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Sagar BS
Department of Horticulture, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India

Athani SI
Department of Horticulture, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India

Kulapati Hipparagi
Department of Horticulture, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India

Allolli TB
Department of Horticulture, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India

Revanappa Gopali JB
Department of Horticulture, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India

Mallikarjun Awati
Department of Horticulture, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India

Raghavendra S
Department of Horticulture, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India

Correspondence
Sagar BS
Department of Horticulture, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India

Effect of high density planting and pruning seasons on growth and yield of mango (*Mangifera indica* L.) cv. Alphonso

Sagar BS, Athani SI, Kulapati Hipparagi, Allolli TB, Revanappa Gopali JB, Mallikarjun Awati and Raghavendra S

Abstract
A study was carried out to know the effects of high density planting and pruning seasons on growth and yield of mango (*Mangifera indica* L.) cv. Alphonso at Regional Horticulture Research and Extension Centre, Dharwad (University of Horticultural Sciences, Bagalkot) during May - 2016 to June – 2018. The maximum plant height increment (17.66 cm) was recorded in D_3T_2 (5.0 x 5.0 m with previous season growth pruning) whereas, the maximum plant girth (1.87 cm) was recorded in D_1T_3 (2.5 x 2.5 m with current season growth pruning**)**. The maximum plant spread (East-West) (22.62 cm), plant spread (North-South) (26.04 cm) and canopy volume (0.92 m^3) were recorded in the treatment D_2T_1 (5.0 x 2.5 m in un-pruned plants) whereas, the highest number of primary branches (4.08) and tertiary branches (26.76) were recorded in the treatment D_2T_2 (5.0 x 2.5 m with previous season growth pruning) and highest number of secondary branches (8.81) was recorded in the treatment D_2T_3 (5.0 x 2.5 m with current season growth pruning). The maximum number of fruits per plant (54.95) and yield per plant (14.72 kg) was recorded in the treatment D_4T_2 (7.5 x 5.0 m with previous season growth pruning). Treatment D_1T_2 (2.5 x 2.5 m with previous season growth pruning) showed the maximum yield per hectare (14.61 t/ha). Plants spaced at 5.0 x5.0 m and 7.5 x 5.0 m with pruning showed beneficial results whereas, to get maximum yield per unit 2.5 x 2.5 m spacing (high density planting) with previous season growth pruning was found to be effective.

Keywords: Mango, high density, seasons and pruning

Introduction
Mango (*Mangifera indica* L.) belongs to family Anacardiaceae. It is the most important commercially grown fruit crop of the country. It is called the king of fruits. Cultivation of mango is believed to have originated in South East Asia and it is being cultivated in southern Asia for nearly six thousand years. Mango is the most important fruit crop in the sub-tropical and tropical regions of the world normally planted at 10-12 m distance. The high density orcharding in mango is suggested to make the maximum use of land to achieve higher yields in the early years of the orchard life. Pruning is an operation familiar to all arborists and horticulturists managing growth and reproductive habits of fruit trees especially under close spaced orchards/plantations. The pruning strategies in mango have been developed to prevent trees from getting large through annual pruning as part of a production management programme, reshape intermediate size trees to smaller or more manageable sizes and completely rejuvenate large trees that are no longer productive due to their size and height.
In most of the regions, where mango is grown, solar radiation is abundant and thus productivity largely depends upon its efficient utilization. Ever increasing population of our country warrants more production of fruits to bridge the gap between per capita consumption and recommendation. This can be achieved by increasing the area under fruit crops and or by increasing the productivity per unit area. All pruning techniques which induce changes in the partitioning of metabolic reserves tend to reduce excessive vegetative growth, at lowest in the short-term, the study was undertaken to know the effects of high density planting with pruning.

Materials and methods
The present investigation on ’Effects of high density planting and pruning seasons on growth and yield of mango (*Mangifera indica* L.) cv. Alphonso’ was carried out in Regional

Horticulture Research and Extension Center, Dharwad (University of Horticultural Sciences, Bagalkot,) during May - 2016 to June - 2018. The material used, techniques adopted and observations recorded during the course of the investigation are presented in this chapter. Five year old mango orchard cv. Alphonso established during 2011 was selected for the experiment. The pruning was done after harvesting of fruits in 2016 and 2017. Three pruning seasons like T_1 (control), T_2 (15cm from apex of previous season growth) and T_3 (15cm from apex of current season growth) on four different densities like 2.5 × 2.5 m (1600 plants/ ha), 5.0 × 2.5 m (800 plants/ ha), 5.0 × 5.0 m (400 plants/ ha) and 7.5 × 5.0 m (267 plants/ ha). Each treatment was replicated three times and four plants were chosen from each replication. The experiment was laid out in two Factorial Randomized Block Design.

