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

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Abstract
A study was carried out to know the effects of high density planting and paclobutrazol 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 incremental data of plant height (18.48 cm) and plant spread East- West increment (18.65 cm) were recorded in D_1P_1 (2.5 x 2.5 m spacing with control plants). The treatment D_4P_2 (7.5 x 5.0 m spacing with 2 ml paclobutrazol) recorded the maximum plant girth (1.17 cm), tertiary branches (25.67), number of fruits per plant (53.24) and yield per plant (13.71 kg) whereas, the treatment D_4P_1 (7.5 x 5.0 m spacing with untreated plants) recorded the maximum canopy volume (0.88 m^3). The treatment D_4P_1 (7.5 x 5.0 m spacing in control) recorded the maximum plant spread North- South (17.84 cm) whereas, the highest number of primary branches (4.43) and secondary branches (8.66) were recorded in the treatment D_2P_1 (5.0 x 2.5 m spacing in control). The maximum yield per hectare (8.94 t/ha) was recorded in D_1P_2 (2.5 x 2.5 m spacing with 2 ml paclobutrazol). Plants spaced at 5.0 x5.0 m and 7.5 x 5.0 m spacing with 2ml paclobutrazol showed beneficial results whereas, to get maximum yield per unit area 2.5 x 2.5 m with 2ml paclobutrazol was effective.

Keywords: High density, paclobutrazol and alphonso

Introduction
Alphonso mango is one of the most expensive varieties of mango and is grown mainly in the western part of India including Sindhudurg, Ratnagiri and Raigad districts of Maharashtra and in the Konkan region of India. Alphonso is generally referred to as 'Hapus' in Maharashtra and Gujarat, also known as Appus, Badami, Gundu and Khader. It is used to make sweets, candies and smoothies and mango drinks. Fruits are orange-yellow in colour, medium-sized and oval/oblique in shape. The high density planting technology is the most viable proposition to increase the productivity by dwarf tree canopy and for efficient and profitable land use. Its basic function is to confine the exploitation zone of the plant with regard to light, water and nutrients, so that highest total yield potential can be realized in the smallest possible area. The main aim of high density planting is to produce more and more from unit area, from one species, in order to make the venture of tropical fruit production more remunerative and sustainable. It is necessary that the impact of system architecture on bio-physical parameters be closely investigated for various agro-ecological situations. With shrinking land-holdings the future lies only in integrated systems that would lead to stable soil and environment health besides getting maximum useful biomass from unit land.
The first report about the use of paclobutrazol (PBZ) on mango (*Mangifera indica* L.) came from India where Kulkarni (1988) [3] tested concentrations of 1.25 to 10 g a.i. per tree on 'Dashehari' and 'Banganepalli'. PBZ is a synthetic plant growth regulator, which has been used in fruit tree crops to control vegetative growth and to induce flowering (Swietlik and Miller, 1985) [8]. PBZ can be applied to mango trees as a foliar spray or as a soil drench (Tongumpai *et al.*, 1991) [9]. Plant growth retardant induced manipulation in physiological activity has been considered important determinant. Among them, paclobutrazol is considered as one of the important plant growth retardants which restricts vegetative growth and induces flowering in many fruit species including mango (Davenport, 2007) [2].

Excessive vegetative growth is a common characteristic of most of the mango cultivars. Efficacy of PBZ (Cultar) was evaluated for use in restricting vegetative growth and yield. Studies have undertaken to know the effects of high density planting and paclobutrazol on growth and yield of mango cv. Alphonso.

Materials and Methods

The present investigation of "Studies on high density planting in 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. Paclobutrazol sprayed at different concentrations like P_1 (control), P_2 (2 ml/ l/ m^2 of canopy), P_3 (4 ml/ l/ m^2 of canopy), paclobutrazol solution contains 23% W/W SC. 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

Plant height (cm)

Table 1 revealed the results of plant height which was influenced by different plant densities, different concentrations of paclobutrazol and interaction and showed significant difference among the treatments.

