Short communication

Pruning alters fruit quality of mango cultivars (*Mangifera indica* L.) under high density planting

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Abstract

The effects of four pruning treatments on fruit quality parameters were studied in three mango cultivars ('Amrapali', 'Mallika' and 'Dashehari') grown under high density planting (23 to 26-year-old trees) in the sub-tropical conditions of Delhi during 2006 and 2007. Pruning intensities (un-pruned, light pruning: branches removed up to 30 cm from the apex, moderate pruning: branches removed up to 60 cm, and severe pruning: branches removed up to 90 cm) significantly (p<0.05) influenced fruit weight and volume with the highest fruit weights (194 and 186 g in 2006 and 2007 respectively) and volumes (165 and 164 ml in 2006 and 2007, respectively) in the light and severely pruned trees, respectively. However, moderately pruned 'Amrapali' trees had the highest pulp: stone ratio (3.6) in both years. Total soluble solids (TSS) was highest in the severely pruned trees while TSS: acid ratios were highest in the lightly pruned trees. No-pruning (control) gave high acidity and low TSS: acid ratio. Reducing sugars improved under moderate pruning intensities, while pruning intensity did not influence total fruit sugars. Light and severe pruning also severely affected reducing sugars and total carotenoid contents, implying that moderate-pruning may be appropriate for improving fruit quality of mango planted under high density and such effects were more pronounced during the second year after pruning.

Keywords: Fruit weight, Total soluble solids, Sugars, Acidity, Carotenoids.

Mango (*Mangifera indica* L.) is an important fruit crop in the tropical and subtropical regions of the world. Although high density orcharding (HDO) has been standardized for the popular cultivars of this crop (e.g., 2.5 x 2.5 m for 'Amrapali'; Majumder et al., 1982; 6 x 6 m for 'Mallika' and 3.0 x 2.5 m for 'Dashehari'; Ram et al., 1997), these cultivars often show sharp decline in yield and quality after 10 to 12 years of fruiting owing to overlapping/intermingling of branches, poor light interception, poor photosynthetic rate, high relative humidity, and pests and disease incidence (Lal and Mishra, 2007). Pruning, if resorted to, not only regulates the canopy size but also ensures quality, size, and appearance of fruits through better exposure of branches and fruits (Rao and Shanmugavelu, 1975). Although Sharma and Singh (2006) advocated pruning for 'Amrapali', the effects of such practices on other popular mango cultivars have been only scarcely investigated. Moreover, inter annual variations in pruning response are also probable. The present investigation, therefore, was undertaken to evaluate the inter annual variations in fruit quality parameters of three mango cultivars as affected by different pruning regimes.

The field experiment in factorial randomized block design was conducted at the Main Orchard, New Delhi, during 2005–'07. Three mango cultivars viz. 'Amrapali' (23-year-old); 'Mallika' (24-year-old), and 'Dashehari' (26-year-old) grown under high density (2.5 x 2.5 m, 4.0 x 3.0 m, and 3.0 x 2.0 m, respectively) were used for this study. Each variety had three replications (12

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trees per block) on which pruning treatments were imposed with single tree replicates. Pruning was done in mid-August 2005 with four intensities, viz., un-pruned (control), light pruning (removing all branches up to 30 cm from the apex), moderate pruning (removing all branches up to 60 cm from the apex), and severe pruning (removing all branches up to 90 cm from the apex). The trees were maintained under uniform cultural practices and were pruned with hand secateurs after measuring the distance from shoot tip with a wooden scale. Balanced pruning (removal of branches from interior and peripheral canopy) was performed throughout the dense and over-crowded canopy dome, uniformly in all directions. The control trees were left without pruning. Following pruning, the trees showed mild-flowering/fruiting in 2006 ('off' year) and better flowering/fruiting in the subsequent year (2007) – 'on' year. Fruits were sampled separately from each tree at full maturity. Weights of five randomly selected mature ripe fruits from three trees per plot were recorded. Fruit size in terms of length (from the apex to stem end) and diameter were recorded by Vernier calipers. The fruit volume was determined by water displacement method. Pulp: stone ratio was calculated by weighing the ripened fruits, pulp, and stone (after peeling). Total soluble solids (TSS) were measured by a hand refractometer (Atago 3T Abbe, Tokyo, Japan) and the values were corrected at 20°C (Ranganna, 1986). Titrable acidity was determined by titrating a known quantity of blended (homogenized) pulp, diluted with distilled water, against NaOH solution (1N), using phenolphthalein as indicator and the results were expressed as percentage of citric acid. TSS: acid ratio was calculated by dividing the TSS value by acidity. Total, reducing, and non traducing sugars from the pulp of ripe fruits were analyzed as suggested by Ranganna (1986). Total carotenoids were extracted with a mixture of petroleum ether and acetone (3:1; Roy, 1973) and assayed calorimetrically using a spectro-photometer (Mini Spec SL-171; Elico, Hyderabad, India) at 450 nm. The experimental data were subjected to factorial analysis of variance for randomized block design (Gomez and Gomez, 1984) (SPAR 1.0) and the differences tested at $p<0.05$.