Growth parameters recorded during this study *viz*., plant height (cm), stem girth (mm), plant spread in both directions North-South and East-West (cm), canopy volume (m^3), number of primary branches, number of secondary branches and number of tertiary branches were measured at 60 days interval after imposition of treatments, in four representative plants in each treatment and average was calculated. For all the vegetative parameters the final growth and incremental growth is given. The growth increment was recorded by calculating the difference occurred after imposing of treatment to harvesting and given in results and discussed. Yield parameters *viz*., number of fruits harvested/plant, fruit yield (kg/plant), fruit yield (tones/ ha) were recorded at the harvesting time.

Results

Vegetative parameters

Plant height (cm)

From the pooled data of both seasons (Table 1), the increment in plant height varied significantly among the different plant densities. The increment in plant height was found the maximum in the plants spaced at 5.0 x 2.5 m **(**16.79 cm) which was followed by 5.0 x 2.5m (12.20 cm) whereas, the minimum increment in plant height increment was noticed in 7.5 x 5.0 m (10.90 cm) over the other spacing used. With respect to different pruning seasons, the increment in plant height was found maximum in control (14.80 cm) which was followed by current season growth (12.32 cm) whereas, the minimum plant height increment was recorded in previous season growth (11.90 cm) over other pruning seasons. In interaction effect of plant density and pruning, the increment in plant height was found maximum in D_3T_2 (17.66 cm) which was on par with D_2T_1 (16.46 cm), D_3T_3 (16. 44 cm) and the minimum increment in plant height increment was found in D_4T_2 (8.86 cm).

Plant girth (cm)

From the pooled data of both seasons, the increment in plant girth varied significantly among the different planting densities and pruning (Table 1). The increment in plant girth was found maximum in 2.5 x 2.5 m spacing (1.22 cm) which was followed by the spacing 5.0 x 5.0 m (0.84) whereas, the minimum increment in plant girth was noticed in 5.0 x 2.5 m (0.53 cm). With respect to different pruning seasons, increment in plant girth was found maximum in the plants pruned with current season growth (1.25 cm) whereas, the minimum as recorded in control (0.56 cm). In interaction effect of plant density and pruning, the increment in plant girth increment was found maximum in D_1T_3 (1.87 cm) which was followed by D_3T_3 (1.53 cm) whereas, minimum increment in plant girth was found in D_2T_2 (0.20 cm).

Plant spread East- West (cm)

Pooled data of two seasons showed the highest plant spread (East-West) in the plants spaced at 2.5 x 2.5 m (17.04 cm) on par with 5.0 x 2.5 m (16.90 cm) and the minimum plant spread (East-West) increment was recorded in the plants spaced at 5.0 x 2.5 m (13.26 cm). With respect to different pruning seasons, the maximum plant spread (East-West) increment was recorded in control (19.14 cm) which was followed by current season growth (14.54 cm) and the minimum plant spread (East-West) increment was recorded in pruning of previous season growth (13.32 cm). Interaction data revealed the maximum plant spread (East-West) increment was recorded in D_2T_1 (22.62 cm) which was followed by D_1T_1 (20.55 cm) and the minimum plant spread (East-West) increment was recorded in D_3T_2 (11.78 cm).

Plant spread North- South (cm)

Table 2 represents the pooled data of both seasons (2016-18) and it depicted the maximum plant spread (North-South) was recorded in the treatment 5.0 x 2.5 m (19.91 cm) which was followed by the treatment 2.5 x 2.5 m (17.56 cm) and the minimum plant spread (North-South) increment was recorded in 5.0 x 5.0 m (14.63 cm). With respect to different pruning seasons, the maximum plant spread (North-South) increment was recorded in control (20.54 cm) and the minimum plant spread (North-South) increment was recorded in current season growth (14.76 cm). Interaction data revealed the maximum plant spread (North-South) increment was recorded in D_2T_1 (26.04 cm) which was followed by D_1T_1 (21.50 cm) and the minimum plant spread (North-South) increment was recorded in D_3T_2 (13.15 cm).

