International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 1471-1475
© 2019 IJCS
Received: 16-05-2019
Accepted: 18-06-2019

D Kiranshankar
University of Horticultural Sciences, Bagalkot, Karnataka, India

Athani SI Chavan
University of Horticultural Sciences, Bagalkot, Karnataka, India

ML Praveen Jholgikar
University of Horticultural Sciences, Bagalkot, Karnataka, India

Allolli
University of Horticultural Sciences, Bagalkot, Karnataka, India

TB Ramachandra Naik K
University of Horticultural Sciences, Bagalkot, Karnataka, India

Naik RB
University of Horticultural Sciences, Bagalkot, Karnataka, India

Correspondence
D Kiranshankar
University of Horticultural Sciences, Bagalkot, Karnataka, India

Effect of time of pruning and use of paclobutrazol on fruit physical and biochemical traits of mango cv. Alphonso

D Kiranshankar, Athani SI Chavan, ML Praveen Jholgikar, Allolli, TB Ramachandra Naik K and Naik RB

Abstract
Alternate bearing is one of the important challenges of the mango industry, there are several practices to overcome alternate bearing and among them pruning and use of growth retardants like paclobutrazol have become most effective. Hence an experiment was conducted to study the effect of pruning and paclobutrazol on fruit parameters of mango cv. Alphonso. The treatment T_1P_1 (pruning soon after harvest with no paclobutrazol application) showed highest fruit volume (195.5 cc), fresh fruit weight (276.59 g), ripe fruit weight (257.50 g), pulp weight (204.00 g) and lowest physiological loss in weight (6.90 %). The treatment T_1P_3 (pruning soon after harvest with 3 ml paclobutrazol application) showed highest fruit length. The highest TSS (19.85 °B), ascorbic acid content (39.77 mg/100g) and non-reducing sugar (9.95 %) was observed in the treatment T_1P_3 (pruning soon after harvesting with application of paclobutrazol 3ml/lit/meter) and the treatment T_1P_2 (pruning soon after harvesting with application of paclobutrazol 2ml/lit/meter) showed highest titretable acidity (0.57 %) and total sugar (14.88 %).

Keywords: Pruning, paclobutrazol, fruit physical, biochemical traits

Introduction
Mango (*Mangifera indica* L.) is the leading fruit crop of India, belonging to family Anacardiaceae and cultivated in tropical and subtropical regions of the world. It is considered to be a King of fruits because of its delicious taste, excellent flavor and attractive fragrance. Besides, it is rich in vitamin A and C. In India, mango occupies per cent of the total area under fruits comprising of 2.26 million hectares, with a total production of 19.69 million tonnes. Although, India is the largest mango producing country, accounting about 60 per cent of the world production (Anon., 2017) [10], but the productivity is low compare to other countries. Under Dharwad condition in Karnataka, there is a production of minor vegetative flush during October-December, which is the period, critical for fruit-bud differentiation. The trees have the tendency to develop extension growth on the matured shoot during the critical period of flower-bud differentiation which also hamper the chances of flowering (Ravishankar *et al.*, 1990) [21]. In fact, it has been observed that the alternation in cropping has a direct relation to alternate year occurrence of major flush under Dharwad condition (Rao, 1995) [19].
In this regard, some of the pruning and growth regulators could be used for induction of flowering directly on fruited shoots (Rao *et al.,* 1978) [20]. Therefore, there is a need for harnessing the potentiality of the fruited shoots to flower directly by the use of pruning and growth regulators. There are several operations involved in improving the yield and quality of mango fruits. Among them, pruning is one of the most important factors to sustain the yield and quality of fruits in mango. In general, compact and small trees capture and convert sunlight into fruit production in a better way than the larger ones. It can be enhanced by proper canopy management practices. For commercial fruit cultivation, the natural form and shape of fruit trees are to be modified through the practice of pruning to achieve the targeted yield by scientific approach. This is because; it is not always wise to allow a plant to develop naturally, since unwanted portions may develop at the expense of those which are essential. Appropriate pruning practices keep the plant in such shape and condition as to yield fruits of desired quality. Canopy management depends on the nature and growth pattern of plant, number of plants per hectare and pruning techniques.