'Mallika' produced bigger fruits (length, diameter, and fruit volume) compared to 'Amrapali' and 'Dashehari' (Table 1), implying that fruit size is a varietal character. However, 'Amrapali' gave higher fruit yield than 'Mallika'; presumably because of high competition for assimilate partitioning during fruit development (Singh, 2007). Mean fruit weight was significantly influenced by pruning intensity and was highest in the lightly pruned trees (194 and 186 g in 2006 and 2007, respectively). However, average fruit weight decreased in the 'on' year due to increase in the number of fruits per tree. Number of fruits per tree was highest in the moderately pruned trees (Singh, 2007). Fruit volume increased in the severely pruned trees. It is expected that pruning improves microclimate, enhances the vegetative as well as reproductive behavior, and improves photosynthetic rates (Singh et al., 2009), which explains the higher fruit volumes in severely pruned trees.

'Amrapali' had the highest pulp: stone ratio and 'Mallika' recorded the highest TSS, reducing and total sugars as well as acidity percentage. But TSS: acid ratio was better in 'Amrapali', which had least acidity among all cultivars. 'Amrapali' also had the highest total carotenoids, implying intrinsic genetic variability in fruit quality parameters. Our results also indicate that pruning improved pulp: stone ratio (Table 1). Severe pruning increased TSS and reducing sugars in fruits as well as reduced TSS: acid ratio and pulp: stone ratio. Poor performance of the un-pruned trees may be due to limitations in photosynthesis, as indicated earlier. However, higher reducing sugar percent was recorded in moderately pruned trees. Pruning intensity positively affected total carotenoids content also (Table 1) and it was maximum in the moderately pruned trees, regardless of varieties. Both light and severe pruning affected reducing sugars and total carotenoid contents, signifying that moderate pruning is beneficial to improve fruit quality in mango under HDP especially in terms of pulp: stone ratio, TSS, and total carotenoid contents. As regards to inter annual variations, second year after pruning was better in terms of pulp: stone ratio, reducing sugars, and total carotenoids contents than the immediate year.

Table 1. Effect of pruning intensity on fruit characters of three mango cultivars planted under high density at New Delhi, India.

Treatments	Fruit weight (g)		Fruit volume (ml)		Pulp: Stone ratio		TSS (^{0}B)		Acidity (% citric acid)		TSS: acid ratio		Reducing sugars (%)		Total sugars (%)		Total carotenoids (mg 100 g^{-1} fresh wt.)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Varieties																		
'Amrapali'	131	130	134	137	3.63	3.59	21.7	21.3	0.14	0.14	159	158	4.73	4.79	16.8	17.0	5.76	5.81
'Mallika'	278	260	183	179	3.50	3.47	23.2	22.8	0.36	0.34	65	66	6.21	6.30	17.4	17.6	4.73	4.87
'Dashehari'	161	156	160	156	3.29	3.31	20.2	19.7	0.21	0.20	95	28	4.71	4.76	15.0	15.2	3.41	3.46
$CD_{0.05}$	2.57	2.65	2.65	2.91	0.06	0.07	0.32	0.34	0.06	0.07	5.64	4.7	0.17	0.16	0.20	0.16	0.19	0.13
Pruning intensity																		
Un-pruned (control)	193	186	149	151	3.27	3.25	21.3	21.1	0.24	0.23	102	102	5.27	5.32	16.0	16.3	4.37	4.46
Light	194	187	159	157	3.39	3.41	21.3	20.9	0.23	0.22	113	111	5.05	5.09	16.5	16.7	4.58	4.67
Moderate	186	178	162	157	3.60	3.63	21.9	21.5	0.24	0.23	106	108	5.33	5.40	16.4	16.6	5.03	5.09
Severe	188	178	165	164	3.62	3.54	22.2	21.7	0.24	0.23	107	109	5.17	5.33	16.6	16.8	4.54	4.63
$CD_{0.05}$	2.27	3.06	3.01	3.51	0.07	0.08	0.37	0.39	NS	NS	6.5	5.4	0.20	0.19	NS	NS	0.16	0.15

2006='off' year; 2007='on'- year. Data are the means of three trees (replicates). Light pruning: branches removed up to 30 cm from the apex, moderate pruning: branches removed up to 60 cm, and severe pruning branches removed up to 90 cm.

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