Canopy volume (m^3)

For the pooled data of 2016-18, the highest canopy volume increment (0.84 m^3) was recorded in the treatment 5.0 x 5.0 m which was followed by the treatment 7.5 x 5.0 m (0.72 m^3) and the lowest canopy volume increment (0.61 m^3) was recorded in the treatment 2.5 x 2.5 m. With respect to different pruning seasons, the highest canopy volume increment (0.87 m^3) was recorded in the treatment control which was followed by the previous season growth (0.58 m^3) and the lowest canopy volume increment (0.62 m^3) was recorded in the treatment current season growth previous season growth. Interaction data showed the highest canopy volume increment (0.92 m^3) was recorded in the treatment D_2T_1 which was on par with the treatment D_3T_1 (0.90 m^3) and the lowest canopy volume increment (0.46 m^3) was recorded in the treatment D_2T_2.

Number of primary, secondary and tertiary branches in mango cv. Alphonso

The number of primary, secondary and tertiary branches were significantly influenced by different plant densities and pruning seasons recorded in Table 2.

The highest number of primary branches (3.92) was recorded in the plants spaced at 5.0 x 2.5 m which was followed by the treatment 2.5 x 2.5 m (3.25) and the lowest was recorded in the treatment 5.0 x 5.0 m (2.80). The highest number of primary branches was recorded in the plants pruned with current season growth (3.38) but the results were found non significant. Whereas in interaction highest number of primary branches (4.08) was recorded in the treatment D_2T_2 which

was on par with the treatment D_2T_3 (3.92) and the lowest was recorded in the treatment D_3T_2 (2.58).

The highest number of secondary branches (8.80) was recorded in the plants spaced at 5.0 x 2.5 m which was followed by the treatment 7.5 x 5.0 m (7.49) and the lowest secondary branches was recorded in the treatment 5.0 x 5.0 m (5.73). The highest number of secondary branches was recorded in current season growth (7.48) and the lowest number of secondary branches was recorded in the plants pruned with previous season growth (7.15). Whereas in interaction, the highest number of secondary branches (8.81) was recorded in the treatment D_2T_3 which was on par with the treatment D_2T_1 (8.76) and the lowest number of secondary branches was recorded in the treatment D_3T_2 (5.33).

Tertiary branches (26.64) recorded maximum in the plants spaced at 5.0 x 2.5 m which was followed by the treatment 2.5 x 2.5 m (23.12) and the lowest tertiary branches was recorded in the treatment 7.5 x 5.0 m (19.76). The highest number of tertiary branches was recorded in control (23.56) and the lowest number of tertiary branches was recorded in the treatment current season growth (20.46). Whereas in interaction, the highest number of tertiary branches (26.76) was recorded in the treatment D_2T_2 which was on par with the treatment D_2T_3 (26.67), D_2T_1 (26.50) and the lowest number of tertiary branches was recorded in the treatment D_3T_3 (20.08).

Yield parameters

Number of fruits per plant

Pooled data of both the seasons was recorded in Table 3. Among the four different planting densities, the maximum number of fruits per plant was recorded in the plants spaced at 7.5 x 5.0 m (47.67) on par with the spacing 5.0 x 5.0 m (46.69) and the minimum number of fruits per plant was recorded in 2.5 x 2.5 m (30.04). Among the different pruning seasons, the maximum number of fruits per plant was recorded in the plants pruned with previous season growth (45.50) and the minimum number of fruits per plant was recorded in control (32.63). Whereas in interaction, the maximum number of fruits per plant was recorded in D_4T_2 (54.95) which was on par with the treatment D_3T_2 (52.72) and the minimum number of fruits per plant was recorded in D_1T_1 (24.57).

Yield per plant (kg)

Pooled data of both the seasons results showed the maximum yield per plant in the spacing 7.5 x 5.0 m (12.78 kg) which was on par with the spacing 5.0 x 5.0 m (12.57 kg) and the minimum yield per plant was recorded in the treatment 2.5 x 2.5 m (7.56 kg). Among the different pruning seasons, the maximum yield per plant was recorded in the plants pruned with previous season growth (12.13 kg) which was followed by current season growth (10.77 kg) and the minimum yield per plant was recorded in control (8.31 kg). Whereas in interaction the maximum yield per plant was recorded in D_4T_2 (14.72 kg) which was on par with the treatment D_3T_2 (14.23 kg) and the minimum yield per plant was recorded in D_1T_1 (5.96 kg).

