Indian Journal of Agricultural Sciences **79** (8): 632–5, August 2009

Effect of pruning on morpho-physiological parameters and microclimate under high density planting of mango (*Mangifera indica*)*

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Received: 30 November 2008

Key words: Growth, Micro-climate, Mango, *Mangifera indica*, Pruning intensity

Pruning is an age-old horticultural practice followed in deciduous and temperate fruit crops such as apple, pear, peach, plum etc., and in few sub-tropical fruits, like grape (*Vitis vinifera* L.), fig (*Ficus caricae* L.) and phalsa (*Grevia subinequalis*). Many evergreen fruit trees including mango (*Mangifera indica* L.) respond to pruning (Davenport 2006) and gainful results have been obtained as well. Architecture and form of a tree varies with cultivars and keep on changing with the tree age, climate, cultural practices, training and pruning etc. The high-density orcharding in some cultivars of mango have been standardized, viz. 'Amrapali' (2.5 m×2.5 m) (Sharma and Singh 2006), 'Mallika' (6 m×6 m) and 'Dashehari' (3.0 m×2.5 m) with pruning and also with application of paclobutrazol. Nevertheless, the above cultivars showed sharp decline in yield and quality after 10–12 years of fruiting owing to overlapping/intermingling of branches, poor light interception, poor photosynthetic rate, high relative humidity and proneness to diseases and pests etc. (Lal and Mishra 2007). The pruning as a tool is not only to control size but also to maximize yield. Therefore, the present investigation was undertaken to study the effect of pruning on morpho-physiological and tree micro-climatic parameters in some common mango cultivars.

The field experiments were conducted at the Main Orchard, Division of Fruits and Horticultural Technology of the Institute, New Delhi, during 2005–07. Three mango cultivars namely 'Amrapali' (V_1), 'Mallika' (V_2) and 'Dashehari' (V_3) planted under high density at 2.5 m×2.5 m, 4.0 m×3.0 m and 3.0 m×2.0 m, respectively were selected and maintained under uniform cultural practices. Pruning was done in mid August 2005 with following 4 intensities, ie I0 (control): un-pruned, I1 (light): 30 cm from the apex, I2 (moderate): 60 cm from the apex and I3 (severe): 90 cm from the apex. Each variety had 3 replications with 3 trees/ treatment. The experiment was conducted under factorial randomized block design. The balanced pruning was performed in all directions of the canopy, which were dense and over-crowded. The control trees were left as such without pruning. As a result of pruning, the trees did show mild-flowering/ fruiting in 2005–06 and was referred as off-year and following year (2006–07) as on-year. Morpho-physiological characters [number of sprouted shoots / branch, shoot length, canopy volume, trunk girth, net photosynthetic rate, transpiration rate, relative water content] and tree micro-climatic parameters (light penetrance, canopy temperature and canopy relative humidity) were recorded at 3 stages [stage I: 1 month after pruning; stage II: at the time of fruit bud differentiation (FBD) (November and December); stage III: during flowering] in each experimental years. The number of sprouted shoots/ branch was recorded by counting the number of new shoots. The shoot length was measured on individual branch. The canopy volume (from the root base of a tree to maximum spreading) was recorded by measuring tape (fastened on a bamboo stick) and calculated by formula suggested by Samaddar and Chakrabarti (1988).

$$\text{Canopy volume } (m^3) = 4/3\ \pi(r^2h)$$

where r = diameter/2, h= height of the plant

The canopy diameter was measured in both the direction (NS and EW) of the canopy. Plant height (m) was measured from graft union to top of the tree by measuring tape (fixed on a bamboo stick). The tree micro-climatic parameters, like light penetrance was recorded (at 0–1 m from crotch in N-S and E-W directions) using portable digital lux meter), canopy temperature (in the middle of the canopy) using maximum and minimum thermometer (in degrees Celsius). Likewise, canopy relative humidity was recorded by using dry and wet bulb thermometer. The relative water content in the recently

*Short note

*Based on a part of Ph D thesis of the first author submitted to IARI, New Delhi during 2007

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mature leaves was determined using the method suggested by Weatherley (1950).

$$\text{Relative water content (\%)} = \frac{\text{Fresh weight–oven dry weight}}{\text{Turgid weight–oven dry weight}} \times 100$$

The other physiological parameters, viz net photosynthetic and transpiration rates were measured with the help of Portable Photosynthesis System-I (CIRAS 2, Amesbury, USA version 2.01). The two years data at all stages were analyzed as per methods suggested by Gomez and Gomez (1984).

