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Effect of canopy management on growth and yield of mango cv. Amrapali planted at close spacing

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Abstract

Investigations were undertaken at ICAR Research Complex for Eastern Region, Research Centre, Ranchi, Jharkhand, India (ICAR RCER, RC, R) to standardize canopy architecture of rejuvenated mango plants of cv. Amrapali planted at a closer spacing. Twenty four years old mango trees cv. Amrapali planted at a spacing of 5.0 m x 5.0 m were topped at three different heights: 1.0 m (R1), 1.5 m (R2) and 2.0 m (R3) above ground during December, 2005. Treatments on length of primary shoot [60 cm (P1), 120 cm (P2), no control on length of primary shoot (P3)] and length of secondary shoots [60 cm (S1) and no control on length of secondary shoot (S2)] were imposed after one year of rejuvenation pruning in 18 different combinations. The earliest bud sprouting occurred in R3 and longer in R1 trees. There were significant differences among treatments for tree height during both the years of study and canopy spread and shoot girth after one year of rejuvenation pruning. The treatment R1 resulted in lower plant height as compared to R2 and R3 trees. With respect to girth of primary shoots, R1 resulted in lower values as compared to other treatments after one year of rejuvenation pruning. However, the differences among the values of girth of primary shoot during 2010 were non-significant. Initiation of fruiting began after third year of rejuvenation pruning. Yield greater than 60 kg/tree were recorded in R2 and R3. Pruning at 1.0 m (R1), 60 cm length of primary shoot (P1), and no control on length of secondary shoots (S2) was found to be the best management practice for rejuvenation of unproductive mango orchards of cv. Amrapali planted at close spacing.

Key words: Mango, rejuvenation, canopy architecture, pruning.

Introduction

Mango is the most important fruit of India which is being grown since antiquity. Consequent upon the continuous and long span of mango orcharding in the country, a large number of orchards have become old and unproductive. Rejuvenation of old and unproductive mango orchard through pruning has already been standardized in traditionally grown vigorous mango cultivars [1, 7, 10, 16]. Davenport [3] has suggested severe pruning of old, nonproductive mango trees coupled with subsequent tip pruning for rapid restoration of orchard production.

The eastern plateau and hill agro-climatic zone of India is home to a large diversity of mango genotypes. However, commercial mango orcharding is recent and the region is emerging as a new potential mango growing region of the country. The mango cultivar Amrapali is the most commonly planted variety in the new orchards due to its precociousness, dwarfing growth habit and high yield potential. Due to the dwarf nature of the variety, the plants are being planted at a spacing of 5-6 m x 5-6 m. However, overcrowding of orchards has been recorded after 20 years in the absence of regular canopy management. Beneficial effect of pruning on increasing the production of mango cv. Amrapali grown under high density have been successfully demonstrated [11]. Rejuvenation of overcrowded orchards have been standardized for vigorous cultivars planted at a spacing of 10-12 m x 10-12 m. However, no work has been done to manage canopy architecture of rejuvenated mango plants planted at closer spacing. For appropriate light penetration and adequate yield, closely-spaced trees should have a compact and spherical canopy. This work was undertaken with the objective of standardizing canopy architecture of rejuvenated mango plants cv. Amrapali planted at a closer spacing.

Materials and Methods

The investigations were undertaken at Indian Council of Agriculture Research, Research Complex for Eastern Region, Research Centre, Ranchi, Jharkhand, India (ICAR RCER, RC, R). Twenty four years old mango plants of cv. Amrapali planted at a spacing of 5.0 m x 5.0 m were topped back at three different heights: 1.0 m (R1), 1.5 m (R2) and 2.0 m (R3) above ground during December, 2005. The mango plants were grafted plants where scions were grafted on seedling rootstocks at a height of 30-45 cm above the ground level. Before the pruning operation the orchard was overcrowded and no appreciable fruit yield had been obtained since 2003 and the plants had attained a height of more than 6.0 m from the ground. All the trees had scaffold branching below the post pruning heights. Four shoots per branch were maintained out of the shoots emerging after rejuvenation pruning by monthly removal of unwanted shoots. Treatments on length of primary shoot [60 cm (P1), 120 cm (P2), no control on length of primary shoot (P3)] and length of secondary shoots [60 cm (S1) and no control on length of secondary shoot (S2)] were imposed after one year of rejuvenation pruning. The experiment consisted of 18 treatment combinations. Data on plant growth were recorded during February in vegetative stage and at the time of 100% flowering after attaining the flowering stage. The trunk girth was recorded at a height of 10 cm above the graft union. Data on light penetration inside the canopy was recorded using a single Lux Meter inside the tree canopy from four different sides and the average value was expressed as per cent of total light intensity in open space. Data on leaf area index were recorded using a Canopy Analyzer (LAI 2000). The experiment was laid out in a randomized block design with three replications per treatment (two plants per treatment) and the data were subjected to analysis of variance.