Yield per hectare (t/ha)

The pooled data of both seasons (2016-18) presented in Table 3 and it depicted the highest yield per hectare in the plant spacing 2.5 x 2.5 m (12.11 t/ha) which was followed by the spacing 5.0 x 2.5 m (6.95 t/ha) and the minimum yield per hectare was recorded in the treatment 7.5 x 5.0 m (3.41 t/ha). With respect to different pruning seasons the results differed significantly with the maximum yield per hectare was recorded in the plants pruned with previous season growth (8.14 t/ha) which was followed by current season growth (7.03 t/ha) and the minimum yield per hectare was recorded in the treatment control (5.44 t/ha). The interactive effect of planting densities and pruning seasons had a positive influence, the treatment D_1T_2 (14.61 t/ha) recorded the maximum yield per hectare which was followed by D_1T_3 (12.17 t/ha) whereas, the minimum yield per hectare was recorded in the treatment D_4T_1 (2.77 t/ha).

Discussion

Vegetative growth

The vegetative variables were evaluated in different planting densities and they showed significant results among the different treatments (Table 1 and 2). Spacing 5.0 x 5.0 m showed the maximum plant height, plant girth and canopy volume. The maximum plant spread East- West and North-South were observed in 7.5 x 5.0 m spacing whereas, primary branches, secondary branches and tertiary branches were found maximum in 5.0 x 2.5 m spacing. This might be due to the fact that better availability of water, nutrients and light distribution in less denser plants compared to high densities planting reported by Gaikwad *et al.* (2017) [3]. The minimum vegetative growth was observed in high density planting because of the fact that the area for each plant was decreased. In mango cv. Tommy Atkins under high density planting as reported by Sousa *et al.* (2012) [14]. In higher planting densities, East - West and North – South spread showed reduction of growth due to the restrictions of light this probably occurred due to overlapping of branches reduced mango tree growth under high density planting was reported by Nath *et al.* (2007) [7].

Results indicated that, control (un-pruned) plants exhibited the maximum plant height, plant spread East- West, North-South, canopy volume and tertiary branches. Current season growth recorded the maximum plant girth and secondary branches. This might be due to total vegetative growth attained by an un-pruned tree is always greater than that of the pruned tree because there is removal of biomass from the plant. After hard pruning, the growth of the new shoots developed quickly in mango. Pruning annually after each harvest in July - August was found beneficial in maintaining the tree canopy open to receive sufficient sun shine and sustaining high production reported by Pandey and Singh (2008) [8].

Planting density and pruning seasons on vegetative parameters showed significant difference among different treatments (Table 1 and 2). Results indicated the maximum plant height was attained in the plants spaced at 5.0 x 5.0 m from un-pruned plants whereas, the maximum plant girth from current season growth in same spacing. Plants spaced at 7.5 x 5.0 m from un-pruned plants attained the maximum plant spread East- West, North- South and canopy volume. Plants spaced at 5.0 x 2.5 m showed the maximum number of primary branches and tertiary branches in previous season growth whereas, maximum number of secondary branches in current season growth in the same spacing. The maximum plant height increment was observed in 5.0 x 5.0 m spacing with previous season growth whereas, plant girth was found maximum in 2.5 x 2.5 m spacing with current season growth. The maximum plant spread East- West, North- South and canopy volume were observed in 5.0 x 2.5 m spacing without pruning. This is because un-pruned plants showed maximum

plant spread growth because there is no removal of any biomass from the plants. A possible explanation is the competition for water and soil nutrients (Policarpo *et al.*, 2006) [9] in high density planting. Regular pruning is required to maintain the plant height and canopy in high density planting.

Table 1: Effect of different plant density and pruning seasons on vegetative growth parameters of mango cv. Alphonso pooled incremental data of both seasons (2016-18)

