Paclobutrazol in Mitigating Irregular Bearing in Mango

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Abstract

The investigation was carried out at the Central Research Farm of Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal, India during the years 2006-07 and 2007-08 to evaluate the response of paclobutrazol in mitigating irregular bearing and improving yield and quality of mango 'Himsagar'. The observations were recorded on inflorescence behaviour, yield and yield attributing characters and quality. The treatments consisted of six different doses of paclobutrazol (1 to 6 ml/m of canopy spread) applied at monthly interval during August to November (150, 120, 90 and 60 days before flower emergence). Two-way ANOVA technique without interaction was followed to compare the means of main effect due to dose(s) and month of application. Multivariate data reduction technique Principal Component Analysis (PCA) was used to adjudge the treatment combination i.e., dose of paclobutrazol vs. month of application following the correlation matrix as dispersion matrix. Paclobutrazol at the higher doses (5 and 6 ml/m of canopy spread) applied in the month of August/September (150/120 days before flower emergence) was found most effective in improving flowering, yield and quality. In contrast, the lower doses of paclobutrazol (3 and 4 ml/m of canopy spread) were also found equally effective with October application. From the results it appears that cost effective but equipotent solution in mitigating irregular bearing could be achieved by applying paclobutrazol at 4 ml/m of canopy spread during second fortnight of September (120 days before flower emergence) to first fortnight of October (90 days before flower emergence).

INTRODUCTION

The mango (*Mangifera indica* L.) is the most important and popular fruit among the people of tropical countries. It comes next to banana, apple and oranges on the basis of global acreage and production. However, productivity is poor in West Bengal than other mango producing states in India. Generally scientific cultural practices are not adopted by the growers and proper care is not taken before and during flowering and fruit set. Adoption of improved cultural practice such as manuring, irrigation, use of growth regulators and orchard sanitation is considered essential for improving productivity of mango in West Bengal. Flowering and fruit set are the two most critical phenomenon of fruit production. Application of different growth regulators has proved effective in inducing flowering in mango. Paclobutrazol, a gibberellins biosynthesis inhibitor, has been found to induce flowering in mango and increase yield (Kulkarni and Hamilton, 1997; Tangumpai et al., 1997). Hence the investigation was undertaken to evaluate the response of paclobutrazol in 'Himsagar' the most commercial variety of mango in West Bengal, India.

MATERIALS AND METHODS

The experiment was conducted at the Central Research Farm of Regional Research Station, New Alluvial Zone, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal, India during the years 2006-2008 to study the effect of paclobutrazol on yield and quality of mango 'Himsagar'. Data were observed for different variables length of panicle, width of panicle, number of fruits, length of fruits, width of fruits, weight of fruits, total soluble solids, acidity, reducing sugar, non reducing sugar, total sugar and vitamin C against six different doses of paclobutrazol (1 ml to 6 ml/m of canopy spread) applied at monthly interval from August to November. Two-way ANOVA technique without interaction was followed to compare the main effect means due to dose and month of application. Duncan's test at 5% level of significance was also followed to compare main effect means if significant for all above mentioned values. Multivariate data reduction technique like Principle Component Analysis was used to adjudge the treatment combination i.e., (dose of paclobutrazol vs. month of application) following the correlation matrix as dispersion matrix. Component loading for all variables are taken into consideration for those components which had Eigen values more than 1. Scatter diagram of regression factor score for first two components explaining larger variance will be drawn to delineate the performance of all treatment combinations in a two dimensional space as a representation of multi-trait evaluation. It is to be noted that paclobutrazol at 6 ml/m of canopy spread when applied in month of November there was no panicle emergence and so no variable were observed. Total titratable acidity percentage was determined by titrating against 0.1 N NaOH using phenolphthalein as an indicator and expressed as percentage in terms of citric acid (Ruck, 1969). The total sugar content of the mesocarp sample (fruit pulp) was determined by titrimetric procedures. Firstly the non- reducing sugar content of pulp samples was converted into reducing sugar by acid hydrolysis. after conversion, the sugar of the aqueous solution were determined by titrating against the freshly made mixture containing equal volume of Fehling's solution a and b and using methylene blue as indicator (A.O.A.C., 1990). The reducing sugar content of the aqueous extract was determined by titrating against the Fehling's solution as stated above (A.O.A.C., 1990). The non-reducing sugar percentage of fruit pulp were determined by subtracting the value of reducing sugars content from that total sugars and multiplying the values with 0.95 (A.O.A.C., 1990). The ascorbic acid content of fruit was estimated following method described by A.O.A.C. (1990) and was expressed as mg/100 g of pulp.

