Advancing Alphonso mango harvest season in lateritic rocky soils of Konkan region paclobutrazol

Data · July 2016

CITATIONS
0

READS
248

5 authors, including:

Murad Mohamed Burondkar
Dr. Balasaheb Sawant Konkan Krishi Vidypeeth
92 PUBLICATIONS **201** CITATIONS
SEE PROFILE

Shailendra Rajan
Central Institute for Subtropical Horticulture
168 PUBLICATIONS **473** CITATIONS
SEE PROFILE

K.K. Upreti
Indian Institute of Horticultural Research
56 PUBLICATIONS **584** CITATIONS
SEE PROFILE

Narayana Reddy
Indian Institute of Horticultural Research
29 PUBLICATIONS **164** CITATIONS
SEE PROFILE

Journal of Applied Horticulture, 15(3): 178-182, 2013

Advancing Alphonso mango harvest season in lateritic rocky soils of Konkan region through manipulation in time of paclobutrazol application

M.M. Burondkar[1]*, Shailendra Rajan[2], K.K. Upreti[3], Y.T.N. Reddy[3], V.K. Singh[2], S.N. Sabale[1], M.M. Naik[1], P.M. Nigade[1] and Pooja Saxena[2]

[1]Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. [2]Central Institute of Subtropical Horticulture, Rehmankhera, Lucknow. [3]Indian Institute of Horticultural Research, Bangalore, India.
**E-mail: burondkarmm@yahoo.co.in*

Abstract

The present study, aimed at advancing Alphonso mango harvest season through manipulation in time of soil application of paclobutrazol (PBZ) [soil application on 15th of May, June, July, and August]; foliar spray of KNO_3 (3%) [August and September], was conducted during 2010 to 2012 cropping seasons in red lateritic rocky soil of Konkan (Maharashtra, India). Results of individual years and mean for three years revealed that significant earliness in flowering (85.4 day) and advancement in harvesting (82 day) was achieved with the application of PBZ on 15th May. PBZ application on 15th June was relatively less effective in inducing early flowering (56 day) and harvesting (69 days). However, the greater extent of flowering (72.23 %) and fruit yield per tree (40.72 kg/tree) were recorded with PBZ applied at recommended time *i.e.,* on 15th August. Individual fruit weight was higher in KNO_3 sprayed tree in the months of August (268g) and September (265.5 g), whereas fruit T.S.S. was higher (19.37 °Brix.) in trees receiving PBZ on 15th August. The findings of study indicated huge potential for realizing about 5-6 times higher returns from Alphonso produced in February-March months as compared to May harvest.

Key words: Early season, Alphonso, mango, lateritic rocky area, Konkan, paclobutrazol, flowering, harvesting season

Introduction

Konkan region of Maharashtra in India is well known for the commercial production of world famous mango variety Alphonso which presently occupy area of more than one lakh ha, spreading along the west coast of the state. Due to excellent fruit quality and flavour of the variety, it is in great demand both in domestic and international markets. Flowering in Alphonso takes place during December-February and harvesting of fruit starts from the third week of March till May end and resulting in crash of prices in major markets like Mumbai towards the end of May due to glut in the market. The early harvested fruit fetches the average price ranging between Rs. 750-800 per dozen during February- March as compared to price ranging from Rs. 150-200 per dozen for normal season harvest (April-May). Hence, induction of early season Alphonso crop to fetch maximum profits for the growers has been priority area of mango research in Konkan region of Maharashtra.

Mango orchards grown along the West coast on lateritic rocky lands, which presently covers over 30,000 ha of area in South Konkan, occasionally exhibit off-season flowering in mid August to mid September (once in 2 to 3 years). This is mainly under the influence of water stress due to prolonged dry spell of more than three weeks during August as well as mechanical leaf shaking and salt residue deposition from western sea breeze. However, flowering owing to this stimulus is very rare. Fruit set, as a result of this early flowering, is badly damaged by anthracnose/ blossom blight due to heavy rains continuing till September end. Hence, natural off-season flowering does not offer technological option for producing reproducible off-season mango crop in this region.