Results and Discussion

Restoration of the growth status existing before pruning operation is the first response to pruning [9]. In the present investigation, initiation of bud sprouting was observed 42 days after rejuvenation pruning, however, the earliest bud sprouting on R3 trees (25 days) and longest in R1 trees (56 days; data not shown). During the first six months after rejuvenation pruning, the number of flushes was 7-9 in different plants. The longest shoot length 6 months after pruning was recorded in case of R1 (0.49 m) whereas trees receiving treatments R2 and R1 attained lengths of 0.42 m and 0.41 m, respectively (data not shown). This is in accordance to Kookmann's rule [6] indicating that new shoot growth increases with severity of pruning. Gross [4] has also reported that to maintain vegetativeness of mango shoot, pruning should not be done at diameter < 6 cm. The delayed bud sprouting in case of rejuvenation pruning at 1.0 m height can be attributed to emergence of bud from older tissue characterized by increased lignifications and accumulation of higher amount of growth inhibitors [8]. However, higher rate of shoot growth in case of 1.0 m rejuvenation pruning during the initial six months can be attributed to increased biosynthesis of gibberellic acid with increase in pruning intensity. Increases in vegetative vigour with increase in pruning severity has also been reported in other fruit crops [5]. Increased accumulation of gibberrellic acid with increase in pruning intensity have been reported in different crops [9].

Data on effect of canopy management on rejuvenated mango plants on growth after one year and four years of rejuvenation pruning is given in Table 1. There were significant differences among treatments for plant height during both the stages, canopy spread and shoot girth after one year of rejuvenation pruning. The treatment R1 resulted in lower plant height than R2 and R3. Non-significant differences in the values of canopy spread during 2010 indicated stabilization of canopy spread in all the treatments. With respect to girth of primary shoots, R1 resulted in lower values as compared to other treatments after one year of rejuvenation pruning. This can be attributed to low rate of cambial differentiation in case of shoots emerging out of older tissues having higher accumulation of growth inhibitors [13]. However, non-significant differences in girth of primary shoot during 2010 can be considered as stabilization of growth rate after four years of rejuvenation pruning. In a trial conducted in mango cv. Dashehari, higher values of tree height, shoot length, shoot girth and internodal length were recorded after rejuvenation pruning at 5 m height than that recorded in case of 4 m height [12]. Data on rate of growth in girth of primary shoot during different periods in this investigation are depicted in Fig. 1. Significant treatment effects in rate of increase in shoot girth were obtained in 2007-2008 and 2008-2009 but not in 2009-2010. During both 2007-2008 and 2008-2009, in general a higher rate of increase in shoot girth was recorded in case of treatments with no control on length of primary shoots. Presence of higher number of apical meristem due to presence of higher number of branches in the absence of any control on length of primary shoots might have resulted in increased action of auxins resulting in accelerated formation of cambial tissue.

Data on yield per plant under different treatments are given in Table 1. Initiation of fruiting began during third year of rejuvenation pruning. However, trees receiving R1 and R2 treatments produced less fruit than those of R3. Delayed flowering in severly pruned plants has been reported in different crops [2]. In the present investigations, a yield greater than 60 kg per tree was recorded during 2010 in R2 and R3 and no control on growth of primary or secondary shoots (i.e., P3 and S2). Superior performance of light pruning over rejuvenation involving removal of trees every two rows and light pruning have been reported [15].

The beneficial effects of pruning on light penetration of mango trees of cv. Amrapali have been reported [14]. As expected, in this study trees receiving treatment S1 had higher % of light penetration into the canopy than S2 trees (Fig. 2). Leaf area index differed significantly among treatments (Fig. 3). The treatment S1 resulted in lower leaf area index than that in other treatments. Reduction in foliage owing to removal of any shoot emerging below 60 cm length of secondary shoot can be attributed to lower values of leaf area index.