'Amrapali' cultivar showed increasing trend in the number of sprouted shoots/branch at stage I and II because it produced very little growth in first year. The severe pruning resulted in sprouting of maximum number of shoots due to low shoot: root ratio compared to control (old-aged trees).The longest shoot length was recorded in 'Mallika' and shortest in 'Amrapali' because of lesser number of shoots produced in 'Mallika'. The light pruning led to longer shoot length than severe or moderate (Lal and Mishra 2007) (Table 1). Under high density planting, due to genetical factor 'Dashehari' (a vigorous cultivar) had the highest canopy volume, followed by 'Mallika' (semi-vigorous) and 'Amrapali' (dwarf). The un-pruned (control) trees had the higher canopy volume which decreased with the increase in pruning intensities. The trunk girth was highest in 'Dashehari', followed by 'Mallika' and 'Amrapali'. Though the all 3 pruning intensities significantly affected trunk girth but maximum was noticed at stage III of light pruned trees (Table 1).

'Mallika' had the maximum net photosynthetic rate compared with the other cultivars. Maximum net photosynthetic rate was recorded in severely pruned trees due to large number of young leaves than meagre growth in un-pruned (control) trees (Pratap *et al.* (2003).The transpiration rate and leaf relative water content was estimated higher in regular bearing cultivars ('Mallika' and 'Amrapali') than the biennial bearer ('Dashehari'). The un-pruned trees had the highest transpiration rate and the lowest values were recorded in moderately pruned trees because of

Table 1 Effect of pruning intensity on (a) sprouted shoots and shoot length (b) canopy volume and trunk girth in different mango cultivars planted under high density

Treatment	No. of sprouted shoots/ branch						Shoot length (cm)					
	2005–06*			2006–07**			2005–06*			2006–07**		
	I	II	III	I	II	III	I	II	III	I	II	III
(V1)	1.74	2.58	4.06	2.33	2.95	3.05	1.80	2.97	3.20	1.98	3.21	3.36
(V2)	1.69	1.99	1.96	2.16	2.60	2.45	2.25	2.41	2.70	2.37	2.54	2.85
(V3)	1.80	2.56	2.76	2.60	2.77	2.79	2.03	3.64	3.80	2.05	2.22	2.33
SEm±	0.14	0.10	0.14	0.12	0.13	0.09	0.10	0.13	0.15	0.09	0.11	0.11
CD (*P*=0.05)	NS	0.28	0.40	0.35	NS	0.28	0.29	0.38	0.43	0.26	0.33	0.33
I0	0.60	1.02	1.55	1.35	2.22	2.12	1.64	2.18	2.46	1.77	2.16	2.54
I1	1.07	1.70	2.45	2.01	2.27	2.20	2.20	3.85	3.91	2.33	3.25	3.48
I2	2.41	2.76	3.02	2.66	2.96	2.93	2.08	3.11	3.38	2.15	2.67	2.76
I3	2.92	4.03	4.70	3.43	3.63	3.01	2.20	2.90	3.18	2.28	2.54	2.62
SEm±	0.17	0.11	0.16	0.14	0.16	0.11	0.12	0.15	0.17	0.10	0.13	0.13
CD (*P*=0.05)	0.58	0.33	0.47	0.41	0.47	0.32	0.34	0.44	0.50	0.31	0.38	0.39
	Canopy volume (m^3)						*Trunk girth (cm)*					
(V1)	46.22	51.64	56.60	61.91	66.73	70.44	64.33	67.01	67.81	68.56	69.63	70.40
(V2)	65.51	71.73	75.32	79.18	83.50	80.35	66.87	68.72	69.42	70.42	71.45	72.48
(V3)	71.97	80.41	85.03	88.22	91.99	98.37	73.73	75.20	76.33	77.21	78.80	79.8
SEm±	4.59	5.49	5.60	5.59	5.60	5.44	0.34	0.37	0.32	0.33	0.36	0.32
CD (*P*=0.05)	13.10	15.77	16.00	16.06	16.10	15.92	0.98	0.96	0.91	0.96	1.05	0.93
I0	141.02	156.52	163.40	167.69	173.10	181.46	68.07	70.41	71.50	72.42	73.75	74.61
I1	44.94	49.46	52.54	57.20	61.52	65.46	68.55	70.08	72.06	72.73	73.59	74.64
I2	36.20	39.97	43.47	47.37	51.74	55.61	67.86	69.72	70.45	71.10	72.41	73.30
I3	22.78	25.74	29.86	33.40	36.60	40.35	68.77	70.23	70.74	71.99	73.43	74.39
SEm±	5.30	6.34	6.46	6.45	6.47	6.40	0.39	0.39	0.37	0.38	0.42	0.37
CD (*P*=0.05)	15.22	18.21	18.57	18.54	18.60	18.38	NS	NS	1.06	1.10	NS	1.07