Several reports on the beneficial effects of PBZ in flower induction in different mango cultivars are available (Tongumpai *et al.,* 1991; Winston, 1992; Kulkarni, 1988; Blaikie *et al.,* 2004; Yeshitela *et al.,* 2004; Nafees *et al.,* 2010). Paclobutrazol has also been found predominantly effective in early flower induction in mango and thus has been one of the important approaches for the off-season production (Upreti *et al.,* 2013, Protacio *et al.,* 2000). Extensive research conducted earlier on flower induction with paclobutrazol has revealed that the paclobutrazol 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 and Gunjate, 1991; 1993; Burondkar *et al.,* 1997; 1999; 2009). Currently, use of paclobutrazol in July- August, is a standardized technology (Burondkar and Gunjate, 1993) and recommended practice being used since 1992 for induction of regular flowering for producing crop during main season (March 15- May end), over an area of more than 10,000 ha, with an estimated quantity of paclobutrazol 20,000 litres used every year.

Induction of off-/ early-season flowering in Alphonso with chemical interventions has not been attempted so far in Konkan. Hence, the present investigation was taken up with an objective to produce early flowering in Alphonso resulting off-season harvest in lateritic rocky soils of Konkan by modifying time of PBZ application and also to explore the role of KNO_3 in off-season mango production under Konkan conditions.

Materials and methods

The trial was conducted in the mango orchard of cv. Alphonso, located at 17°05'N and 73°17'E and 88 m. above mean sea level. The entire orchard was planted in 1997 on typical red lateritic rocky soil, adopting technique of pit blasting and filling it by bringing non-native soil at the time of planting. In general, lateritic soils of Konkan region are acidic (pH 4.75 to 6.50) with low electrical conductivity values. These soils are medium in available nitrogen, potassium and phosphorus, well supplied with organic carbon, iron and manganese content and low in copper and zinc. The trial was conducted for three consecutive years (2010-12) on 28 randomly selected 12 years old Alphonso trees with uniform stature and having recently matured shoots, without or with meagre fruits in April-May. Seven treatments, comprising four different dates of PBZ application and two KNO_3 applications (Table 1), along with control (without PBZ or KNO_3 treatment), were replicated on four trees in randomized block design. PBZ was applied through recommended soil drenching method, along the drip line @ 2.5 mL of PBZ formulation m^{-1} of canopy diameter per tree (Burondkar and Gunjate, 1993) and KNO_3 3 % was applied foliarly during August and September months. Cultural practices were scrupulously followed uniformly for all the trees. Meteorological parameters, collected at the nearest observatory (DBRKKV, Dapoli) during the flowering season, are depicted in Fig 1.

Randomly selected 100 shoots per tree were tagged all over the tree for collecting data on the flowering percent, flowering and harvesting date. The date of flowering was recorded when panicles reached 515 stage of BBCH scale (Rajan *et al.*, 2011). Average fruit weight was recorded on 25 randomly selected fruits. Data were analysed in ANOVA (Randomized Block Design) and mean were compared with LSD (P=0.05) values. Duncan's Multiple Range Test at (P=0.05) was used for mean separation.

Results

Significant differences were observed in extent of flowering, fruit harvest time, yield and fruit weight as a response of paclobutrazol (PBZ) and KNO_3 application on different dates. From the data (Table 1), it is apparent that both, the time of application and chemical influenced the studied parameters. Irrespective of time of application, the extent of flowering was higher under all PBZ treatments as compared to KNO_3 treatments. Application of PBZ on 15th May induced significantly early flowering than control (69-98 days). Earliness in flowering within treatment varied with the year; however the earliness in flowering was strongly associated with the time of application. Application of PBZ on 15th June induced early flowering but it was about 30 days late as compared to May treatment. Effect of KNO_3 on induction of early flowering was less pronounced and at variance with the year.

PBZ treatment in May, June and July recorded early harvest as compared to KNO_3 treatment and control trees (Table 2). Early fruit harvest (82.83 days) was possible through 15th May PBZ application followed by 15th June (69 days). Mean data on the effect of treatments on early harvest indicated that different PBZ treatments advanced harvest for 19 to 82 days. Year to year variation (within treatment) associated with time of earliest harvest was observed (January 4th week to 1st week of February), however the earliness due to PBZ treatments followed consistently similar trend during all the three years. Earliness in harvest followed the similar pattern as recorded with different treatments for time of flowering. Effect of KNO_3 on harvest time was not significant.