With respect to canopy shape, trees with rejuvenation pruning at 1.0 m height, 60 cm length of primary shoot and no control on length of secondary shoot could attain a spherical shape without intermingling of canopy of adjacent plants after 4 years of rejuvenation pruning. The average canopy attained by the plant was amenable to different canopy management practices.

Conclusions

We conclude from this study that pruning at 1.0 m height (P1), 60 cm length of primary shoot (S1) and no control on length of secondary shoot (S2) were found to be most appropriate treatments to attain an adequate canopy architecture in unproductive mango plants of cv. Amrapali planted at close spacing. Maintenance of canopy size could later be achieved and can be maintained through regular shoot tipping after fruit harvesting.

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Table 1. Effect of canopy management after rejuvenation pruning on plant growth parameters and yield of mango cv. Amrapali.

Treatments on Canopy architecture	Trunk girth (cm)		Height (m)		Canopy spread (EW) (m)		Canopy spread (NS) (m)		Shoot girth (cm)		Yield (kg/tree)	
	2007	2010	2007	2010	2007	2010	2007	2010	2007	2010	2009	2010
Rejuvenation pruning 1m, primary shoot 60 cm, secondary shoot 60 cm	81.75	87.33	2.43	4.05	2.04	5.40	2.28	5.60	3.06	6.46	0.00	37.99
Rejuvenation pruning 1m, primary shoot 120 cm, secondary shoot 60 cm	79.20	90.50	2.73	4.32	2.49	5.15	2.38	5.08	3.20	6.98	0.00	8.35
Rejuvenation pruning 1m, No control on primary shoot and secondary shoot 60 cm	81.27	89.50	2.75	4.38	2.72	5.40	2.89	5.57	3.31	6.78	10.95	24.53
Rejuvenation pruning 1m, primary shoot 60 cm, No control on secondary shoot	75.27	81.83	2.37	4.08	2.15	4.92	1.93	4.80	2.80	6.22	1.67	51.68
Rejuvenation pruning 1m, primary shoot 120 cm, No control on secondary shoot	77.63	83.83	2.81	4.30	2.42	5.13	2.60	5.30	2.98	7.09	5.80	8.64
Rejuvenation pruning 1m, No control on primary and secondary shoot No control	83.62	91.00	3.10	4.52	3.25	5.40	3.20	5.30	3.91	7.31	0.00	30.54
Rejuvenation pruning 1.5 m, primary shoot 60 cm, secondary shoot 60 cm	92.61	97.17	2.97	4.60	2.43	5.22	2.60	5.15	3.36	6.48	4.73	51.44
Rejuvenation pruning 1.5 m, primary shoot 120 cm, secondary shoot 60 cm	80.04	85.83	3.35	4.75	2.63	5.08	2.52	4.83	3.60	6.74	1.83	47.90
Rejuvenation pruning 1.5 m, No control on primary shoot and secondary shoot 60 cm	84.88	94.00	3.29	4.67	3.19	5.18	3.30	5.38	3.92	7.50	9.40	39.53
Rejuvenation pruning 1.5 m, primary shoot 60 cm, No control on secondary shoot	80.32	88.17	2.98	4.33	2.66	5.13	2.61	4.97	3.18	6.55	2.30	57.74
Rejuvenation pruning 1.5 m, primary shoot 120 cm, No control on secondary shoot	81.30	87.67	3.12	4.57	2.52	5.23	2.54	5.02	3.39	6.89	0.00	31.63
Rejuvenation pruning 1.5 m, No control on primary and secondary shoot	92.95	100.83	3.60	5.08	3.63	5.65	3.47	5.67	4.43	7.96	0.00	61.43
Rejuvenation pruning 2 m, primary shoot 60 cm, secondary shoot 60 cm	95.62	103.33	3.45	5.07	2.80	5.42	2.60	5.23	3.44	6.70	6.12	51.95
Rejuvenation pruning 2 m, primary shoot 120 cm, secondary shoot 60 cm	70.15	76.33	3.72	4.90	2.72	5.08	3.05	4.85	3.40	6.04	5.67	43.02
Rejuvenation pruning 2 m, No control on primary shoot and secondary shoot 60 cm	78.01	85.83	3.63	4.83	2.96	5.23	2.87	4.93	3.80	6.68	2.97	57.03
Rejuvenation pruning 2 m, primary shoot 60 cm, No control on secondary shoot	99.43	105.50	3.48	5.22	2.66	5.38	2.79	5.43	3.34	6.50	1.17	38.40
Rejuvenation pruning 2 m, primary shoot 120 cm, No control on secondary shoot	87.83	94.33	3.60	5.08	2.89	5.17	2.90	5.20	3.33	6.64	0.00	51.30
Rejuvenation pruning 2 m, No control on primary and secondary shoot	88.30	95.50	3.51	5.13	4.03	5.32	3.83	5.22	4.12	6.65	6.12	61.80
SEm±	7.64	7.06	0.11	0.17	0.21	0.22	0.17	0.24	0.15	0.36	1.89	15.81
C.D. at 5%	ns	ns	0.31	0.48	0.60	ns	0.47	ns	0.43	ns	ns	32.27