RESULTS AND DISCUSSION

The highest yield was recorded with application of paclobutrazol at 6 ml/m of canopy spread in the month of September (Table 1). Higher yield in mango with application of paclobutrazol was also reported by Sergent et al. (1997), Salazar-Garcia and Vazquez-Valdivia (1997) and Ahmed et al. (1998). Application of paclobutrazol at 5 ml/m of canopy spread also gave higher yield when applied 120 days before flower emergence. The higher doses of paclobutrazol (5 and 6 ml/m of canopy spread) was also found to increase yield when applied 90 days before flower emergence. However the response of paclobutrazol was discouraging when applied in the month of November.

The data presented in Table 2 indicated that the response to all doses of paclobutrazol (1, 2, 3, 4, 5 and 6 ml/m of canopy spread) for the variables of length of panicle, number of fruits, length of fruits, width of fruits, acidity %, non reducing sugar and total sugar. Variables such as weight of fruit, total soluble solids, reducing sugar and vitamin C showed their maximum values with higher concentrations (5 and 6 ml/m of canopy spread) of paclobutrazol. These results confirm the findings of Singh and Dhillon (1992). However, the lower dose of paclobutrazol (2 ml/m of canopy spread) also appreciably increased the width of panicle, weight of fruit and vitamin C content.

Application of paclobutrazol in the months of August and September (150 and 120 days before flower emergence, respectively) improved the variables like length of panicle, width of panicle, number of fruits, length of fruit, width of panicle, width of fruits, weight

of fruit and vitamin C (Table 3). Paclobutrazol applied in the month of October also showed favourable effects on increasing the number of fruits. But the response of paclobutrazol applied in the month of November was quite insignificant. However, the time of application of paclobutrazol had no significant effect on total soluble solids, acidity, reducing sugar, non reducing sugar and total sugar content.

Total number of variables was reduced to 5 components through PCA analysis. Both positively and negatively influenced variables and their treatment combinations are presented in Table 5. Out of twenty four treatment combinations (time of application [4] x doses of paclobutrazol [6]) (Table 5) which were observed for12 variables when subjected to PCA, 5 extracted components explained 76.95% total variance. Considering the first two components explaining larger variance it was 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 m of canopy spread showed positive influence for variable such as length of fruit, weight of fruit, width of fruit, fruit number, length of panicle, total soluble solids, vitamin-C, reducing sugar, non-reducing sugar and acidity content (Fig. 1).

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Tables

Table 1. Effect of different doses and time of application of paclobutrazol on yield of mango 'Himsagar'.

Dose of paclobutrazol (ml/m of canopy spread)	August		September		October		November	
	Yield (kg)							
	Per tree	Per ha	Per tree	Per ha	Per tree	Per ha	Per tree	Per ha
1	9.04	903.86	12.96	1296.00	29.73	2972.80	1.95	195.12
2	8.34	834.30	28.30	2380.40	27.48	2748.00	12.82	1281.60
3	6.01	601.26	22.85	2285.00	29.85	2984.85	1.52	151.92
4	16.12	1611.60	24.68	2467.80	22.99	2295.80	2.27	226.80
5	21.01	2101.00	31.47	3146.50	26.43	2643.35	6.90	690.48
6	9.13	912.87	32.65	3264.52	19.87	1986.60	-	-

Table 2. Mean results of all variables due to varying doses of paclobutrazol.

