Response of Paclobutrazol Application Time on Flowering, Fruiting and Yield of Mango cv. Alphonso

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Abstract

A field experiments was conducted to study "The effect of paclobutrazol application time on flowering, fruiting and yield of mango (Mangifera indica L.) cv. Alphonso." The experiment consisted of 11 treatments comprising of fort nightl paclobutrazol applied to the soil @ 3 ml/canopy m^2 from June to October every forthnighty, one as control without paclobutrazol application. These treatments were evaluated under one way ANOVA design with three set of experiment. The pooled data also indicates that vegetative growth viz, shoot length, shoot diameter, no. of leaves were suppressed significantly by the paclobutrazol application and the results revealed that the paclobutrazol application in second forth nighty of July has resulted highest yield 206.07 fruits $tree^{-1}$ (45.73 kg) and the estimated yield was 4.47 t^{-1} with early flowering by 51.58 days and harvesting by 35.39 days with maximum net returns of Rs. 2, 47,862.40 per ha^{-1}. with 2.51 B:C ratio.

Keywords: Paclobutrazol, Flowering, Fruit Character, Yield, β -Caotene Alphonso.

Introduction

The mango (Mangifera indica L.), is one of the 73 genera of the family Anacardiaceae in order Sapindles, is amongst the most important tropical fruits of the world. (Shankar Swamy, 2012).It is unarguably considered as king of fruits (Purseglove,1972)and cv. Alphonso is called as king of all mango varieties in India, owing to its luscious taste, captivating flavour and high nutritive quality. Maharashtra state is an emerging as the leading mango growing state, currently occupying 4.7 lakh ha area with production of 5.97 lakh tons and productivity 3.93 tons/ha. The other states in India which produces mangos (lakh tons) are Andhra Pradesh (4.05), Uttar Pradesh (3.58), Karnataka (1.688), Bihar (0.995), Gujarat (0.856), Tamilnadu (0.762), West Bengal (0.578), Orissa (0.577), Kerala (0.373) (Anon, 2010)

The cv. Alphonso is high yielding variety with average productivity varying from 2.3 to 3 tons/ha which perhaps lowest in the country. Among the several factors ascribed for low yield, susceptibility to pests (Mango hopper), disease (Powdery mildew) and occurrence of alternate bearing (Pandey, 1989) are major. Among these, alternate bearing is most important physiological disorder of mango where, trees carry a heavy load of crop in one year ('on' year) and show tendency towards reduced yield in the following year ('off' year). A better understanding of the nature of flowering induction in mango is necessary not only for yield sustainability but also for yield increase. Flowering is the first of several events that set the stage for mango production each year. Soil application of paclobutrazol induced precious flowering in young trees and promoted early flowering in bearing trees (Kulkarni 1988).Considering the above fact, the present study was carried out to find out the effect of time of application of paclobutrazol on the manipulation of harvest time and improving yield as well as quality of mango cv. Alphonso.

Materials and Method

The experiment was carried out at the Educational Research Farm, plot No. 28 (at 17^o45`, North latitude and $73^o12$`, East longitude and at an elevation of 280 meters above MSL). Department of Horticulture, College of Agriculture, Dr. B.S.K.K.V, Dapoli.during the fruiting season of 2012-2013. Investigations related to bio-chemical analysis were carried out in the Department of Chemistry and Soil Science ,Dr.Balasaheb Sawant Konkan Krishi Vidypeeth,Dapoli,Dist-Ratnagiri.(M.S.).The 20 years old Alphonso plants with a plant spacing of 10x10m were used in the study. The factorial experiment was laid out in a one way Anova Design with 3