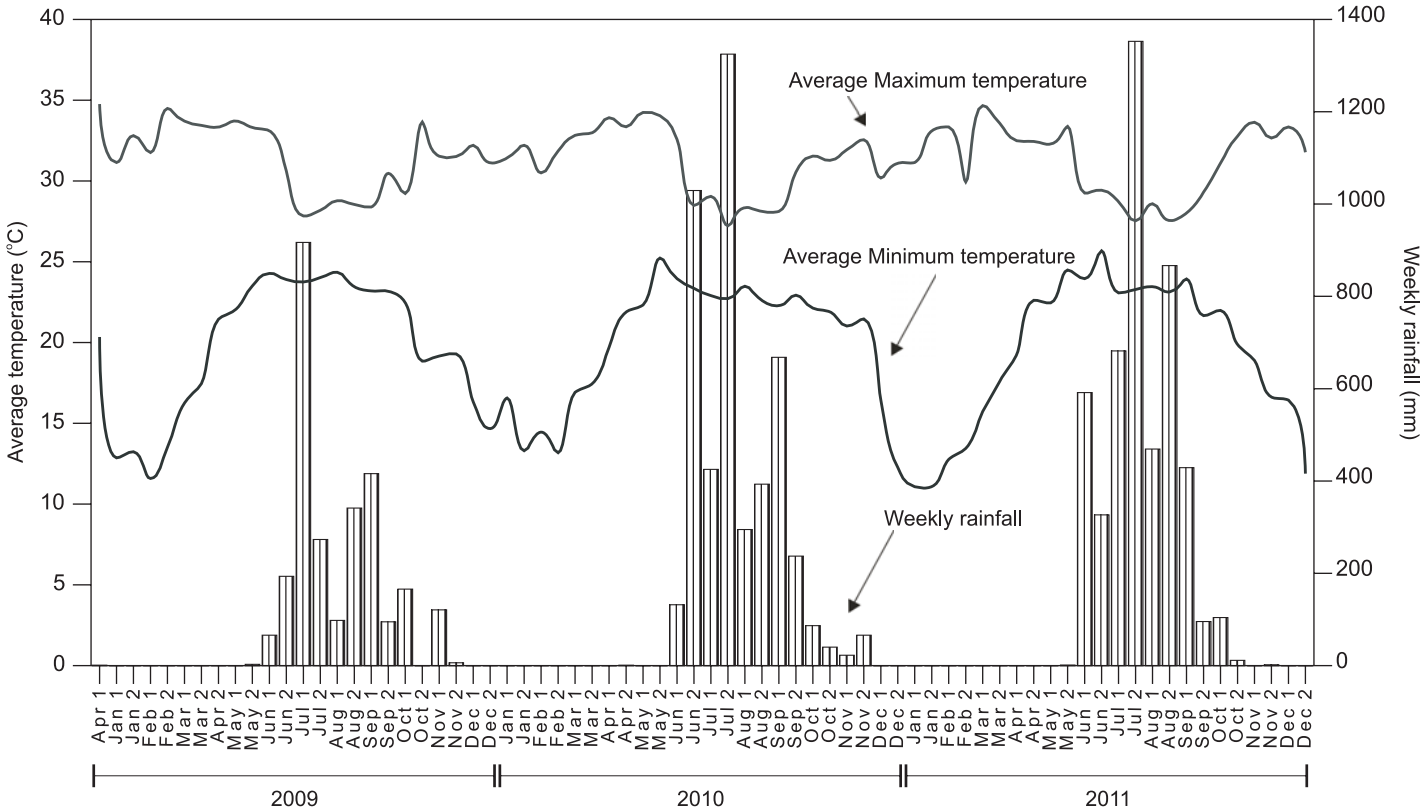

Fig. 1. Meteorological parameters during the flowering season collected at the nearest observatory (DBRKKV, Dapoli)

Table 1. Effect of time of PBZ application on induction of flowering in Alphonso mango under lateritic soil in Konkan