Variable	Dose of paclobutrazol					
	1	2	3	4	5	6
Length of panicle (cm)	21.00	22.45	20.83	22.48	20.80	20.01
Width of panicle (cm)	15.68 ^{a}	13.93 ^{ab}	11.70 ^{ab}	9.18 ^{b}	12.43 ^{ab}	12.81 ^{ab}
Number of fruits	72.75	108.75	83.00	91.00	118.00	112.33
Length of fruits(cm)	6.88	6.89	7.03	6.81	6.77	6.70
Width of fruits (cm)	5.38	5.50	5.44	5.46	5.76	5.54
Weight of fruits (g)	180.18 ^{ab}	176.43 ^{b}	178.68 ^{ab}	177.75 ^{ab}	179.38 ^{ab}	183.43 ^{a}
Total soluble solids (°Brix)	15.60 ^{b}	16.75 ^{ab}	17.60 ^{ab}	17.60 ^{ab}	18.30 ^{a}	18.87 ^{a}
Acidity (%)	0.13	0.14	0.11	0.16	0.14	0.15
Reducing sugar (%)	2.52 ^{ab}	2.37 ^{c}	2.46 ^{bc}	2.37 ^{c}	2.95 ^{a}	2.70 ^{ab}
Non-reducing sugar (%)	5.88	5.78	5.68	6.45	5.49	5.50
Total sugar (%)	8.70	8.45	8.37	9.66	8.89	8.49
Vitamin (mg/100 g pulp)	21.70 ^{b}	23.45 ^{ab}	23.63 ^{ab}	27.13 ^{a}	25.55 ^{ab}	24.97 ^{ab}

The similar alphabets beside mean value of any variable denote no significance differences among them.

Table 3. Variable means observed in fruit treated with paclobutrazol at four application dates.

Variable	Paclobutrazol application date			
	August	September	October	November
Length of panicle (cm)	20.75 ab	24.78 a	21.25 ab	17.90b
Width of panicle (cm)	16.37 a	13.82 bc	11.42 ab	8.08 b
Number of fruits	61.50 b	140.83 a	143.33 a	31.40 b
Length of fruits (cm)	7.07 ab	6.76 b	7.13 a	6.37 c
Width of fruits (cm)	5.55 ab	5.41 ab	5.69 a	5.37b
Weight of fruits (g)	187.80 a	180.95 b	181.57 b	163.60 c
Total soluble solids (°Brix)	18.03	17.30	16.93	17.28
Acidity (%)	0.13	0.16	0.14	0.13
Reducing sugar (%)	2.62	2.46	2.56	2.58
Non-reducing sugar (%)	5.27	5.59	6.18	6.26
Total sugar (%)	8.51	8.34	9.17	9.12
Vitamin C (mg/100 g)	25.67 ab	22.52 b	25.90a	23.24 ab

The similar alphabets beside mean value of any variable denote no significance differences among them. Time of application of paclobutrazol: August – 150 days before flower emergence, September – 120 days before flower emergence, October – 90 days before flower emergence, November – 60 days before flower emergence.

Table 4. Component matrix of extracted components (corresponding to Eigen values more than 1).

Variable	Component				
	1	2	3	4	5
Length of panicle (cm)	0.490	-0.431	0.277	0.275	-0.234
Width of panicle (cm)	0.619	-0.433	0.026	-0.411	0.208
Number of fruits	0.559	-0.079	0.278	0.593	-0.294
Length of fruits (cm)	0.864	-0.071	0.144	-0.265	0.032
Width of fruits (cm)	0.667	0.446	-0.239	0.205	-0.306
Weight of fruits (g)	0.847	-0.159	-0.069	-0.083	0.341
Total soluble solids (°Brix)	0.265	0.421	-0.506	0.063	0.144
Acidity (%)	-0.152	0.201	0.335	0.523	0.568
Reducing sugar (%)	0.134	0.319	-0.689	0.155	-0.141
Non-reducing sugar (%)	0.076	0.813	0.439	-0.246	-0.183
Total sugar (%)	0.123	0.875	0.327	-0.220	-0.086
Vitamin C (mg/100 g)	0.257	0.502	-0.038	0.150	0.505
Eigen value	3.042	2.606	1.382	1.148	1.055
% of Variance	25.351	21.720	11.517	9.565	8.793
Cumulative %	25.351	47.071	58.588	68.154	76.947

Table 5. Principal component classification of treatment combinations assisted by variables association.