replications. Paclobutrazol @ 3 ml/canopy meter^2 were soil drenched every fort nighty w.e.f June to October. The solutions of specific quantity by measuring average canopy diameter were prepared by dissolving of 25 % paclobutrazol (Syngenta Chem. Co. Ltd., India) into 5-6 litre of fresh water each respectively.Paclobutrazol treatments were soil drenched according to Burondkar & Gunjate (1993), in which 10 small holes (10–15 cm depth) were prepared in the soil around the collar region of the plants just inside the fertilizer ring. The prepared solutions of paclobutrazol as per treatment uniformly drenched into the wholes and the soil was reworked after application of paclobutrazol. Only water was applied in the control plants. The data of the following parameters were recorded: length of terminal shoot, diameter of shoot, number of leaves per terminal shoot, length of panicle,width of panicle, date of first panicle emergence, fruit set per panicle, number of fruits retained per panicle at 10 day intervals starting from pea stage upto harvest, date of harvest, number of fruits per plant, fruit weight, yield, shelf-life, TSS, titratable acidity, B-carotene , reducing sugar, non reducing sugar and total sugar content. The length and number of leaves of ten randomly selected terminal shoots at flowering stage were measured and the average was worked out. Ten panicles were randomly selected from each treatment. The initial number of fruits of each panicle and the fruits to be retained per panicle at 10 day intervals starting from pea stage up to harvest were recorded and the average was worked out. After harvest, ten randomly selected fruits were allowed to ripen at room temperature and fruit quality was determined using 10 fruits per tree. Total Soluble Solid (TSS) of 10 fully ripened fruits for each treatment was estimated by a hand refractometer and the average was worked out. The titratable acidity (A.O.A.C.,2012), B-carotene (Roy,1973) reducing sugar (Ranganna 1997) and total sugar content (Ranganna 1997) in mango pulp were determined. The recorded data on different parameters of the experiment were tabulated and analyzed and the treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance. (Fisher 1955).

Results and Discussion

Effect of Paclobutrazol on Leaf, Shoot and Panicle Characters of Mango

Paclobutrazol treatments markedly influenced the terminal shoot length, shoot diameter, number of leaves per terminal shoot and panicle length, (Table1). Regardless of the time of application, paclobutrazol caused a marked reduction in terminal shoot length, shoot diameter, leaf number per terminal shoot as compared with the control and the reduction of above traits was noted the maximum when paclobutrazol was applied in soil drenched at second fort nighty of July which was closely followed by paclobutrazol applied at first forth night of July and first fort nighty of August. Plants without paclobutrazol produced the longest panicle, thin panicle, highest number of leaves per terminal shoot. There was significant variation due to time of application in respect of terminal shoot length, diameter and number of leaves. Plants treated with paclobutrazol on second forth night of October demonstrated longer terminal shoot, higher number of leaves and panicles per plant as compared to those of second forth nighty of July application. The highest suppression of vegetative growth was manifested when paclobutrazol was treated at second fort nighty of July. According to Kurian and Iyer (1992) paclobutrazol can enhance the total phenolic content of terminal buds and alter the phloem to xylem ratio of the stem, which is important in restricting the vegetative growth and enhancing flowering by altering assimilate partitioning and patterns of nutrient supply for new growth. Suppressed vegetative growth of 'Tommy Atkins' mango trees due to soil drench application of paclobutrazol at 5.50 and 8.25 g a.i. per tree are reported (Yeshitela et al., 2004). Soil drench applications of Cultar (Paclobutrazol) to mango cv. Dashehari at Ludhiana prior to flower bud differentiation during the first week of October affected the vegetative growth and promoted flowering (Zora et al., 2000). According to Cardenas and Rojas (2003) paclobutrazol inhibited the vegetative growth and stimulated flower development. The soil-applied paclobutrazol treatments at 7500 ppm had an impact on reduction of vegetative growth, resulting in a higher intensity of flowering. Higher total non-structural carbohydrates (TNC) in the shoots of the paclobutrazol treated trees 2 weeks before flowering compared with the control have been reported by Yeshitela et al. (2004). He also stated that the increased number of panicles for paclobutrazol treated plants was due to lower expenditure of tree reserves to the vegetative growth parameters and consequently no assimilates limitations, compared with an excessive vegetative growth on the control trees. A higher accumulation of reserves in the current year shoots before flowering was also observed by Stassen and Janse Van Vuuren (1997). Either 7500 ppm or 10000 ppm paclobutrazol solution applied as soil drench on 15 October exhibited the earliest panicle emergence by 19 days, compared to control (Table 2). Flowering earliness in paclobutrazol treated plants was reported by Kulkarni (1988). He also ascribed that the flower-inductive factor might commence earlier in the season. It is also probable that the application of paclobutrazol caused an early reduction of endogenous gibberellins levels within the shoots as also observed by Anon. (1984), causing them to reach maturity earlier than those of untreated trees. This finding is similar to that of Tran et al. (2002), where paclobutrazol induced flowering 85 days after treatment application. The total activity of auxin-like substances increased the higher starch reserve, total carbohydrates and higher C: N ratio in the shoots favour flower bud initiation in mango (Jogdande and Choudhari, 2001). Regular, profuse and early bearing was also reported to be found due to paclobutrazol application in mango cv. Banganapalli grown at Andaman and Nicobar Islands, India (Singh and Ranganath, 2006).