Treatments	Vegetative growth parameters								
	Plant height (cm)			Plant girth (cm)			Plant spread (cm) (East-West		
	Season 1 (2016-17)	Season 2 (2017-18)	Pooled (2016-18)	Season 1 (2016-17)	Season 2 (2017-18)	Pooled (2016-18)	Season 1 (2016-17)	Season 2 (2017-18)	Pooled (2016-18)
Spacing (D)									
D_1	14.69	9.58	12.14	1.32	1.12	1.22	15.42	18.66	17.04
D_2	12.74	11.66	12.20	0.57	0.48	0.53	18.19	15.60	16.90
D_3	19.91	13.69	16.79	0.95	0.73	0.84	12.15	14.36	13.26
D_4	11.41	10.28	10.90	0.81	0.85	0.83	12.89	18.10	15.51
S.Em±	0.34	0.43	0.44	0.04	0.05	0.04	0.55	0.60	0.20
CD @ 5%	1.24	1.37	1.17	0.17	0.12	0.13	1.62	1.77	0.60
Pruning (T)									
T_1	16.79	12.81	14.80	0.57	0.55	0.56	16.76	21.57	19.14
T_2	13.91	9.83	11.90	0.76	0.74	0.75	13.71	12.93	13.32
T_3	15.37	11.27	12.32	1.40	1.10	1.25	13.52	15.54	14.54
S.Em±	0.42	0.42	0.06	0.03	0.06	0.04	0.48	0.52	0.18
CD @ 5%	1.35	1.23	0.75	0.10	0.17	0.02	1.41	1.53	0.52
Interaction									
D_1T_1	19.00	10.37	14.69	0.22	0.35	0.29	18.20	23.09	20.55
D_1T_2	14.23	9.51	11.88	1.67	1.35	1.51	14.90	15.19	15.06
D_1T_3	10.85	8.85	9.87	2.07	1.67	1.87	13.17	17.69	15.43
D_2T_1	19.00	13.91	16.46	0.71	0.61	0.66	24.00	21.22	22.62
D_2T_2	10.30	8.14	9.21	0.16	0.24	0.20	15.30	10.79	13.05
D_2T_3	8.93	12.92	10.93	0.85	0.59	0.72	15.27	14.80	15.05
D_3T_1	16.45	16.12	16.28	0.75	0.53	0.64	11.96	19.12	15.54
D_3T_2	22.67	12.66	17.66	0.33	0.35	0.34	12.10	11.45	11.78
D_3T_3	20.60	12.30	16.44	1.77	1.31	1.53	12.38	12.50	12.45
D_4T_1	12.73	10.83	11.79	0.60	0.72	0.67	12.87	22.84	17.86
D_4T_2	8.47	9.00	8.86	0.89	1.00	0.95	12.55	14.28	13.42
D_4T_3	13.05	11.00	12.04	0.93	0.82	0.88	13.26	17.18	15.22
S.Em±	0.64	0.52	0.66	0.06	0.06	0.07	0.96	1.04	0.35
CD @ 5%	2.13	1.65	1.74	0.16	0.18	0.21	2.81	3.06	1.03

D_1- 2.5 × 2.5 m (1600 plants/ ha) T_1- Control (un-pruned)
D_2- 5.0 × 2.5 m (800 plants/ ha) T_2- Previous season growth
D_3- 5.0 × 5.0 m (400 plants/ ha) T_3- Current season growth
D_4- 7.5 × 5.0 m (267 plants/ ha)

Table 2: Effect of different plant density and pruning seasons on vegetative growth parameters of mango cv. Alphonso pooled incremental data of both seasons (2016-18)

Treatments	Vegetative growth parameters								
	Plant spread (cm) (North-South)			Canopy volume (m^3)			Number of branches		
	Season 1 (2016-17)	Season 2 (2017-18)	Pooled (2016-18)	Season 1 (2016-17)	Season 2 (2017-18)	Pooled (2016-18)	Primary branches	Secondary branches	Tertiary branches
Spacing (D)									
D_1	19.12	16.00	17.56	0.63	0.58	0.61	3.25	7.39	23.12
D_2	23.07	16.74	19.91	0.67	0.62	0.64	3.92	8.80	26.64
D_3	12.15	17.13	14.63	0.97	0.73	0.85	2.80	5.73	20.35
D_4	12.89	19.67	16.28	0.71	0.73	0.72	3.22	7.49	19.76
S.Em±	0.71	0.82	0.42	0.03	0.02	0.02	0.04	0.06	0.42
CD @ 5%	2.07	2.41	1.24	0.08	0.06	0.07	0.13	0.19	1.34
Pruning (T)									
T_1	18.97	22.11	20.54	0.88	0.85	0.87	3.22	7.44	23.56
T_2	15.65	16.33	15.99	0.71	0.56	0.63	3.29	7.15	23.38
T_3	15.80	13.72	14.76	0.65	0.59	0.62	3.38	7.48	20.46
S.Em±	0.61	0.71	1.05	0.02	0.02	0.02	0.04	0.06	0.34
CD @ 5%	1.80	2.09	3.10	0.07	0.05	0.06	NS	0.16	1.05
Interaction									
D_1T_1	22.50	20.50	21.50	0.83	0.75	0.79	3.15	7.83	23.51
D_1T_2	18.55	16.51	17.54	0.59	0.52	0.55	3.21	8.14	23.09
D_1T_3	16.30	11.00	13.65	0.49	0.48	0.49	3.25	7.16	22.75
D_2T_1	28.57	23.50	26.04	0.98	0.88	0.93	3.75	8.76	26.50
D_2T_2	19.40	16.23	17.82	0.50	0.43	0.46	4.08	7.83	26.76