*'off' year, †the details of treatment are given in the text.

** 'on' year

Stage I: one month after pruning;

Stage II: at the time of fruit buds differentiation (November and December);

Stage III: during flowering

Table 2 Effect of pruning intensity on net photosynthetic and transpiration rates, leaf relative water content and light penetrance, canopy temperature and relative humidity in different mango cultivars planted under high density

Treatment	Net photosynthetic rate (μ mol $Co_2/m^2/S$						Transpiration rate (m mil/m^2/S)					
	2005–06*			2006–07**			2005–06*			2006–07**		
	I	II	III	I	II	III	I	II	III	I	II	III
(V1)	6.69	6.63	6.17	6.93	6.71	6.40	3.88	3.78	3.69	3.84	3.57	3.65
(V2)	7.48	7.35	7.50	7.56	7.40	7.55	3.92	3.84	3.75	3.86	3.62	3.70
(V3)	5.86	6.17	6.29	5.94	6.06	5.98	3.32	3.26	3.14	3.25	3.03	3.09
SEm±	0.07	0.06	0.06	0.06	0.07	0.09	0.03	0.03	0.03	0.03	0.03	0.03
CD (*P*=0.05)	0.20	0.17	0.17	0.19	0.21	0.26	0.08	0.09	0.09	0.09	0.08	0.08
I0	5.62	5.53	5.58	5.71	5.59	5.73	4.52	4.46	4.37	4.47	4.22	4.33
I1	6.62	6.47	6.32	6.72	6.31	6.37	3.62	3.51	3.41	3.56	3.30	3.37
I2	7.08	7.11	7.09	7.24	7.12	6.72	3.30	3.20	3.09	3.24	2.98	3.05
I3	7.40	7.76	7.61	7.56	7.88	7.75	3.39	3.33	3.23	3.33	3.13	3.19
SEm±	0.08	0.07	0.06	0.07	0.08	0.10	0.03	0.03	0.03	0.03	0.03	0.03
CD (*P*=0.05)	0.23	0.20	0.19	0.22	0.24	0.30	0.10	0.11	0.10	0.10	0.10	0.10
	Relative water content (RWC) (%)						*Light penetrance (K lux)*					
(V1)	89.26	91.75	93.37	91.52	94.55	95.31	7.66	6.31	6.15	6.82	5.87	5.74
(V2)	87.77	90.27	91.68	90.28	93.54	95.11	5.27	4.46	4.21	4.68	4.19	3.87
(V3)	84.21	86.60	87.74	86.19	89.70	91.11	7.46	6.16	6.31	7.00	6.61	6.15
SEm±	0.64	0.86	0.85	0.60	0.61	0.62	0.54	0.59	0.59	0.62	0.64	0.67
CD (*P*=0.05)	1.84	2.47	2.45	1.74	1.77	1.70	1.55	1.69	1.71	1.80	1.83	1.94
I0	88.30	91.30	92.46	90.47	92.59	93.69	5.46	4.28	4.20	4.55	4.03	3.76
I1	88.24	91.06	92.41	89.94	93.67	94.93	7.31	6.18	6.10	6.70	6.03	5.79
I2	85.68	88.18	89.72	87.97	92.32	92.50	5.96	5.03	4.97	5.67	5.16	4.87
I3	86.84	87.61	89.18	88.94	92.82	94.25	8.46	7.07	6.95	7.76	7.01	6.59
SEm±	0.74	0.99	0.98	0.70	0.71	0.72	0.62	0.68	0.69	0.72	0.74	0.78
CD (*P*=0.05)	NS	2.85	2.83	NS	NS	NS	1.80	1.96	1.97	2.08	2.12	NS
	Canopy temperature (°C)						*Canopy relative humidity (%)*					
(V1)	32.33	29.08	30.08	32.83	29.08	30.83	46.16	49.58	51.25	49.50	52.08	52.66
(V2)	32.33	29.33	30.41	32.58	30.08	31.16	49.66	51.83	52.91	50.58	52.33	53.41
(V3)	32.75	30.16	31.00	33.08	30.50	31.41	47.41	50.08	51.25	48.58	50.58	51.41
SEm±	0.32	0.18	0.21	0.34	0.31	0.32	0.53	0.40	0.39	0.46	0.53	0.49
CD (*P*=0.05)	NS	0.53	0.60	NS	0.90	0.92	1.52	1.14	1.13	1.33	1.54	1.42
I0	30.33	27.44	28.44	31.44	28.66	29.77	51.44	53.88	54.77	52.22	54.77	55.00
I1	32.11	29.22	30.22	32.33	29.22	30.44	48.66	51.77	53.11	50.55	52.44	53.44
I2	32.00	29.55	30.55	32.44	29.88	30.66	46.00	48.88	50.44	48.11	50.00	50.66
I3	35.44	31.88	32.77	35.11	31.77	32.66	44.88	47.44	48.80	47.30	49.44	50.00
SEm±	0.28	0.21	0.24	0.39	0.36	0.37	0.61	0.46	0.45	0.53	0.62	0.57
CD (*P*=0.05)	0.93	0.62	0.70	1.13	1.03	1.06	1.75	1.32	1.30	1.54	1.70	1.64