Treatments	Extent of flowering (%)				Time of flowering			Earliness in flowering over control (Days)			
	Year I	Year II	Year III	Pooled	Year I	Year II	Year III	Year I	Year II	Year III	Pooled
PBZ 15th May	57.62 (49.460)	49.91 (44.952)	46.50 (42.992)	51.34 (45.801)	3rd week of September	4th week of September	1st week of October	98.5	89.5	68.2	85.4
PBZ 15th June	66.75 (54.792)	58.67 (49.997)	51.27 (45.729)	58.997 (50.173)	4th week of October	1st week of November	3rd week of November	64.0	55.0	51.5	56.9
PBZ 15th July	73.25 (58.862)	62.10 (52.006)	69.07 (56.225)	68.140 (55.697)	1st week of December	1st week of December	3rd week of December	26.2	18.5	16.2	20.3
PBZ 15th August	78.00 (62.033)	66.44 (54.605)	72.25 (58.245)	72.230 (58.294)	3rd week of December	4th week of December	4th week of December	7.7	2.0	13.0	7.6
KNO_3 August	32.50 (34.751)	28.71 (32.399)	42.92 (40.922)	34.710 (36.024)	3rd week of December	3rd week of December	4th week of December	-2.2	10.5	17.5	8.6
KNO_3 September	34.20 (35.814)	30.25 (33.359)	39.38 (37.729)	34.610 (35.634)	3rd week of December	4th week of December	1st week of January	-2.2	9.5	8.5	5.3
Control	45.00 (42.130)	38.10 (38.114)	48.69 (44.247)	43.930 (41.497)	3rd week of December	3rd week of December	3rd week of December	1.0	1.0	1.0	1.0
S.E ±	0.472	0.465	0.915	1.712	-	-	-	1.9	1.2	1.5	5.1
LSD (*P*=0.05)	1.401	1.381	2.718	5.274	-	-	-	5.6	3.6	4.4	15.7

Figures in parenthesis are arc sin values; two sprays of KNO_3 weres applied at 15 days interval in each month

PBZ treatments consistently (in all the years) improved the yield (number of fruits per tree) when applied in May, June, July and August. Maximum yield was produced by 15th August PBZ application (40.72 kg/tree) followed by 15th July (39.37 kg/tree). KNO_3 did not show any favourable effect on fruit yield. Application of PBZ on 15th May and 15th June produced 14.8 and 21.7% higher yield (than control), respectively. Fruit yield was low (15-20%) in KNO_3 treatment than the control (Table 3).

From the data (Table 4), it is apparent that fruit weight was influenced by the time of application of PBZ however early crop produced as a result of May application had fruit weight at par with control. In general, fruit weight was higher in KNO_3 treatments than PBZ treatments. Data indicate that there was no reduction in fruit weight due to induction of early harvest maturity. In general, TSS was higher in fruit produced in PBZ treatment given during July and August.

Discussion

It is evident from the results that the early PBZ application could significantly advance the flowering and harvest season. Induction of such an early flowering advanced by two and half to three months assures high returns from early harvested crop. A strong relationship between early flowering and off-season harvest is the basis for harvesting the benefits of PBZ induced early flowering under costal region where, in general, mean maximum temperature is suitable for fruit development of early crop. Successful off-season production through early flower induction seems to be practically viable under tropics and coastal reasons where low temperature is not a limiting factor during fruit development during off-season (Fig 1).

In this study also PBZ application induced early flowering leading to early harvest which corroborates with the earlier studies in

Table 2. Effect of time of PBZ application on time of Alphonso mango harvesting under lateritic soil in Konkan

Treatments	Time of harvesting			Earliness in harvesting (Days)			
	Year I	Year II	Year III	Year I	Year II	Year III	Pooled
PBZ 15th May	4th week of January	1st week of February	3rd week of February	91.0	80.7	76.0	82.83
PBZ 15th June	2nd week of February	3rd week of February	1st week of March	76.0	68.0	63.0	69.00
PBZ 15th July	2nd week of March	2nd week of March	4th week of March	47.0	42.2	43.0	44.17
PBZ 15th August	1st week of April	2nd week of April	3rd week of April	22.0	19.5	17.0	19.75
KNO_3 August	4th week of April	2nd week of May	3rd week of May l	0.5	-4.5	-7.5	-3.83
KNO_3 September	4th week of April	1st week of May	1st week of June	-2.7	7.0	9.0	4.42
Control	1st week of May	1st week of May	2nd week of May	1.0	1.0	1.0	1.00
LSD (*P*=0.05)	-	-		12.0	10.4	6.6	8.37

