressed.

The profound effect of pruning & PBZ was also observed on pulp weight **(Table 2)**. The higher pulp content was noticed in $M_0F_0T_0$ (147.93 g), $M_2F_2T_2$ (126.57 g), $M_2F_2T_1$ (121.87 g), $M_1F_1T_1$ (121.61 g), $M_0F_0T_0$ without PBZ (120.06 g), $M_1F_2T_2$ (119.44), which were found statistically *at par* with each other, whereas, lower content of pulp with $M_1F_1T_2$ (82.24) followed by $M_2F_1T_1$ (85.61 g), $M_2F_1T_2$ (88.09 g) and $M_1F_2T_1$ (98.18 g). Significant variation was also observed in TSS and acidity in pruned trees with use of PBZ. The higher TSS was observed in $M_0F_0T_0$ (19.85 %B), followed by $M_2F_2T_1$ (19.59 %B), $M_1F_2T_2$ (19.56%B), $M_1F_1T_1$ (19.06%B), $M_2F_2T_2$ (18.88%B), whereas, the lower content was noticed in $M_1F_1T_2$ (15.21%B), $M_2F_1T_2$ (15.45%B), $M_2F_1T_1$ (15.63%B). The perusal of data **(Table 2)** on fruit acidity showed that lower content of titratable acidity was observed in $M_1F_1T_2$ (0.22 %) and $M_2F_1T_1$ (0.23 %), whereas maximum titratable acidity in $M_1F_2T_1$, $M_1F_2T_2$, $M_0F_0T_0$ without PBZ each 0.28 %. The fruit quality improvements with respect to TSS and acidity in response to PBZ treatments can be related to assimilate partitioning of the plant. Higher net return from mango could be assured by increasing the productivity through adoption of appropriate management practices. Paclobutrazol is reported to exert influence on partitioning the photosynthates to the sites of flowering and fruit production, consequent to the reduction of vegetative growth. Kurian *et al*. (2001) reported that the paclobutrazol appeared to favourably alter the source sink relationship of mango to support fruit growth.

Thus, finally it can be concluded that the annual pruning of tree by heading back of 10 cm terminal shoots immediately after fruit harvest and with application of paclobutrazol @ 1 ml active ingredient per meter canopy spread may be adopted under high density planting for higher yield with maintained fruit quality in mango cv. Dashehari.

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