Effect of Paclobutrazol Application Time on Flowering, Fruit Set As Well As Fruit Retention and Yield of Mango

The effect of paclobutrazol application time in terms of flowering fruit set as well as number of

fruits retained per panicle varied significantly (Table 1). Plants soil drenched with paclobutrazol at second fort night of July resulted in the highest fruit set as well as fruit retention per panicle up to harvest. The control plants got the least fruit set and fruit retention per panicle. Trees soil drenched with paclobutrazol, which had higher reserves enhanced fruit set compared to the lowest fruit set in the untreated tree with low reserves because of excessive vegetative growth (Yeshitela et al., 2004) and corroborate the present findings.

Effect of Paclobutrazol Application Time on Harvest Time, Number of Fruits, Yield and Fruit Characters

The date of harvest ranged between 22 April 2013 and 4 May 2014 having the earliest harvest by 35 days in plants treated with paclobutrazol in second fort nighty of July and the delayed harvest in control plants (Table 2). The earlier harvest due to paclobutrazol of the current study is in line with the result of Xie et al. (1999), where spraying of paclobutrazol in late August/early September in the southwestern part of Hainan province had promoted flowering and ripening date by 1-3 months. The advancement of harvesting by 40-45 days in case of paclobutrazol application in mango cv. Banganapalli grown at Andaman and Nicobar Islands, India (Singh and Ranganath, 2006) provides support to the result of the present investigation. Paclobutrazol irrespective of time of application exhibited earlier harvest than that of the control. Number of fruits per plant, shelf-life and yield due to the paclobutrazol application time were noticed to be significant. The weight of fruit is reduced with increase in yield and number of fruits. Irrespective of time of application, paclobutrazol increased the number of fruits per plant although the highest number of fresh fruits per plant was harvested from the plants soil drenching with paclobutrazol second forth night of July, whereas the control plants gave the lowest number of fruits. The plants treated with paclobutrazol from second fort nighty of August to second forth night of October had the lowest value in fruit set. fruit retention, number of fruits and yield in kg per tree next to control. This might not be the effect of paclobutrazol applied, because it works prior 90-100 days before application(Burondkar and Gunjate,1993; Kulkarni,1988).The highest yield (45.73 kg/tree) was noted in plants which received paclobutrazol at second forth nighty of July as against the very low yield (16.99 kg/plant) in control.

A significantly higher fruit set and fruit retention in the paclobutrazol treated plants had a favourable impact on culminating higher final fruit number and yield per plant. Paclobutrazol has been reported to exert influence on partitioning the photosynthates to the sites of flowering and fruit production consequent to the reduction of vegetative growth. In this context, Kurian et al. (2001) reported that paclobutrazol appeared to favourably alter the source sink relationship of mango to support fruit growth with a reduction in vegetative growth. Plants treated with paclobutrazol at 7.5 g a.i. per plant of mango cv. Langra in Sabour, Bihar, India produced the highest. The paclobutrazol applied in second forth nighty of July has significantly increased TSS (18.04 %) and β-carotene (11382.23 µg/100 g of pulp) not improved the acidity and sugars.(Table 4).These results are in conformity with results reported by (Sarker and Rahim,2012)

Conclusion

Soil drench application of paclobutrazol at second fort nighty of July caused earlier panicle emergence by 51.58 days and harvesting by 35.39 days highest yield, and improved the β -carotene and TSS in mango cv. Alphonso compared with control.

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Table 1:Vegetative and Generative Characters as Influenced By Time of Paclobutrazol Application in Alphonso Mango.