D_2T_3	21.25	10.50	15.88	0.54	0.54	0.53	3.92	8.81	26.67
D_3T_1	11.96	20.41	16.17	0.90	0.90	0.90	2.78	5.65	20.58
D_3T_2	12.10	14.20	13.15	1.08	0.58	0.83	2.58	5.33	20.40
D_3T_3	12.38	16.79	14.58	0.93	0.70	0.82	3.04	6.21	20.08
D_4T_1	12.87	24.05	18.45	0.83	0.87	0.85	3.09	7.67	23.66
D_4T_2	12.55	18.36	15.46	0.67	0.69	0.67	3.25	7.28	23.25
D_4T_3	13.26	16.59	14.92	0.64	0.63	0.63	3.31	7.52	22.35
S.Em±	1.22	1.42	1.12	0.04	0.04	0.04	0.08	0.11	0.48
CD @ 5%	3.64	4.17	3.35	0.13	0.10	0.12	0.23	0.33	1.64

D_1- 2.5 × 2.5 m (1600 plants/ ha) T_1- Control (un-pruned)
D_2- 5.0 × 2.5 m (800 plants/ ha) T_2- Previous season growth
D_3- 5.0 × 5.0 m (400 plants/ ha) T_3- Current season growth
D_4- 7.5 × 5.0 m (267 plants/ ha)

Yield

Yield parameters as influenced by different plant densities and differed significantly as presented in Table 3. The highest number of fruits per plant and yield per plant were observed in the plants spaced at 7.5 x 5.0 m which was on par with the spacing 5.0 x 5.0 m. This is because high percentage of fruit set, number of fruits and fruit weight which increased the yield per plant.

In this experiment, plants spaced at 2.5 x 2.5 m recorded the highest yield (t/ha) this is because in closer spacing it accommodates more number of plants per unit area which increases the yield per hectare these results were in accordance with Joglekar *et al.* (2013) [5] for indigenous cultivars and Sousa *et al.* (2012) [14] found the same results in mango cv. Tommy Atkins. More number of plants/unit area resulted in higher yield/ha, and thereby, more tonnage per unit area these results are similar to those as reported by Nath *et al.* (2007) [7]. HDP system of mango increased the productivity and to reach the king of fruit to the common people (Rajbhar *et al.,* 2016) [10].

Yield parameters were influenced by pruning seasons and differed significantly. The highest number of fruits per plant, yield per plant and yield per hectare were observed in previous season growth followed by current season growth. Previous season growth was found superior over other treatments with respect to yield this is because high percentage of fruit set, more number of fruits and more fruit weight increased the yield per plant and yield per hectare. Previous season growth helped in producing more panicles even in off-season compare to other treatments this is due to pruning of past season growth produces sub-epical shoots which put forth panicles and fruits in that shoots in the off-season also. Increased fruit yield owing to pruning was due to increased number of flowering shoots and reduced vegetative / dormant shoots, in general, compared to the control. Irrespective of intensity and severity, pruning helps in balanced vegetative growth, better nutrition depending upon shoot: root ratio and better availability of the sunlight to the leaves, which lead to the production of more hermaphrodite flowers. Pruning provides better shape to the plants and builds the congenial climate to the fruits to grow not only it increases the quality but also it increases the productivity (Lal *et al.,* 2000) [6].

The yield which is the most important aspect for fruit growers was found significantly influenced by genotype and also cultural practices like pruning. Pruning and thinning operations lead to increase in yield which was reported by Rao and Shanmugavelu (1976) [11] because they are effective in diverting nutrients and water taken up by the tree to productive branches in mango. Swaroop *et al.* (2001) [15] reported that, in 'on' year trees, July and August pruning increased fruit yield and fruit quality.