Pooled data of both the seasons showed significant difference among the treatments. The maximum pooled increment of plant height was recorded in the plants spaced at 7.5 x 5.0 m (11.70 cm) which is on par with 2.5 x 2.5 m (11.47 cm) and the minimum pooled increment of plant height was recorded in 5.0 x 5.0 m (9.18 cm). Among the different concentrations of paclobutrazol, the maximum plant height increment was recorded in control (15.53 cm) which was followed by paclobutrazol at 2 ml (8.59 cm) and the minimum plant height increment was recorded in paclobutrazol at 4 ml (6.45 cm). Interaction data showed that the maximum increment of plant height was recorded in D_1P_1 (18.48 cm) which was on par with D_2P_1 (18.23 cm) and the minimum plant height increment was recorded in D_2P_2 (6.51 cm).

Stem girth (cm)

Stem girth (cm) increment was influenced by different plant densities, different concentrations of paclobutrazol and interaction, showed significant difference among the treatments with respect to increment data for the year 2016-2018. Stem girth was depicted in Table 1.

The pooled data of two seasons exhibited that the highest plant girth in the treatment 7.5 x 5.0 m (0.77 cm) which was followed by 5.0 x 2.5 m (0.68 cm) and the minimum stem girth increment was recorded in 5.0 x 5.0 m (0.57cm). Among the different concentrations of paclobutrazol, the maximum stem girth increment was recorded in paclobutrazol at paclobutrazol at 2 ml (0.75 cm) which was followed by control (0.65 cm) and the minimum stem girth increment was recorded in paclobutrazol at 4 ml (0.55 cm). Interaction data revealed the maximum stem girth increment was recorded in D_4P_2 (1.17 cm) which was followed by D_2P_1 (0.74 cm) and the minimum stem girth increment was recorded in D_1P_3 (0.47 cm).

Plant spread East- West (cm)

The pooled data of both seasons (2016-18) presented in Table 1 and it depicted the highest plant spread (East-West) in the plants spaced at 7.5 x 5.0 m (13.48 cm) which was followed by 5.0 x 2.5 m (12.81 cm) and the minimum plant spread (East-West) increment was recorded in 5.0 x 5.0 m (12.47 cm). With respect to different concentration of paclobutrazol the maximum plant spread (East-West) increment was recorded in control (16.74 cm) which was followed by paclobutrazol at paclobutrazol at 2 ml (11.11 cm) and the minimum plant spread (East-West) increment was recorded in paclobutrazol at 4 ml (10.82 cm). Interaction data revealed that the maximum plant spread (East-West) increment was recorded in D_1P_1 (18.65 cm) which was followed by D_2P_1 (16.41 cm) and the minimum plant spread (East-West) increment was recorded in D_1P_3 (8.81 cm).

Plant spread North- South (cm)

Data of two seasons exhibited the maximum plant spread (North-South) was recorded in the treatment 7.5 x 5.0 m (13.72 cm) which was followed by 5.0 x 5.0 m (13.25 cm) and the minimum plant spread (North-South) increment was recorded in 2.5 x 2.5 m (12.24 cm). With respect to different concentration of paclobutrazol the maximum plant spread (North-South) increment was recorded in control (16.41 cm) which was followed by paclobutrazol at paclobutrazol at 2 ml (12.44 cm) and the minimum plant spread (North-South) increment was recorded in paclobutrazol at 4 ml (10.10 cm). Interaction data revealed the maximum plant spread (North-South) increment was recorded in D_2P_1 (17.84 cm) which is on par with D_4P_1 (16.98 cm) and the minimum plant spread (North-South) increment was recorded in D_1P_3 (8.29 cm).

Canopy volume (m^3)

For the pooled data of 2016-18, the highest canopy volume increment (0.66 m^3) was recorded in the plants spaced at 7.5 x 5.0 m which was followed by the treatment 5.0 x 5.0 m (0.60 m^3) and the lowest canopy volume increment (0.47 m^3) was recorded in the treatment 2.5 x 2.5 m. With respect to different treatments of paclobutrazol, the highest canopy volume increment (0.78 m^3) was recorded in the treatment control which was followed by the treatment paclobutrazol at paclobutrazol at 2 ml (0.46 m^3) and the lowest canopy volume increment (0.42 m^3) was recorded in the concentration of 4 ml. Interaction data showed the highest canopy volume (m^3) increment (0.88 m^3) in D_4P_1 which was on par with the treatment D_2P_1 (0.77 m^3) and the lowest canopy volume increment (0.31 m^3) was recorded in the treatment D_1P_3.