Table 3. Effect of time of PBZ application on yield of Alphonso mango under lateritic soil in Konkan

Treatments	Number of fruit/tree				Yield (kg/tree)			
	Year I	Year II	Year III	Mean	Year I	Year II	Year III	Mean
PBZ 15th May	154.75c*	132.50c	112.00c	133.08c	38.65c	33.88c	28.52ab	33.69cd
PBZ 15th June	165.75cd	143.25cd	125.00cd	144.67cd	40.79cd	35.77c	30.61b	35.72de
PBZ 15th July	177.25de	151.25de	156.00e	161.50de	42.53d	36.77c	38.81c	39.37e
PBZ 15th August	186.00e	159.25e	173.00f	172.75e	43.03d	36.92c	42.21c	40.72e
KNO_3 August	93.50a	85.00a	103.25b	93.92ab	25.09a	22.78a	27.51ab	25.13ab
KNO_3 September	90.75a	81.50a	91.00a	87.75a	24.15a	21.69a	24.22a	23.36a
Control	114.75b	101.50b	120.00c	112.08b	29.39b	27.06b	31.52b	29.33bc

*Values in a column followed by same letter are not significantly different at *P*=0.05, as determined by Duncan's Multiple Range Test.

Table 4. Effect of time of PBZ application on fruit size and TSS in Alphonso mango under lateritic soil in Konkan

Treatments	Average fruit weight (g)				TSS (^{0}Brix)			
	Year I	Year II	Year III	Mean	Year I	Year II	Year III	Mean*
PBZ 15th May	249.25cd*	255.50c	251.50bd	252.08bc	18.6c	18.9bc	18.5bc	18.7abcd
PBZ 15th June	247.25bc	249.75bc	243.25abc	246.75ab	18.9c	19.0bc	18.5bc	18.8bcd
PBZ 15th July	239.50ab	243.25b	246.50b	243.08ab	19.5d	19.4c	18.9cd	19.3cd
PBZ 15th August	233.75a	232.75a	238.75a	235.08a	19.5d	19.2c	19.4d	19.4d
KNO_3 August	267.50e	268.25e	267.756f	267.83d	18.1ab	17.9a	18.1ab	18.1ab
KNO_3 September	267.25e	266.25de	264.25ef	265.92cd	18.5bc	18.5b	18.3abc	18.5abc
Control	256.25d	258.25cd	257.75de	257.42bcd	17.8a	17.7a	17.9a	17.8a

*Values in a column followed by same letter are not significantly different at P=0.05, as determined by Duncan's Multiple Range Test.

different varieties of mango (Yeshitela *et al.*, 2004; Yadava and Singh, 1998; Tongumpai *et al.*, 1991; Kulkarni, 1988; Blaikie *et al.*, 2004; Winston, 1992; Murti *et al.*, 2001; Nafees *et al.*, 2010) whereas early harvest with PBZ application has also been reported in other important mango cultivars from Australia (Winston, 1989), Indonesia (Voon *et al.*, 1991) and Thailand (Tongumpai *et al.*, 1991, Rachadaporn *et al.*, 2000).

Inhibition in gibberellin activity has been attributed as the possible primary mechanism by which PBZ restricts the vegetative growth and promotes flowering (Tommer *et al.*, 1984). Upreti *et al.* (2013) reported that application of PBZ as soil drench @ 3.0 mL/m canopy diameter during the 3rd week of August induced early flowering and advanced fruit harvest by 22 days in mango *cv.* Totapuri. The induction in early flowering was associated with increase in shoot C: N ratio and leaf water potential due to increase in ABA and cytokinins and decline in gibberellins, GA_4, GA_3, GA_7 and GA_1, in buds. The present study also indicated that off-season production through manipulation of time of application of PBZ can be extended for more than one month (Fig. 2) in Konkan. It seems that the association between time of PBZ application and early flowering can be harnessed profitably from May to June. Especially in Konkan region early harvest ensures high returns due to enormous price differences in early and normal season fruits. PBZ application at 2.5 mL/m canopy during 15th May and 15th June advanced flowering and harvesting of fruits resulting in high returns due to higher market prices of fruits.