Treatments	Shoot length (cm)	Shoot diameter (cm)	Number of leaves per shoot	Length of panicle (cm)	Width of panicle (cm)	Per cent hermaphrodite flowers	Fruit set (%)	Retention (%)	Days to harvest	No. of fruits plant^{-1}	Yield kg plant^{-1}	Av. weight of fruit (g)	No.of fruits plant^{-1}	Yield kg plant^{-1}
T_1	17.24	0.80	20.10	22.27	0.51	12.50	2.788	0.993	116.05	132.98	30.98	232.96	132.98	30.98
T_2	17.20	0.81	19.29	21.91	0.52	12.61	2.976	1.195	113.30	147.10	33.18	226.03	147.10	33.18
T_3	16.27	0.82	18.30	17.85	0.61	14.24	3.444	1.221	110.63	159.91	35.64	222.90	159.91	35.64
T_4	15.80	0.92	16.48	16.95	0.83	14.87	3.866	1.386	108.14	206.07	45.73	222.16	206.07	45.73
T_5	17.02	0.82	17.09	18.84	0.77	13.74	3.364	1.356	109.70	151.06	33.81	223.81	151.06	33.81
T_6	17.91	0.74	26.98	20.37	0.66	13.08	3.401	0.975	113.12	108.04	24.64	228.09	108.04	24.64
T_7	18.90	0.69	27.28	21.93	0.61	13.30	2.936	0.871	115.57	104.95	24.32	231.72	104.95	24.32
T_8	19.14	0.71	24.21	22.78	0.57	12.16	2.875	0.861	115.60	100.60	23.62	234.84	100.60	23.62
T_9	19.94	0.67	28.14	25.89	0.56	11.89	2.774	0.838	118.43	89.11	20.94	234.64	89.11	20.94
T_{10}	24.53	0.62	27.78	25.75	0.56	11.68	2.724	0.885	118.39	86.18	20.80	241.43	86.18	20.80
T_{11}	25.04	0.59	29.19	30.98	0.46	10.17	1.722	0.243	142.26	66.49	16.99	255.42	66.49	16.99
Range	15.80-25.04	0.60-0.92	16.48-29.19	16.95-31.14	0.46-0.83	10.17-14.87	1.722-3.866	0.243-1.386	108.14-142.26	66.49-206.07	16.99-45.73	222.16-255.42	66.49-206.07	16.99-45.73
Mean	**18.99**	**0.74**	**23.17**	**22.32**	**0.60**	**12.75**	**3.06**	**1.03**	**116.47**	**122.95**	**28.24**	**232.18**	**122.95**	**28.24**
S. Em ±	1.00	0.05	1.33	1.26	0.03	0.41	0.09	0.12	1.20	12.23	2.81	1.003	12.23	2.81
C. D. at 5%	3.07	NS	4.01	3.79	0.119	1.24	0.299	0.369	3.61	36.71	8.43	3.02	36.71	8.43
CV %	20.73	9.03	21.10	17.44	24.99	12.41	19.20	18.53	17.41	23.32	20.83	22.64	23.32	20.83

Table 2: Effect of Paclobutrazol Application Time on Flowering Intensity, Flowering Period and Earlinessin Flowering in Alphonso Mango.

Treatments	Flowering intensity (%)			Flowering period		Earliness in flowering over control (Days)		
	2012-13	2013-14	Pooled	2012-13	2013-14	2012-13	2013-14	Pooled
T_1	63.20	64.57	63.88	First week of Dec.	Third week of Dec.	27.77	26.33	27.05
T_2	64.26	66.13	65.19	Third week of Nov	Second week of Dec..	38.66	31.11	34.88
T_3	77.80	79.58	78.69	First week of Nov.	Third week of Nov.	52.33	47.25	49.79
T_4	81.13	84.24	82.68	First week of Nov.	Second week of Nov.	54.50	48.66	51.58
T_5	80.93	82.16	81.54	First week of Nov.	Third week of Nov.	54.50	48.50	51.50
T_6	59.53	62.10	60.81	First week of Nov.	Third week of Nov.	46.33	40.25	43.29
T_7	59.00	61.74	60.37	Third week of Nov	Second week of Dec.	35.11	33.11	34.11
T_8	46.93	49.17	48.05	First week of Dec.	Third week of Dec.	24.25	27.12	25.68
T_9	45.00	48.00	46.50	Second week of Dec.	Second week of Jan.	14.25	14.66	14.45
T_{10}	44.53	46.34	45.43	Second week of Dec.	Second week of Jan.	11.33	10.56	10.94
T_{11}	33.53	30.28	31.90	Forth week of Dec.	Third week of Jan.	1.00	1.00	1.00
Range	33.53-81.13	30.28-84.24	31.90-82.68	First week of Nov- Forth week of Dec..	Second week of Nov- Third week of Jan.	11.33-54.50	10.56-48.66	10.94-51.58
Mean	**59.93**	**61.91**	**60.92**			**32.73**	**29.86**	**31.29**
S. Em ±	3.04	3.37	3.16			2.52	2.28	2.40
C. D. at 5%	9.12	10.13	9.48			7.58	6.86	7.22
C.V. %	21.11	19.86	20.35			12.43	11.27	11.85