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

In present investigation, the number of primary, secondary and tertiary branches differed significantly among different plant densities and paclobutrazol treatment showed non significant difference Table 2.

The highest number of primary branches (4.20) was recorded in the treatment 5.0 x 2.5 m which was followed by the plants spaced at 7.5 x5.0 m (3.24) and the lowest was recorded in the treatment 2.5 x 2.5 m (3.00). The highest number of primary branches treated with paclobutrazol was recorded in paclobutrazol at 4 ml (3.51) but the results were non significant. Whereas in interaction, the highest number of primary branches (4.43) was recorded in the treatment D_2P_1 which was on par with the treatment D_2P_2 (4.08) and D_2P_3 (4.06) and the lowest was recorded in the treatment D_1P_1 (3.08).

The highest number of secondary branches (8.55) 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 (7.57) and the lowest secondary branches was recorded in the treatment 5.0 x 5.0 m (6.18). The highest number of secondary branches treated with paclobutrazol was recorded in paclobutrazol at 4 ml (7.50) but the results were non significant. Whereas in interaction, the highest number of secondary branches (8.66) was recorded in the treatment D_2P_1 which was on par with the treatment D_2P_2 (8.64) and the lowest was recorded in the treatment D_3P_2 (6.00).

Tertiary branches (24.86) was recorded the highest in the plants spaced at 5.0 x 2.5 m which was on par with the treatment 7.5 x 5.0 m (24.55) and the lowest tertiary branches was recorded in the treatment 5.0 x5.0 m (20.68). The highest number of tertiary branches treated with paclobutrazol was recorded in paclobutrazol at paclobutrazol at 2 ml (23.80) and the lowest number of tertiary branches was recorded in the treatment control (22.24). Whereas in interaction, the highest number of tertiary branches (25.67) was recorded in the treatment D_4P_2 which was on par with the treatment D_2P_3 (25.25), D_2P_2 (25.05), D_4P_3 (24.69), D_2P_1 (24.27) and the lowest was recorded in the treatment D_3P_3 (19.75).

Table 1: Effect of different plant density and paclobutrazol concentrations 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	11.45	11.49	11.47	0.75	0.45	0.58	12.56	13.06	12.81
D_2	12.41	9.16	10.79	0.84	0.54	0.69	13.28	12.34	12.81
D_3	10.15	8.22	9.18	0.66	0.49	0.57	11.30	13.63	12.47
D_4	13.31	10.10	11.70	0.91	0.63	0.77	12.27	14.68	13.48
S.Em±	0.43	0.40	0.32	0.01	0.01	0.01	0.34	0.23	0.06
CD @ 5%	1.27	1.19	1.12	0.04	0.02	0.02	1.00	0.66	0.21
Paclobutrazol (P)									
T_1	16.60	14.47	15.53	0.77	0.54	0.64	13.71	19.77	16.74
T_2	8.88	8.30	8.59	0.90	0.60	0.75	11.20	11.02	11.12
T_3	10.01	6.46	8.24	0.69	0.44	0.55	12.14	9.50	10.82
S.Em±	0.37	0.35	0.31	0.01	0.01	0.01	0.30	0.20	0.07
CD @ 5%	1.10	1.03	1.02	0.03	0.02	0.02	0.86	0.57	0.25
Interaction									
D_1T_1	19.50	17.45	18.48	0.84	0.51	0.67	16.51	20.77	18.65
D_1T_2	7.41	10.51	8.95	0.74	0.46	0.60	11.63	10.31	10.98
D_1T_3	7.45	6.52	6.99	0.65	0.31	0.47	9.53	8.10	8.82
D_2T_1	20.10	16.37	18.23	0.89	0.60	0.74	14.44	18.41	16.42
D_2T_2	6.51	6.53	6.51	0.76	0.51	0.64	10.13	10.10	10.11
D_2T_3	10.62	4.58	7.62	0.86	0.51	0.68	15.27	8.52	11.90
D_3T_1	10.10	11.51	10.80	0.68	0.48	0.59	11.38	19.80	15.59
D_3T_2	8.81	7.58	8.20	0.68	0.52	0.60	11.11	10.95	11.04
D_3T_3	11.55	5.56	8.56	0.62	0.45	0.53	11.41	10.15	10.78
D_4T_1	16.71	12.54	14.62	0.66	0.55	0.60	12.50	20.11	16.31
D_4T_2	12.81	8.59	10.70	1.43	0.92	1.17	11.93	12.71	12.33
D_4T_3	10.41	9.17	9.79	0.62	0.43	0.53	12.36	11.22	11.80
S.Em±	0.75	0.70	0.71	0.02	0.01	0.01	0.59	0.39	0.36
CD @ 5%	2.20	2.05	2.02	0.06	0.04	0.03	1.73	1.14	1.11