Paclobutrazol has also been found predominantly effective in early flower induction in mango. It significantly influence the pattern of vegetative growth, flowering, yield and fruit quality attributes during normal season of Alphonso, predominantly grown in Konkan region on west coast of India (Burondkar *et al.*, 2000, 2005, 2013) [13, 11, 12]. Currently, use of paclobutrazol in July-August, is a standardized technology and recommended practice being used since 1992 for induction of regular flowering for producing crop during main season (March 15- May 30), over an area of more than 10,000 ha, with an estimated quantity of paclobutrazol 20,000 litres used every year (Burondkar and Gunjate, 2000) [13]. Hence an experiment was conducted to study the effect of pruning and paclobutrazol on physical and biochemical traits of mango cv. Alphonso.

Material and Methods

The investigation to know the effect of planting density and mulching on fruit parameters of mango mango cv. Alphonso was carried out in the mango orchard of the Regional Horticulture Research and Extension Center, Dharwad (University of Horticultural Sciences, Bagalkot) during July-2013 to June- 2015. The Regional Horticultural Research and Extension Center is situated at 15^0-16' Northern latitude, 70°-07' Eastern longitude and at an altitude of 678 m above the mean sea level. The soil of the experimental plot is red sandy loam, reddish brown colour, well drained having moderate water holding capacity. Dharwad has a transitional type of climate, which received the total rainfall of 733.8 mm during the year 2013-2014, whereas the rainfall was 761.3 mm during the period of study 2014 - 2015. Three year old mango orchard cv. Alphonso established during 2010 was selected for the experiment. Alphonso is one of the most preferred variety of mango and is grown mainly in the western part of India including the Konkan region of India. Alphonso is generally referred to as 'Hapus' in Maharashtra and Gujarat. In Karnataka, it is also popularly also known as Appus, Badami, Gundu. It is used to make sweets, candies smoothies and mango drinks. Fruits are orange-yellow in colour, medium-sized and oval/oblong in shape. The average fruit length is 9.3 cm, width is 7.0 cm, weighing 250-350 g. The peel is thin and smooth, pulp is firm to soft, low in fiber, pulp is yellow and has pleasant taste and good eating quality. The seed is mono-embryonic large woody stone. The fruit matures in early to mid-season. The tree is moderately large and vigorous with a broadly rounded dense canopy.

The treatments of pruning was imposed in two seasons (2013-15), soon after harvest (T_1), 15 days after harvest (T_2) and 30 days after harvest (T_3) in the month of May (second forth night) and June (first and second forth night) and the branches are pruned fifteen centimeters. The spraying of paclobutrazol at different concentrations *i.e.* P_1- 0 ml/ lit/ m^2 of canopy (no application), P_2- 2 ml/ lit/ m^2 of canopy, P_3- 3 ml/ lit/ m^2 of canopy and P_4- 4 ml/ lit/ m^2 of canopy was done in month of August on different pruned plants as per the treatments adopted. The treatments were replicated thrice by following Factorial Randomized Complete Block Design. Five plants were selected in each treatment, totally one eighty plants which were having good growth were selected for recording observations. The data of the two years was pooled and statistically analysed.

The fruits from five tagged plants were used to record the observations the mean of physical and quality parameters of ten fruits was recorded. Fruit volume (cc) was determined by the conventional water displacement method, and the mean was computed. Immediately after the harvest of the fruit the stalk was removed and the weight of raw fruit was recorded and later the ripe fruit weight was recorded. Matured fruits from each treatment were collected and kept for storage under ambient conditions. Physiological loss in weight was calculated by using the formula**.**

$$\text{Physiological loss in weight} = \frac{\text{Fresh fruit weight - ripe fruit weight}}{\text{Fresh fruit weight}} \times 100$$

