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Effect of Plant Growth Regulators on Fruit Quality and Leaf Mineral Composition of Litchi cv. Bombai Grown in New Alluvial Zone of West Bengal

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ABSTRACT

An investigation was carried out to study the effect of plant growth regulators (PGRs) on fruit quality and leaf mineral composition of litchi (*Litchi chinensis* Sonn.) cv. 'Bombai'. The treatments consisted of four sprays (applied between September and December at monthly intervals) of three PGRs: α-naphthaleneacetic acid (NAA), gibberellic acid (GA_3) and kinetin. Treatment with any PGR significantly increased fruit weight, size, the edible: non-edible ratio, the biochemical constitutents of fruit and also the leaf mineral content (N, P and K). Treatment with NAA at 50 mg/L resulted in maximum fruit weight (24.22 g), size (3.8/3.4 cm) and edible ratio (2.25) followed by NAA at 25 mg/L while GA_3 at 100 mg/L recorded maximum TSS (19.8 °Brix), total sugar (14.30%), sugar: acid ratio (23.8) and ascorbic acid (32.25 mg/100 g pulp) content of fruit followed by GA_3 at 50 mg/L. Anthocyanin content of fruit peel was maximum with 50 mg/L NAA, although kinetin had little effect. Leaf mineral (N, P and K) contents were influenced by PGR treatments. Both NAA at 50 mg/L and GA_3 at 100 mg/L are equally effective in improving the fruit quality and leaf mineral composition of litchi.

Keywords: bio-chemical composition, gibberellic acid, kinetin, major nutrients, α-naphthaleneacetic acid

INTRODUCTION

In recent years, litchi (*Litchi chinensis* Sonn.) cultivation has gained popularity due to increasing international trade, nutritional contents of fruit and the demand for different value-added products. In many orchards the yield and quality of fruits are not very good and farmers are not getting a good return. The use of plant growth regulators (PGRs) could improve the quality of fruits (Dutta and Banik 2006; Cronje *et al.* 2009). To assess this, an investigation was carried out to study the effect of PGRs on physico-chemical qualities and leaf mineral content of litchi cv. 'Bombai' grown in a new alluvial zone of West Bengal.

MATERIALS AND METHODS

The experiment was conducted in a farmer's field of Murshidabad district of West Bengal, India during 2002-2005. Litchi plants cv. 'Bombai', 20-years-old, with uniform growth and vigour, were selected for the study. The experiment was conducted in a randomized block design (RBD) considering one plant as a unit. The following seven treatments were conducted in triplicate: T_1 = 50 mg/L GA_3 (gibberellic acid); T_2 = 100 mg/L GA_3; T_3 = 25 mg/L NAA (α-naphthaleneacetic acid); T_4 = 50 mg/L NAA; T_5 = 25 mg/L kinetin (KIN), T_6 = 50 mg/L KIN, T_7 = control (water only i.e. no PGRs). All PGRs were purchased from Sigma-Aldrich (St. Louis, USA).

Each PGR was sprayed four times between September and December (the season for flower bud differentiation) at monthly intervals in the morning between 7.00 and 9.00 am by thoroughly wetting both surfaces of plants' leaves. Data on fruit weight, and size were recorded at maturity (determined by change of peel colour i.e., deep red, flatness of tubercles and smoothness of the epicarp). Biochemical constituents (total soluble solids (TSS), total sugar, acidity, ascorbic acid, anthocyanin) were estimated following the methods as described by Ranganna (2000). TSS was estimated by a hand refractometer and expressed in °Brix. Total sugar was estimated by the Lane and Eynon method. In this method, invert sugar reduces the copper in Fehling's solution to red insoluble cuprous oxide. The sugar content was estimated by determining the volume of the unknown sugar solution required to completely reduce a measured volume of Fehling's solution. For estimating acidity, an aliquot of the sample was titrated with 0.1 or NaOH using a few drops of 1% phenolphthalein solution as indicator. Titre volume was noted and the result was calculated as the per cent anhydrous citric acid or other acids. The ascorbic acid content of fruit was estimated based on the reduction of 2,6-dichlorophenol indophenol by ascorbic acid and based on the reaction of dehydroascorbic acid with 2,4-dinitro phyenylhydrazine. The method was a 2, 6-dichlorophenol indophenol visual titration method. Estimation of total anthocyanin involved the extraction of anthocyanins with ethanolic HCl (85: 15) and measurement of colour at 535 nm for maximum absorption. The amount was calculated using a formula. Leaf mineral composition was estimated in 3-month-old leaves from the 3^{rd} and 4^{th} leaves of the shoot counting from the apex by the methods described by Linder (1944) for N, and Richards (1968) for P and K. In the latter method P reacts with molybdic acid to form a phosphomolybdate complex. It is then reduces with aminonaphthol sulphonic acid to the complex molybdum blue which was measured colorimetrically. Potassium was estimated by Flam's photometric method. In this method, an aliquot of this potassium solution was diluted and HCl was added so that the concentration of acid was the same as that in the standard solution. Diluted extract was atomized in a calibrated flame photometer with the wavelength dial set as 768 nm and the transmittance set at 100% for the top standard solution of K. From the standard curve, the concentration was noted. K was calculated from a formula.