Table 3: Effect of Paclobutrazol Application Time on Period of Harvest, Earliness in Harvesting, Increment in Yield over Control in Alphonso Mango.

Treatments	Period of harvest		Earliness in harvesting (Days)			Increment in yield over control (t)		
	2012-13	2013-14	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
T_1	First week of May	Second week of May	18.56	27.54	23.05	1.160	1.639	1.399
T_2	First week of May	Second week of May	22.76	28.87	25.81	1.402	1.837	1.619
T_3	Third week of April	First week of May	28.39	36.13	32.26	1.656	2.075	1.865
T_4	Third week of April	First week of May	31.59	39.2	35.39	2.396	3.352	2.874
T_5	Third week of April	First week of May	29.32	35.82	32.57	1.472	1.892	1.682
T_6	First week of May	First week of May	25.13	33.12	29.12	0.551	0.980	0.765
T_7	First week of May	First week of May	22.76	29.11	25.93	0.533	0.933	0.733
T_8	First week of May	First week of May	21.82	30.34	26.08	0.452	0.875	0.663
T_9	First week of May	First week of May	19.71	27.61	23.66	0.199	0.591	0.395
T_{10}	Second week of May	Second week of May	19.43	25.32	22.37	0.177	0.585	0.381
T_{11}	Forth week of May	Forth week of May	1.00	1.00	1.00	0	0	0
Range	Third week of April - Forth week of May	Second week of April- Forth week of May	19.43-57.59	12.32-51.81	15.87-54.70	0.177-2.396	0.585-3.352	100-211.54
Mean			**32.95**	**28.36**	**30.65**	**0.90**	**1.34**	**1.12**
S. Em ±			1.56	1.55	1.55	0.05	0.05	0.05
C. D. at 5%			4.73	4.68	4.70	0.17	0.18	0.17
CV %			12.56	13.72	13.14	17.24	16.81	17.02

Table 4: Effect of Time of Application of Paclobutrazol on Chemical Characteristics of Fruit in Alphonso Mango

Treatments	TSS	Titratable acidity (%)	Reducing sugar	Non-redusing sugar	Total sugar	β-carotene (µg/100 g of pulp)
T_1	17.68	0.29	4.03	10.77	14.80	11181.99
T_2	17.79	0.29	3.73	10.78	14.74	11273.03
T_3	17.51	0.33	3.75	11.24	14.76	11262.57
T_4	18.04	0.29	3.87	12.03	15.89	11382.23
T_5	17.97	0.26	3.78	11.78	15.20	11091.95
T_6	18.02	0.30	3.42	11.77	15.19	10982.25
T_7	17.50	0.32	4.25	11.31	15.74	10550.57
T_8	17.79	0.30	4.14	11.33	15.51	10516.60
T_9	17.70	0.30	4.06	11.08	15.26	11063.48
T_{10}	17.69	0.28	3.97	11.05	15.02	11273.52
T_{11}	17.99	0.29	4.06	9.88	13.94	11202.52
Range	17.50-18.04	0.26-0.33	3.42-4.25	9.88-12.03	13.94-15.89	11382.23-11202.52
Mean	**17.79**	**0.29**	**3.91**	**11.18**	**15.09**	**11070.97**
S. Em ±	0.051	0.064	0.123	0.08	0.051	24.90
C. D. at 5%	0.153	NS	NS	NS	NS	74.7
CV %	1.02	1.97	2.59	1.01	1.11	0.85