Fruit diameter was measured at the widest portion of fruit and the length of the fruit from stalk end to the apex was determined with digital vernier calipers. The pulp, peel and stone were separated and then weighed and expressed in gram (g/fruit). The juice extracted by crushing the ripe pulp from the two halves of each fruit, separately was strained through muslin cloth and used for measuring total soluble solids. TSS was determined by Voisny Erma hand refractometer (0°to 32°range) and expressed in °Brix. Ascorbic acid content was estimated in mature fruits by 2, 6-dichlorophenolindophenol visual titration method and the values were expressed in milligrams per 100gram fresh edible portion at mature stage (Anon, 1984) [9]. Reducing sugar in the fruit sample preserved in 80 per cent alcohol was estimated as per the Dinitro Salicylic acid (DNSA) method reference. The value obtained was expressed as per cent on fresh weight basis and expressed in percentage (Miller, 1959) [18]. The per cent of non-reducing sugar was obtained by subtracting the values of reducing sugar from that of total sugar and multiply the same with 0.95 as correction factor and expressed in percentage. The total sugar in the sample was estimated by same method as that of reducing sugar after inversion of the non-reducing sugar using dilute hydrochloric acid and expressed in percentage (Anon, 1984) [9].

Results and Discussion

Early pruning not only regulates the canopy size but also ensures size and appearance of fruits through better exposure of branches and fruits. Any management practice system, besides increasing the productivity, should aim at the production of better fruits also. Similar results are obtained in present experiment with highest fruit volume (196.67 cc), fresh fruit weight (269.34 g), ripe fruit weight (246.75 g), fruit diameter (6.58 cm), fruit length (8.71 cm), pulp weight (196.63 g) and stone weight (27.88 g) in fruits obtained from plants pruned soon after harvesting (Table 1).

This is true in case of canopy management practices, wherein the main objective is to permit better aeration and light to fall on the inner parts of the trees, Similar results were observed in Kinnow by Ahmad *et al.* (2006) [1] and Singh *et al.* (2010b), Gopu (2011) [16] and Gopalan (2012) [2] in mango.

With respect to different treatments of paclobutrazol the treatment P_1 (control) has shown highest fresh fruit weight (178.69 g), ripe fruit weight (238.60 g), fruit diameter (6.44 cm), pulp weight (189.16 g) and all these parameters were on par with the treatment P_2 (2 ml). Similar results were observed in by Burondkar *et al.* (2000) [13] in which he reported that all the PBZ (2.5, 5.0, 7.5 and 10.0 g/tree) treated mango trees recorded reduction in fruit size (224.0 to 230.1 g) as compared to untreated control (239.0 g). Paclobutrazol (2.5, 5.0, 7.5 and 10.0 gm/tree) applied to plants through soil recorded more fruit set (10.8 to 14.4) per panicle over the control (8.8) leads to more fruits and less in size and weight of fruits in mango (Burondkar *et al.*, 2000) [13].

The treatment P_2 showed highest fruit volume (178.97 cc) and fresh fruit weight (253.66 g) and P_3 (3 ml) showed highest fruit length (8.63 cm). The paclobutrazol application (10 ml/tree) gave a positive effect on the number of fruits/tree over control in mango (Gopu 2011) [16]. Hasan *et al.* (2013) [3] found that application of paclobutrazol in the months of August and September (before 150 and 120 days of flower emergence) at 5 and 4 ml per meter of canopy spread showed positive influence for length of fruit, weight of fruit, width of fruit and fruit numbers. Similar results were noticed by Singh *et al.* (2010b) and Upreti *et al.* (2013) [14, 26] in mango.

With respect to interaction, the treatment T_1P_1 (pruning soon after harvest with no paclobutrazol application) showed highest fruit volume (195.5 cc), fresh fruit weight (276.59 g), ripe fruit weight (257.50 g), pulp weight (204.00 g) and lowest physiological loss in weight (6.90 %). The treatment T_1P_3 (pruning soon after harvest with 3 ml paclobutrazol application) showed highest fruit length. This might be due to early pruning not only regulates the canopy size but also ensures size and appearance of fruits through better exposure of branches, fruits and generally for better sink, better source is essential which is very much ensured in growth inhibitor applied plants. The results are in confirmity to the earlier reports in sapota by Pradeepha (2004) [6] and Sathiya (2005) [23] and in mango by Venkatesan (2006) [27], Singh *et al.* (2010a) [24-25] and Upreti *et al.* (2013) [14, 26] in mango.