The KNO_3 treatment caused almost non significant effect on time of flowering and harvest maturity of Alphonso mango under Konkan conditions. Contrarily, KNO_3 treatment is recommended in the Philippines for inducing off-season fruits in the 'Pico' and 'Carabao' cultivars (Madamba, 1978). Although, it has been successfully used to stimulate off-season flowering of mango, especially in tropical regions (Barba, 1974; Bondad and Linsangan, 1979; Nunez-Elisea, 1985), in India, KNO_3 has been used for flower induction with variable responses and reports on successful off-season production with reproducible results are not available. Goguey (1993) indicated that response of mango to different flower inducing treatments differs according to variety, climatic conditions and geographical location which holds true with present study also.

Based on the results, it can be concluded that advancement in flowering and harvest time of Alphonso can be successfully achieved using PBZ as soil application on 15th May in lateritic rocky soils of Konkan region of Maharashtra as it resulted 82 days early harvest without altering fruit weight and TSS. However, development of precise technology is warrented for sustainable production of vegetative shoots required for early flowering and fruiting.

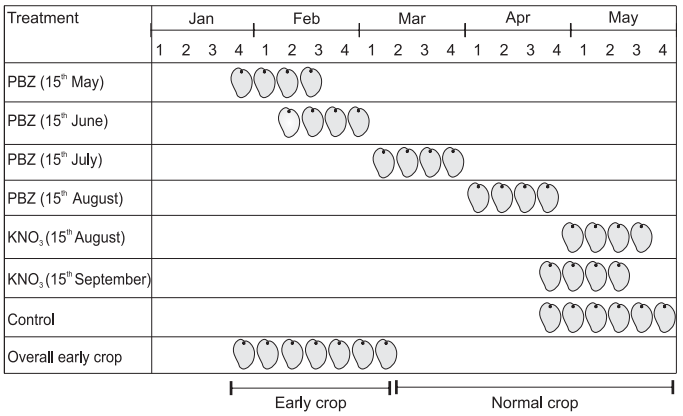

Fig. 2. Extended mango harvest season under Konkan conditions in Maharashtra with PBZ application time (based on 3 years data)

Acknowledgements

We thank Dr. C.P.A. Iyer, (CAC Chairman) and Director, CISH for encouragement and gratefully acknowledge the financial support from NAIP, ICAR, New Delhi and thank Dr. S. Kochhar, National Coordinator and the National Director, NAIP for encouragement.

References

Barba, R.C. 1974. Induction of flowering of mango by chemical spray. *Crop Sci. Soc. Philippines Proc.*, 5: 154-160.

Blaikie, S.J., V.J. Kulkarni, W.J., Muller, 2004. Effects of morphactin and paclobutrazol flowering treatments on shoot and root phenology in mango cv. Kensington Pride. *Sci. Hort*., 101,51-68.

Bondad, N.D. and E. Linsangan, 1979. Flowering in mango induced with potassium nitrate. *HortScience*, 14: 527-528.

Burondkar, M.M. and R.T. Gunjate, 1991, Regulation of shoot growth and flowering habit in Alphonso mango with paclobutrazol. *Acta Hort.*, 291: 79-84.

Burondkar, M.M. and R.T. Gunjate, 1993. Control of vegetative growth and induction of regular and early cropping in Alphonso mango with paclobutrazol. *Acta Hort*., 341: 206-215.

Burondkar, M.M., R.T. Gunjate, M.B. Magdum and M.A. Govekar, 1999. Rejuvenation of old and overcrowded Alphonso mango orchard with pruning and use of paclobutrazol. *Acta Hort*., 509(2): 681-686.

Burondkar, M.M., R.T. Gunjate, M.B. Magdum and G.M. Waghmare, 1997. Increasing productivity of mango orchards by pruning and application of paclobutrazol. *Acta Hort*., 451(1): 367-374.

Burondkar, M.M., B.B. Jadhav and M.B. Chetti, 2009. Effect of plant growth regulators, polyamine and nutrients on fruit quality and occurrence of spongy tissue in Alphonso mango. *Acta Hort*., 820: 689-696.

Goguey, T. 1993. Study of the effects of three flower-inducing substances on 'Kent' and 'Zill' mango. *Acta Hort.*, 341: 216-224.