Yield parameters as influenced by different plant densities, pruning seasons and their interaction effect differed significantly (Table 3). The highest number of fruits per plant and yield per plant were recorded in the plants spaced at 7.5 x 5.0 m with previous season growth. This may be due to the fact that pruning helped in increasing the percentage of fruit set which increased number of fruits, fruit weight and leads to increase the yield per plant this is proven by Das and Jana (2012) [2].

The maximum yield per hectare was recorded in the treatment 2.5 x 2.5 m spacing with previous season growth. This may be due to accommodation of more number of plants per unit area in closer spacing compared to wider spacing. Pruning of previous season growth reduced the biennial bearing because the pruning of previous season growth produced the sub-epical shoots which again produce flowers and fruits. Spacing of plantation as well as intensity of pruning both showed significant effect in the mango cv. Amrapali (Ansari *et al.,* 2018) [1].

Table 3: Effect of different plant density and pruning seasons on yield parameters of mango cv. Alphonso (2016-18)

Treatments	Number of fruits per plant			Yield per plant (kg)			Yield per hectare (t/ha)		
	Season 1 (2016-17)	Season 2 (2017-18)	Pooled (2016-18)	Season 1 (2016-17)	Season 2 (2017-18)	Pooled (2016-18)	Season 1 (2016-17)	Season 2 (2017-18)	Pooled (2016-18)
Spacing (D)									
D_1	32.56	27.52	30.04	8.03	7.20	7.56	12.88	11.33	12.11
D_2	36.50	30.24	33.37	9.31	7.91	8.69	7.45	6.46	6.95
D_3	49.85	43.52	46.69	13.32	11.83	12.57	5.33	4.73	5.03
D_4	51.37	43.96	47.67	13.64	11.91	12.78	3.64	3.18	3.41
S.Em±	0.47	0.65	0.42	0.08	0.09	0.08	0.15	0.09	0.12
CD @5%	1.38	1.92	1.27	0.22	0.29	0.23	0.45	0.28	0.34
Pruning (T)									
T_1	37.90	27.37	32.63	9.50	7.14	8.31	6.19	4.70	5.44
T_2	46.93	44.07	45.50	12.41	11.71	12.13	8.30	7.99	8.14
T_3	42.87	37.49	40.19	11.34	10.29	10.77	7.48	6.58	7.03

S.Em±	0.41	0.57	0.37	0.06	0.07	0.05	0.12	0.08	0.10
CD @5%	1.20	1.66	1.13	0.15	0.21	0.15	0.36	0.24	0.29
Interaction									
D_1T_1	28.39	20.75	24.57	6.74	5.18	5.96	10.78	8.28	9.53
D_1T_2	36.73	34.03	35.38	9.27	9.00	9.13	14.82	14.40	14.61
D_1T_3	32.55	26.48	29.45	8.15	7.06	7.60	13.04	11.31	12.17
D_2T_1	31.51	23.83	27.67	7.64	6.01	6.83	6.10	4.81	5.45
D_2T_2	40.68	39.41	38.95	10.63	10.22	10.43	8.51	8.17	8.34
D_2T_3	37.31	29.67	33.50	9.64	8.00	8.82	7.71	6.41	7.05
D_3T_1	45.84	31.84	38.84	11.75	8.34	10.05	4.70	3.33	4.01
D_3T_2	53.59	51.85	52.72	14.54	13.93	14.23	5.82	5.57	5.69
D_3T_3	50.11	46.87	48.50	13.69	13.23	13.46	5.48	5.29	5.38
D_4T_1	45.87	33.05	39.46	11.86	8.97	10.42	3.17	2.39	2.77
D_4T_2	56.73	53.17	54.95	15.18	14.26	14.72	4.05	3.81	3.93
D_4T_3	51.52	45.66	48.59	13.89	12.51	13.20	3.71	3.34	3.52
S.Em±	0.82	1.13	0.78	0.24	0.27	0.19	0.27	0.16	0.20
CD @5%	2.46	3.35	2.32	0.67	0.78	0.55	0.78	0.50	0.58

D_1- 2.5 × 2.5 m (1600 plants/ ha)
D_2- 5.0 × 2.5 m (800 plants/ ha)
D_3- 5.0 × 5.0 m (400 plants/ ha)
D_4- 7.5 × 5.0 m (267 plants/ ha)

T_1- Control (un-pruned)
T_2- Previous season growth
T_3- Current season growth

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