Component	Positively influenced variables	Negatively influenced variables	Positively influenced treatment combinations (Dose*Time of application)	Negatively influenced treatment combinations (Dose*Time of application)
1	Length of fruit, wt of fruit, width of fruit, width of panicle, no. of fruits, length of panicle, total soluble solids, vitamin C, reducing sugar, total sugar	Acidity	5*8, 3*10, 1*8, 6*8, 2*10, 1*10, 5*10, 2*8, 4*10, 5*9, 3*9, 6*9, 2*9	1*11, 2*11, 5*11, 4*11, 3*11, 3*8, 6*10, 1*9
2	Total sugar, non-reducing sugar, vitamin C, width of fruits, total soluble solids, acidity	Width of panicle, length of panicle, weight of fruits.	5*10, 4*9, 4*11, 5*8, 6*8, 2*10, 3*11, 1*11, 2*11	1*9, 2*9, 2*8, 4*8, 5*9, 3*9, 1*8, 3*8, 3*10, 1*10, 6*9, 5*11
3	Non-reducing sugar, acidity, total sugar, number of fruits, length of panicle, length of fruits	Reducing sugar, total soluble solids, width of fruits	2*10, 2*9, 4*9, 1*9, 4*10, 1*11, 4*11, 1*10, 2*11, 3*9, 5*10, 3*10,4*8	5*11, 5*8, 6*10, 2*8, 6*8, 5*9, 3*8, 1*8, 6*9, 3*11
4	No. of fruits, acidity, length of panicle, width of fruits, reducing sugar, vitamin C	Width of panicle, length of panicle, non-reducing sugar, total sugar	5*9, 6*10, 6*9, 5*11, 4*10, 2*9, 2*10, 5*10, 4*11, 4*9, 2*11, 3*8, 3*9	3*11, 2*8, 1*8, 1*11, 6*8, 1*10, 4*8, 1*9, 3*10
5	Acidity, vitamin C, width of panicle, total soluble solids	Width of fruits, number of fruits, length of panicle, non-reducing sugar, reducing sugar	4*8, 3*8, 6*10, 6*8, 2*10, 1*9, 5*8, 4*9	3*10, 1*10, 2*11, 6*9, 5*11, 5*9, 3*11, 1*11, 4*11, 4*10

Time of application of paclobutrazol: August – 150 days before flower emergence, September – 120 days before flower emergence, October – 90 days before flower emergence, November – 60 days before flower emergence.

Figures

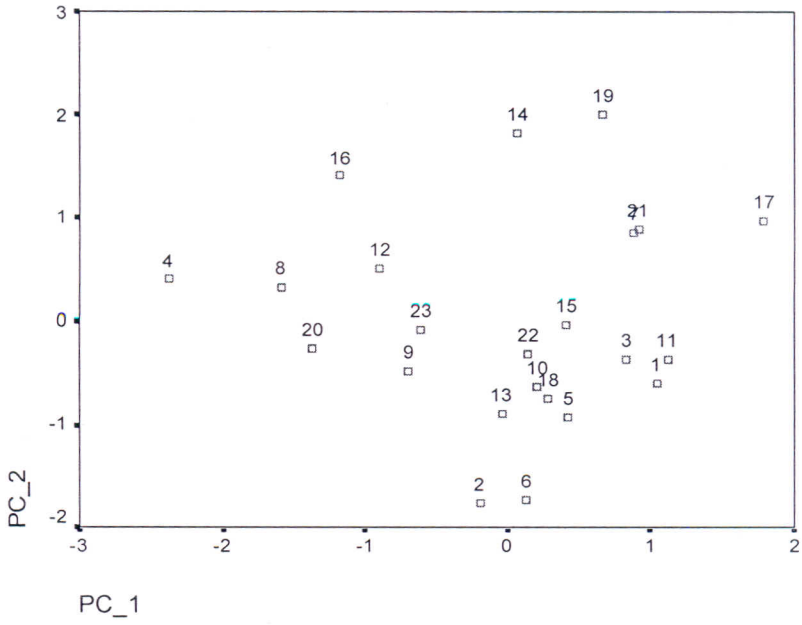

Fig. 1. Scatter diagram of regression factor scores corresponding to first two principal components.

Treatment combination	1	2	3	4	5	6	7	8	9	10	11	12
Dose of PBZ (ml)	1	1	1	1	2	2	2	2	3	3	3	3
Month	Aug	Sept	Oct	Nov	Aug	Sept	Oct	Nov	Aug	Sept	Oct	Nov

Treatment combination	13	14	15	16	17	18	19	20	21	22	23
Dose of PBZ (ml)	4	4	4	4	5	5	5	5	6	6	6
Month	Aug	Sept	Oct	Nov	Aug	Sept	Oct	Nov	Aug	Sept	Oct