Kulkarni, V.J. 1988. Chemical control of tree vigour and the promotion of flowering and fruiting in mango (*Mangifera indica* L.) using paclobutrazol. *J. Hort. Sci. Biotechol.*, 63: 557-566.

Madamba, J.C. 1978. *The Philippines Recommends for Mango*. Philippine Council for Agriculture and Resources Research.

Murti, G.S.R., K.K. Upreti, R.M. Kurian and Y.T.N. Reddy, 2001. Paclobutrazol modifies tree vigour and flowering in mango cv. Alphonso. *Indian J. Plant Physiol.*, 6: 355-360.

Nafees, M., M. Faqeer, S. Ahmad, M. Alam Khan, M. Jamil and M. Naveed Aslam, 2010. Paclobutrazol soil drenching suppresses vegetative growth, reduces malformation, and increases production in mango. *Int. J. Fruit Sci.*, 10: 431-440.

Nuñez-Elisea, R. 1985. Flowering and fruit set of a monoembryonic and a polyembryonic mango as influenced by potassium nitrate sprays and shoot decapitation. *Proc. Florida State Hort. Soc*., 98: 179-183.

Protacio C.M., R.D. Bugante Jr. and J. Quinto, 2000. Regulation of flowering in 'Carabrao' mango trees by paclobutrazol. *Philipp. J. Crop Sci.*, 25(1): 27-33.

Rachadaporn Junthasri, Pongnart Nartvaranant, Suranant Subhadrabandhu and Peeradet Tongumpai, 2000. Flower induction for producing off-season mango in Thailand. *J. Appl. Hort*., 2(1): 65-70.

Rajan, Shailendra, Divya Tiwari, V.K. Singh, Pooja Saxena, Shilpi Singh, Y.T.N. Reddy, K.K. Upreti, M.M. Burondkar, A. Bhagwan and Richard Kennedy, 2011. Application of extended BBCH Scale for phenological studies in mango (*Mangifera indica* L.). *J. Appl. Hort.*, 13(2): 108-114.

Rebolledo Martínez, Andrés, Ana Lid del Angel Perez, and José Rey Moreno, 2008. Effects of paclobutrazol and KNO_3 over flowering and fruit quality in two cultivars of mango Manila. *Interciencia*, 33(7): 523-527.

Tommer, E. 1984. Inhibition of flowering in mango by gibberellic acid. *Scientia Hort*., 24: 299-303.

Tongumpai, P., K. Jutamanee and S. Subhadrabandhu, 1991. Effect of paclobutrazol on flowering of mango cv. 'Khiew Sawoey'. *Acta Hort.*, 291: 67-79.

Upreti, Kaushal K., Y.T.N. Reddy, S.R. Shivu Prasad, G.V. Bindu, H.L. Jayaram and Shailendra Rajan, 2013. Hormonal changes in response to paclobutrazol induced early flowering in mango cv. Totapuri, *Scientia Hort.*, 150: 414-418.

Voon, C.H., C. Pitakpaivan and S.J. Tan, 1991. Mango cropping manipulation with cultar, *Acta. Hort*., 291: 219-228.

Winston, E.C. 1989. Evaluation of paclobutrazol on Kensington pride mango growth flowering and cropping. In: Abstracts of working papers of 3rd Int. Mango Symposium, (E. Chacko), DPIF, Darwin, Australia: 38.

Winston, E.C. 1992. Evaluation of paclobutrazol on growth, flowering and yield of mango cv. Kensington Pride. *Aust. J. Exp. Agric*., 32: 97-104.

Yadava, R.B.R. and V.K. Singh, 1998. Long term effects of paclobutrazol on yield and quality of Dashehari mango (*Mangifera indica* L.). *Indian J. Plant Physiol.*, 3: 166-167.

Yeshitela, T., P.J. Robbertse and P.J.C. Stassen, 2004. Paclobutrazol suppressed vegetative growth and improved yield as well as fruit quality of 'Tommy Atkins' mango (*Mangifera indica* L.) in Ethiopia. *N.Z. J. Crop Hort. Sci*., 32: 281-293.

Received: March, 2013; Revised: May, 2013; Accepted: September, 2013