The highest TSS (19.11 °B), acidity (0.54 %), ascorbic acid content (38.72 mg/100g), non-reducing sugars (8.99 %) and total sugars (13.91 %) was observed in treatment T_1 (Table 2). Early pruning not only regulates the canopy size but also ensures quality, size and appearance of fruits through better exposure of branches and fruits to sun light. Any management practices, beside increasing the productivity, should aim at the production of better quality fruits also. The results are in confirmity to the earlier reports in sapota by Pradeepha (2004) [6] and Sathiya (2005) [23] and in mango by Venkatesan (2006) [27], Pratap *et al.* (2009) [7] and Singh (2010b) [24-25]. This is true in the case of canopy management practices, wherein the main objective is to permit better aeration and light to fall on the inner parts of the trees, so that the developing fruits attain better colour and quality. Similar results were observed in Kinnow by Ahmad *et al.* (2006) [1] and in mango by Singh *et al.* (2010a) [24-25], Gopu (2011) [16] and Gopalan (2012) [2] mango.

With respect to different treatments of paclobutrazol the treatment P_3 (3 ml) showed highest TSS (19.38 °B), acidity (0.53 %), ascorbic acid (39.13 mg/100g) and it is on par the treatment P_2. The treatment P_2 showed highest total sugar (14.16 %), acidity (0.55 %) and it is on par with the treatment P_3.

Application of triazole is known to alter the source-sink relationship in the plant; directly or indirectly reallocating the carbohydrate resources. Higher fruit quality under these treatments may be attributed to the earliness in flowering which provided higher number of growing days and favoured biomass accumulation in the fruits finally improvement in the fruit quality. Generally, for better sink, better source is essential which is very much ensured in triazole applied plants. Further, the beneficial effects on quality of fruits may be due to better partitioning of assimilates to the sink.

The fruit qualities were formed better due to soil application of paclobutrazol than control (Hillier, 1991) [17]. Similar results as that of the findings of present investigation were also reported by Vijayalakshmi and Srinivasan (2002) [28], Yeshitela and Stassen (2005) [29], Karuna *et al.* (2007) [5], Jayavalli *et al.* (2009) [4], Adil *et al.* (2011) [8], Sarker and Rahim (2012) [22] and Hasan *et al.* (2013) [3] in mango. The application of paclobutrazol combined with ethephon also improves the fruit quality characters (Gnanasekaran, 2007) [15].

The interaction effect showed that highest TSS (19.85 °B), ascorbic acid content (39.77 mg/100g) and non-reducing sugar (9.95 %) was observed in the treatment T_1P_3 (pruning soon after harvesting with application of paclobutrazol 3ml/lit/meter) and the treatment T_1P_2 (pruning soon after harvesting with application of paclobutrazol 2ml/lit/meter) showed highest titretable acidity (0.57 %) and total sugar (14.88 %). This might be due to early pruning not only regulates the canopy size but also ensures quality, size and appearance of fruits through better exposure of branches and fruits to sun light. In paclobutrazol treated plants higher fruit quality may be attributed to the earliness in flowering which provided higher number of growing days and favored biomass accumulation in the fruits which finally improvement in the fruit quality. The results are in confirmity to the earlier reports in sapota by Pradeepha (2004) [6] and Sathiya. (2005) [23] and in mango by Venkatesan (2006) [27], Pratap *et al.* (2009) [7] and Singh (2010b), Sarker and Rahim (2012) [22] and Hasan *et al.* (2013) [3] in mango.