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 paclobutrazol concentrations 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	13.01	11.47	12.24	0.46	0.48	0.47	3.00	7.47	21.56
D_2	13.40	12.05	12.72	0.51	0.47	0.49	4.19	8.55	24.86
D_3	11.30	15.21	13.26	0.68	0.52	0.60	3.20	6.18	20.68
D_4	12.27	15.17	13.72	0.72	0.60	0.66	3.24	7.57	24.55
S.Em±	0.43	0.65	0.08	0.03	0.02	0.02	0.05	0.05	0.37
CD @ 5%	1.25	1.89	0.24	0.08	0.06	0.05	0.14	0.16	1.08
Paclobutrazol (P)									
T_1	14.85	17.98	16.41	0.79	0.77	0.78	3.44	7.48	22.24
T_2	12.03	12.85	12.45	0.50	0.43	0.46	3.46	7.35	23.80
T_3	10.60	9.60	10.10	0.49	0.35	0.42	3.51	7.50	22.70
S.Em±	0.37	0.56	0.09	0.02	0.02	0.01	0.04	0.05	0.32
CD @ 5%	1.08	1.64	0.32	0.07	0.05	0.04	NS	NS	0.94
Interaction									
D_1T_1	17.17	14.53	15.85	0.685	0.74	0.71	3.08	7.66	21.17
D_1T_2	12.50	12.66	12.58	0.35	0.41	0.38	3.08	7.25	22.42
D_1T_3	9.37	7.22	8.29	0.33	0.29	0.31	3.56	7.50	21.08
D_2T_1	18.36	17.34	17.84	0.75	0.78	0.77	4.43	8.66	24.27
D_2T_2	12.58	11.03	11.81	0.36	0.36	0.35	4.08	8.64	25.05
D_2T_3	9.26	7.77	8.51	0.43	0.26	0.34	4.06	8.33	25.25
D_3T_1	11.38	18.58	14.98	0.78	0.72	0.75	3.08	6.20	20.24
D_3T_2	11.11	15.41	13.27	0.62	0.47	0.54	3.26	6.00	22.05
D_3T_3	11.41	11.63	11.52	0.64	0.37	0.50	3.25	6.33	19.75
D_4T_1	12.50	21.45	16.98	0.95	0.83	0.88	3.16	7.40	23.29
D_4T_2	11.93	12.29	12.12	0.65	0.50	0.58	3.41	7.50	25.67
D_4T_3	12.36	11.77	12.07	0.57	0.49	0.53	3.15	7.82	24.69
S.Em±	0.74	1.12	0.57	0.05	0.03	0.03	0.08	0.09	0.64
CD @ 5%	2.17	3.28	1.82	0.14	0.10	0.08	0.24	0.27	1.88

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

Number of fruits per plant

The influence of different plant densities, different concentrations of paclobutrazol and their interaction effect with respect to the cumulative data for the year 2016-17 and 2016-18 on number of fruits per plant is presented in Table 3.