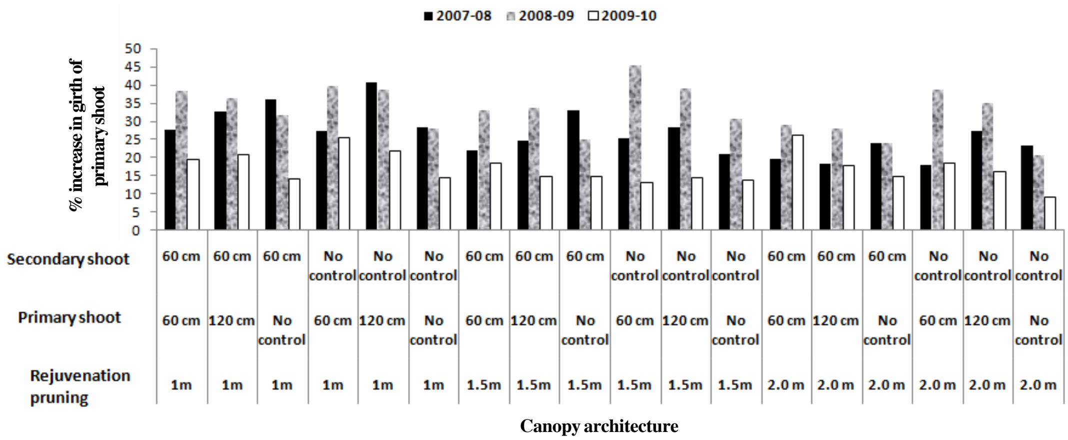

Figure 1. Effect of canopy management on % increase in girth of primary shoot emerged after rejuvenation pruning.

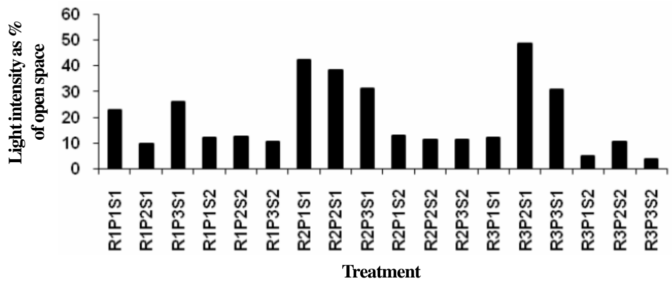

Figure 2. Light intensity (% of intensity in open space) inside plant canopy of mango plants under different training systems.

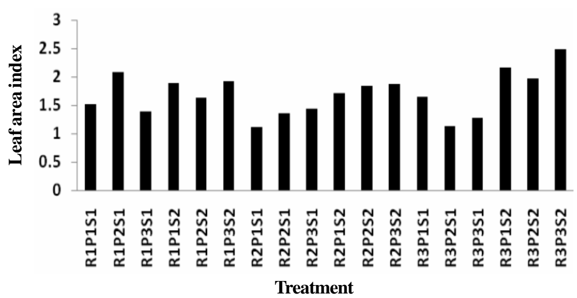

Figure 3. Effect of canopy management on leaf area index of rejuvenated mango plants of cv. Amrapali.