Table 1: Effect of time of pruning and use of paclobutrazol on fruit physical parameters of mango cv. Alphonso

Treatments	Fruit volume (cc)	Fresh fruit weight (g)	Ripe fruit weight (g)	Physiological loss in weight (%)	Fruit diameter (cm)	Fruit length (cm)	Pulp weight (g)	Peel weight (g)	Stone weight (g)	Pulp to peel ratio (%)	Pulp to stone ratio (%)
Pruning (T)											
T_1	196.67	269.34	246.75	8.15	6.58	8.71	196.63	22.26	27.88	0.114	0.142
T_2	178.85	252.28	232.11	7.98	6.31	8.48	182.45	24.29	25.75	0.133	0.141
T_3	155.06	223.72	201.78	9.88	6.05	8.14	160.8	19.31	22.22	0.122	0.139
S.Em±	2.93	2.18	0.83	0.21	0.05	0.04	2.46	0.33	0.25	0.003	0.003
CD @ 5%	8.58	6.51	2.44	0.61	0.16	0.12	7.35	0.98	0.73	0.008	0.007
Paclobutrazol (P)											
P_1	178.69	260.03	238.6	8.28	6.44	8.37	189.16	23.44	27.28	0.124	0.144
P_2	178.97	253.66	232.26	8.09	6.38	8.52	184.23	22.3	25.68	0.121	0.139
P_3	173.89	243.99	222	9.13	6.2	8.63	179.28	20.06	22.67	0.113	0.126
P_4	163.34	236.11	214.67	9.17	6.23	8.26	167.17	22.01	25.5	0.134	0.154
S.Em±	3.38	2.52	0.96	0.24	0.06	0.05	2.84	0.38	0.29	0.002	0.003
CD @ 5%	9.91	7.56	2.82	0.71	0.18	0.13	8.52	1.13	0.85	0.007	0.008
Interaction											
T_1P_1	195.5	276.59	257.5	6.9	6.65	8.7	204	24	29.5	0.118	0.145

T_1P_2	195	273	248	8.16	6.55	8.6	195.5	23.5	29	0.12	0.149
T_1P_3	180	264.01	242.5	8.15	6.35	8.9	198.5	17.5	26.5	0.089	0.134
T_1P_4	180.01	263.75	239.01	9.38	6.75	8.65	188.5	24.02	26.5	0.127	0.141
T_2P_1	170	260.57	237.33	8.92	6.3	8.35	185.5	25.5	28	0.137	0.151
T_2P_2	183.75	252.07	233.11	7.52	6.55	8.7	182.97	25	25	0.137	0.137
T_2P_3	191.67	252.88	232.5	8.06	6.1	8.53	183.83	25.67	23	0.14	0.125
T_2P_4	170	243.58	225.5	7.42	6.3	8.35	177.5	21	27	0.118	0.152
T_3P_1	172.07	242.92	220.98	9.03	6.37	8.05	177.98	20.83	24.34	0.117	0.137
T_3P_2	158.15	235.91	215.66	8.58	6.03	8.27	174.22	18.39	23.05	0.106	0.132
T_3P_3	150	215.08	191	11.2	6.15	8.45	155.5	17	18.5	0.109	0.119
T_3P_4	140	201	179.5	10.7	5.65	7.78	135.5	21	23	0.155	0.17
CV	9.32	8.93	8.14	7.99	8.23	11.15	10.01	9.23	8.78	13.99	9.21
S.Em±	5.85	4.37	1.67	0.42	0.11	0.08	4.92	0.67	0.5	0.005	0.005
CD @ 5%	17.17	12.81	4.99	1.22	0.32	0.23	14.44	1.96	1.47	0.015	0.015

Table 2: Effect of time of pruning and use of paclobutrazol on fruit quality parameters of mango cv. Alphonso