Pooled data (2016-18) of both the seasons is presented in Table 3. The maximum number of fruits per plant was recorded in spacing 7.5 x 5.0 m (49.16) which was followed by the spacing 5.0 x 5.0 m (43.27) and minimum number of fruits per plant was recorded in the plants spaced at 2.5 x 2.5 m (22.43). With respect to different concentrations of paclobutrazol, the maximum number of fruits per plant was recorded in the concentration paclobutrazol at 2 ml (40.51) and the minimum number of fruits per plant was recorded in control (33.28). Whereas in interaction the maximum number of fruits per plant was recorded in D_4P_2 (53.24) which was followed by the treatment D_4P_3 (50.24) and the minimum number of fruits per plant was recorded in D_1P_1 (19.21).

Yield per plant (kg)

The data 2016-18 pertaining to yield per plant (kg) was influenced by different plant densities, paclobutrazol treatments and their interaction effects are presented in Table 3. Table 3 represents the pooled data of both seasons (2016-18) and it depicted the maximum yield per plant in the spacing 7.5 x 5.0 m (12.51 kg) which was followed by the spacing 5.0 x 5.0 m (11.18 kg) and the minimum yield per plant was recorded in the treatment 2.5 x 2.5 m (5.21 kg). Among the different concentrations of paclobutrazol, the maximum yield per plant was recorded in the concentration of paclobutrazol at 2 ml (10.21 kg) and the minimum yield per plant was recorded in the treatment control (8.59 kg). The interactive effect of spacing and paclobutrazol showed a positive effects, the treatment D_4P_2 (13.71 kg) recorded maximum yield per plant which was followed by D_3P_2 (12.54 kg) whereas, the minimum yield per plant was recorded in the treatment D_2P_1 (4.66 kg).

Yield per hectare (t/ha)

The influence of different plant densities, different concentrations of paclobutrazol and their interaction effect with respect to the cumulative data for the year 2016-17 and 2016-18 on yield per hectare (t/ha) is presented in Table 3.

Pooled data of both the seasons showed the maximum yield per hectare was recorded in the plants spaced at 2.5 x 2.5 m (8.33 t/ha) which was followed by the plants spaced at 5.0 x 2.5 m (6.91 t/ha) and the minimum yield per hectare was recorded in the treatment 7.5 x 5.0 m (3.34 t/ha). Among the different concentrations of paclobutrazol, the maximum yield per hectare was recorded in the concentration of paclobutrazol at 2 ml (6.20 t/ha) and which was followed by paclobutrazol at 4 ml (5.88 t/ha) the minimum yield per hectare was recorded in the treatment control (5.18 t/ha). In interaction, the treatment D_1P_2 (8.94 t/ha) recorded maximum yield per hectare which was on par with D_1P_3 (8.60 t/ha) whereas, the minimum yield per hectare was recorded in the treatment D_4P_1 (3.15 t/ha).

Discussion

The interaction effect between these two factors showed significant difference (Table 1 and 2). The maximum plant height, plant spread, canopy volume and tertiary branches were recorded in 7.5 x 5.0 m spacing from control plants whereas, the maximum plant girth and number of primary branches were recorded in paclobutrazol at 2 ml spray in the same spacing. Plants spaced at 5.0 x 2.5 m from control showed the maximum number of primary branches and secondary branches. With respect to incremental data which was depicted in fig, the maximum plant height and plant spread East- West were recorded in 2.5 x 2.5 m spacing from control plants. The plants spaced at 7.5 x 5.0 m with paclobutrazol at 2 ml showed the maximum plant girth whereas, control plants recorded the maximum canopy volume. Plants spaced at 5.0 x 2.5 m spacing from control showed the maximum plant spread North- South. This is because paclobutrazol considerably reduced the vegetative growth by inhibiting the gibberellins synthesis, therefore paclobutrazol can be used for plant growth and flowering management in mango as reported by Rademacher (2004) [5].

Cyclic compounds containing one type of nitrogen, such as ancymidol, flurprimidol, paclobutrazol (PBZ) and uniconazole (UCZ) which inhibit the conversion of ent-caureno to GA aldehyde, which is catalyzed by monoxigenases. The acylcyclohexanediones such as trinexapac-ethyl and prohexadione-Ca, which block final reactions of the GA metabolism (conversion of GA 12-aldehyde to different GAs) related to the action of dioxigenases (Rademacher, 2004) [5]. Paclobutrazol is considered as one of important plant growth retardant which restricts vegetative growth and induce flowering in many fruit species including mango as reported by Yadav *et al.* (2005) [11].