greater no. of non-flowering branches in un-pruned trees (Shivashankra and Mathai 2000) (Table 2). Un-pruned trees (I0) showed highest value of relative water content and the lowest in severely pruned trees (I3) due to un-pruned trees had more number of old leaves (reduction in differences of leaf turgid and dry weights) than in younger leaves of pruned trees. The canopy micro-climate drastically improved after pruning. The light penetration was highest in canopy of 'Amrapali' (low spreading and dwarf stature) than 'Mallika'/ 'Dashehari'. The light penetrance as photosynthetic photon flux was high as one moved away from main trunk (due to exposure of maximum interior canopy to the sun). The light penetration was highest in severely pruned trees (I3) and decreased with pruning severity (Table 2).The better light penetration in the canopy of pruned trees was noticed due to more sieving of light for photons (Pratap *et al.* 2003, Sharma and Singh 2006).

At stage II and III, the maximum canopy temperature was found in 'Dashehari' (had very scarce branches and thinly spread foliage) compared to 'Mallika'/'Amrapali'. However the severely pruned trees (I3) showed the highest canopy temperature owing to defoliation (removal of branches), exposure of interior branches to sunlight etc. The un-pruned trees (I0) showed drastic reduction in canopy temperature. The 'Mallika' had the highest canopy relative humidity than the 'Amrapali'/'Mallika' in first year due to dense foliage

and very close distribution of branches than the later. The highest canopy relative humidity was observed in un-pruned trees (control) due to intermingling of branches; very old shoots and poor light interception, while lowest value was estimated in severely pruned tree due to open centre of canopy with better light penetration (Pratap *et al.* 2003, Sharma and Singh 2006) (Table 2).

SUMMARY

A field experiment was conducted during 2005–07 at Indian Agricultural Research Institute, New Delhi, to assess the effect of pruning intensity in some mango cultivars ('Amrapali', 'Mallika' and 'Dashehari'). Severely pruned trees had the highest number of sprouted shoots while the lowest was in control (unpruned). 'Amrapali' gave the least number of shoots. 'Mallika' had the maximum shoot length while least in 'Amrapali'. Light pruning produced the longest shoot than other pruning intensities. Canopy volume and tree girth were found to be more in 'Dashehari' and low in 'Amrapali'. The net photosynthetic rate, transpiration rates and leaf relative water content were higher in regular bearing cultivars ('Mallika' and 'Amrapali') than the biennial bearer ('Dashehari'). Severely and moderately pruned trees had the highest net photosynthetic rate and greatly reduced in un-pruned trees. The canopy of Amrapali showed the maximum light interception with lowest canopy relative humidity, while least light interception was registered in 'Dashehari'. Severe pruning led to better light penetration and increased canopy temperature, but declined with the reduction in pruning intensities. The lowest light penetrance, canopy temperature and highest canopy volume, transpiration rates and canopy relative humidity was noticed in unpruned trees.

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