Treatments	TSS (°B)	Titratable Acidity (%)	Ascorbic acid (mg per 100 g)	Reducing sugars (%)	Non reducing sugar (%)	Total sugar (%)
Pruning (T)						
T_1	19.11	0.54	38.72	4.59	8.99	13.91
T_2	18.71	0.51	38.29	4.91	8.39	13.47
T_3	18.21	0.45	37.7	4.88	8.15	13.03
S.Em±	0.08	0.01	0.33	0.03	0.08	0.2
CD @ 5%	0.24	0.03	0.98	0.08	0.24	0.58
Paclobutrazol (M)						
P_1	18.31	0.5	37.84	4.94	8.05	13.05
P_2	19.24	0.55	38.66	4.79	8.8	14.16
P_3	19.38	0.53	39.13	4.77	9.06	13.83
P_4	17.78	0.42	37.32	4.67	8.15	12.85
S.Em±	0.1	0.01	0.38	0.03	0.1	0.23
CD @ 5%	0.28	0.03	1.13	0.09	0.28	0.68
Interaction						
T_1P_1	18.83	0.51	38.2	4.71	8.51	13.22
T_1P_2	19.57	0.57	39.04	4.53	9.14	14.88
T_1P_3	19.85	0.56	39.77	4.42	9.95	14.37
T_1P_4	18.19	0.5	37.85	4.69	8.37	13.18
T_2P_1	18.27	0.55	37.95	5.01	7.87	13.04
T_2P_2	19.28	0.54	38.71	4.83	8.82	14.14
T_2P_3	19.7	0.56	39.41	4.92	9	13.92
T_2P_4	17.6	0.4	37.1	4.9	7.89	12.79
T_3P_1	17.83	0.42	37.38	5.11	7.78	12.89
T_3P_2	18.86	0.54	38.25	5.03	8.43	13.46
T_3P_3	18.6	0.48	38.19	4.96	8.23	13.19
T_3P_4	17.53	0.35	37	4.41	8.17	12.59
CV	9.64	9.36	10.25	10.01	11.99	7.97
S.Em±	0.17	0.02	0.67	0.05	0.17	0.4
CD @ 5%	NS	0.05	NS	0.16	0.49	NS

Reference

1. Ahmad S, Chatha ZA, Nasir MA, Aziz A, Virk NA, Khan AR. Effect of pruning on the yield and quality of kinnow fruit. J Agri. Soc. Sci. 2006; 2(1):51-53.
2. Gopalan P, Canopy management studies in mango (*Mangifera indica* L.) cv. Alphonso under ultra-high density planting. M.Sc (Hort.) thesis submitted to the Tamilnadu Agricultural University, Coimbatore-India, 2012.
3. Hasan MA, Manna M, Das BC, Singh B, Mandal KK, Mandal S, *et al*., Paclobutrazol in Mitigating Irregular Bearing in Mango. Acta Hort. 2013; 992:173-179.
4. Jayavalli R, Selvarajan M, Saraswathy S, Kumar N, Subburamu K. Effect of spacing, pruning and paclobutrazol on biochemical constituents of main and off-season mango (*Mangifera indica* L.) cv. Neelum In: National seminar on production, postharvest technology and marketing of mango, held at HC & RI, TNAU, Periyakulam, 2009, 118-120.
5. Karuna K, Mankar A, Singh J. Effect of urea and growth substances on yield and quality of mango cv. langra. Orissa J Hort. 2007; 35(1):67-70.
6. Pradeepha L. Effect of canopy management and nutrients spray on vegetative growth, fruit set, yield and quality characters in sapota (*Manilkara achras* L.) cv. PKM 1, M.Sc. (Hort.) Thesis, submitted to Agricultural College and Research Institute, TNAU, Madurai, 2004.
7. Pratap B, Singh SK, Singh HK, Gaurav SS, Bala S. Effect of pruning on physico-chemical properties of mango cv. Amrapali under high density orcharding. Annals of Hort. 2009; 2(1):62-64.
8. Adil OS, Rahim A, Elamin OM, Bangerth FK. Effect of growth retardants, paclobutrazol (PBZ) and Prohexadione-Ca on floral induction of regular bearing mango (*Mangifera indica* L.) cultivars during off season. J Agri. Biol. Sci. 2011; 6(3):18-26.
9. Anonymous. Official Method of Analysis. Ed. Sidney Williams, Association Official Analytical Virgnia, 14th Edition, 1984, 424-462.