Yield

Plants spaced at 7.5 x 5.0 m spacing with paclobutrazol at 2 ml recorded the maximum number of fruits per plant and yield per plant. This might be due to the fact that changes induced by growth retardant on overall physiology of mango trees *viz.,* improved nutrient uptake, rapid and enhanced photosynthate re-allocation and altered hormonal balance in HDP this is in conformity with Upreti *et al.* (2013) [10]. Effect of quick shifting of assimilates like carbohydtrates, mineral elements and soluble proteins from leaves, stems and root to the sink which helped in increasing the yield. Paclobutrazol application increased the number of fruits and yield per tree in mango cv. Alphonso (Rakshe *et al.,* 2013) [6].

Yield per hectare was found maximum in plants spaced at 2.5 x 2.5 m with paclobutrazol at 2 ml. This may be due to accommodation of more number of plants per unit area in closer spacing compared to wider spacing this is in line with Selvarajan and Jayavalli (2009) [7]. Paclobutrazol treated trees not only induced profuse flowering but also advanced flowering about two weeks and contributed to higher production which was not only regular but also considerably higher over control (Mistry and Patel 2009) [4]. Paclobutrazol application, may place an increased assimilate requirement on young trees to support a greater number of fruit through improved flowering (Bithell *et al.,* 2013) [1].

Table 3: Effect of different plant density and paclobutrazol concentrations 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	24.05	20.81	22.43	5.49	4.92	5.21	8.79	7.87	8.33
D_2	39.24	32.47	35.85	9.17	8.12	8.64	7.34	6.50	6.91
D_3	47.76	38.78	43.27	11.79	10.57	11.18	4.71	4.23	4.47
D_4	52.47	45.85	49.16	13.10	11.92	12.51	3.50	3.19	3.34
S.Em±	0.40	0.95	0.82	0.07	0.09	0.10	0.15	0.13	0.11
CD @5%	1.17	2.77	2.21	0.24	0.27	0.32	0.43	0.41	0.35
Paclobutrazol (P)									
P_1	38.26	28.31	33.28	9.61	7.56	8.59	5.77	4.59	5.18
P_2	41.05	39.98	40.51	10.04	10.37	10.21	6.17	6.23	6.20
P_3	43.34	35.14	39.24	10.01	8.72	9.36	6.31	5.45	5.88
S.Em±	0.35	0.82	0.72	0.06	0.08	0.09	0.07	0.08	0.05
CD @5%	1.02	2.39	2.11	0.20	0.23	0.25	0.22	0.24	0.14
Interaction									
D_1P_1	21.58	16.83	19.21	5.15	4.18	4.66	8.23	6.69	7.46
D_1P_2	24.16	23.84	24.00	5.56	5.61	5.59	8.91	8.96	8.94
D_1P_3	26.42	21.76	24.10	5.78	4.98	5.37	9.24	7.74	8.60
D_2P_1	33.82	27.91	30.86	8.22	7.20	7.71	6.57	5.76	6.15
D_2P_2	39.15	36.12	37.64	9.26	8.74	9.00	7.41	6.99	7.19
D_2P_3	44.76	33.38	39.06	10.03	8.44	9.23	8.03	6.75	7.38
D_3P_1	46.84	31.32	39.08	11.95	8.37	10.16	4.77	3.45	4.06
D_3P_2	48.75	45.59	47.17	12.13	12.95	12.54	4.85	5.18	5.01
D_3P_3	47.70	39.41	43.56	11.29	10.40	10.85	4.51	4.15	4.34
D_4P_1	50.79	37.20	44.00	13.12	10.51	11.82	3.53	2.81	3.15
D_4P_2	52.13	54.35	53.14	13.21	14.20	13.71	3.53	3.80	3.66
D_4P_3	54.49	46.00	50.24	12.96	11.05	12.01	3.46	2.95	3.20
S.Em±	0.69	1.24	0.75	0.19	0.18	0.17	0.18	0.14	0.15
CD @5%	2.03	3.80	2.32	0.61	0.52	0.50	0.58	0.54	0.56

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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