10. Anonymous. Indian data base, 2017. http://www.data.gov.in/apedawebsite/ Announcements/List horticultural crops pdf.
11. Burondkar MM. Influence of plant growth regulators, polyamine and nutrients on post flowering physiological behaviour in relation to yield and quality of Alphonso mango (*Mangifera indica* L.). Ph.D., Thesis submitted to University of Agricultural science, Dharward, 2005.
12. Burondkar MM, Gunjate RT, Magdum MB, Govekar MA. Rejuvenation of old and overcrowded Alphonso mango with pruning and use of paclobutrazol. Acta Hort. 2000; 509(2):681-686.
13. Burondkar MM, Rajput JC, Waghmare GM. Recurrent flowering: A new physiological disorder in 'Alphonso' mango. Acta Hort. 2000; 509:669-673.
14. Burondkar MM, Rajan S, Upreti KK, Reddy YTN, Singh VK, Sabale SN, Naik MM, Nigade PM, Saxena P. Advancing Alphonso mango harvest season in lateritic rocky soils of Konkan region through manipulation in time of paclobutrazol application. J Applied Hort. 2013; 15(3):178-182.
15. Gnanasekaran E. Studies on induction of off-season flowering in mango (*Mangifera indica* L.) cv. Neelum. M.Sc. (Hort.) Thesis submitted to HC & RI, TNAU, Periyakulam, 2007.
16. Gopu B. Canopy management studies in mango (*Mangifera indica* L.) cv. Alphonso under ultra-high density planting. M.Sc (Hort.) *thesis* submitted to the TNAU, Coimbatore-India., 2011, 1-79.
17. Hillier BV. Response of certain cultivar to paclobutrazol on fruiting, yield and quality. Proc. of national seminar on mango. G.A.U. Junagadh, 1991, p. 32.
18. Miller GL. Use of Dinitrosalicylic Acid Reagent for Determination of Reducing Sugar Anal. Chem. 1959; 31(3):426-428.
19. Rao VNM. studies on irregular bearing in mango. Andhra Agric. J. 1995; 38:48-51.
20. Rao VNM, Khader JBMMA. More about mango pruning. Indian Hort. 1978; 23(4):2-5.
21. Ravishankar H, Nalawadi U, Ghulamani NC. Investigation on use of growth regulators for the control alternate bearing plroblems in mango (*Mangifera indica* L.). Indian J Agri. Sci. 1990; 79(6):411-417.
22. Sarker BC, Rahim MA. Vegetative growth, harvesting time, yield and quality of mango (*Mangifera indica* L.) as influenced by soil drench application of paclobutrazol. Bangladesh J Agril. Res. 2012; 37(2):335-348.
23. Sathiya V. Studies on the effect of different levels of training and pruning on yield and quality of sapota (*Manilkara achras* L.) cv.PKM (Sa) 4. M.Sc. (Hort.) Thesis, submitted to Horticulture College and Research Institute, TNAU, Periyakulam, 2005.
24. Singh SK, Singh SK, Sharma RR, Patel VB. Influence of pruning intensity on flowering, fruit yields and floral malformation in three mango cultivars under high density. Indian J Hort. 2010a; 67(Special Issue):84-89.
25. Singh SK, Singh SK, Sharma RR. Pruning alters fruit quality of mango cultivars (*Mangifera indica* L.) under high density planting. J Trop. Agri. 2010a; 48(1-2):55-57.
26. Upreti KK, Reddy YTN, Prasad SR, Bindu GV, Jayaram HL, Rajan S. Hormonal changes in response to paclobutrazol induced early flowering in mango cv. Totapuri. Scientia Hort. 2013; 150:414-418.
27. Venkatesan R. Studies on certain aspects of canopy management in mango (*Magifera indica* L.) cv. Banganapali, M.Sc. (Hort.) *Thesis*, submitted to Horticulture College and Research Institute, TNAU, Periyakulam, 2006.
28. Vijayalakshmi D, Srinivasan PS. Impact of chemicals and growth regulators in induction of flowering in 'off' year mango cv. Alphonso. Orissa J Hort. 2002; 30(2):25-32.
29. Yeshitela TB, Stassen PJC. Paclobutrazol suppressed vegetative growth and improve yield as well as fruit quality of Tommy Atkins mango (*Mangifera indica* L.) in Ethiopia. New Zealand J Crops Hort. Sci. 2005; 32:281-293.