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Short Communication

Table 1 Effect of plant growth regulators on fruit quality of litchi cv. Bombai.

Treatment	Fruit weight (g)	Fruit size (cm) (length/ diameter)	Edible/ non-edible ratio	TSS (°Brix)	Total sugar (% of fresh wt.)	Acidity (% of citric acid)
1. GA_3 50 ppm	21.22	3.2/3.0	1.95	19.0	14.0	0.62
2. GA_3 100 ppm	22.18	3.3/3.2	1.90	19.8	14.3	0.60
3. NAA 25 ppm	22.92	3.5/3.1	2.10	18.8	13.7	0.61
4. NAA 50 ppm	24.22	3.8/3.4	2.25	18.0	14.0	0.62
5. Kinetin 25 ppm	20.42	3.4/3.0	1.92	18.6	13.4	0.61
6. Kinetin 50 ppm	20.14	3.3/3.0	1.90	18.2	13.2	0.60
7. Control	20.12	3.0/2.9	1.79	17.8	12.7	0.62
SEm ±	0.91	0.03/0.07	-	0.12	0.17	NS
C.D. at 5%	3.51	0.17/0.18	-	0.43	0.54	NS

RESULTS AND DISCUSSION

Physical characteristics

Different PGR treatments significantly increased the individual fruit weight and size (length and diameter) (**Table 1**). Treatment with 50 mg/L NAA resulted in maximum (24.22 g) fruit weight followed by 25 mg/L NAA; the control was 20.12 g. 50 mg/L NAA resulted in largest litchis. PGRs might increase the size of litchis due to cell elongation or an increase in the number of cells or cell volume (Leopold 1958; Biswas *et al.* 1988; Singh and Singh 1995). The edible: non-edible ratio was also higher at 50 mg/L NAA. A similar result was also observed by Li *et al.* (2004) who suggested that an increase in litchi fruit size following the application of NAA is related to the capacity of fruit to accumulate assimilates.

Bio-chemical characters

The application of different PGRs significantly increased the TSS, total sugar, sugar: acid ratio, ascorbic acid and anthocyanin content of fruit (**Tables 1, 2**). Fruits treated with 100 mg/L GA_3 showed maximum TSS (19.8 °Brix), total sugar (14.3%), sugar: acid ratio (23.8), and ascorbic acid (32.25 mg/100 g pulp) followed by GA_3 and KIN (50 and 25 mg/L, respectively); the control resulted in the lowest value of these characters. Fruit acidity showed no significant difference between treatments. Minimum acidity was measured with 100 mg/L GA_3 or with 50 mg/L KIN. Anthocyanin content of fruit was also influenced by the application of PGRs: Maximum (25.24 mg/100 g peel) was observed in fruits treated with 50 mg/L NAA; minimum values were observed in the control. The increase in content of TSS and total sugars might be due to the quick transformation of starch into soluble solids and rapid mobilization of photosynthetic metabolites and minerals from other parts of the plant to developing fruits (Singha 2004). The increase in ascorbic acid content following the application of different PGRs may be due to their catalytic influence on the bio-synthesis of ascorbic acid, or through inhibition of the activities of oxidative enzymes such as oxidases and dehydrogenase (Singha 2004). Such beneficial effects of PGRs on fruit quality were also reported by Dutta and Banik (2006) in guava and Das and Das (2001) and Sharma *et al.* (2005) in litchi.

Leaf mineral composition

Leaf mineral composition was also influenced by the application of PGRs (**Table 3**). Maximum (1.92%) N content was measured with 100 mg/L GA_3 in fruits while maximum P (0.37%) and K (0.92%) were noted in 50 mg/L NAA followed by 25 mg/L NAA; the control recorded the lowest values. An increase in leaf mineral content might be due to active transport of nutrients from soil mediated by PGRs (Dutta and Banik 2006).

Table 2 Effect of plant growth regulators on sugar: acid ratio, ascorbic acid and anthocyanin content of litchi fruit.

Treatment	Sugar: acid ratio	Ascorbic acid (mg 100 g^{-1} pulp)	Anthocyanin (mg/100 g^{-1} peel)
1. GA_3 50 ppm	22.5	30.12	20.22
2. GA_3 100 ppm	23.8	32.25	20.27
3. NAA 25 ppm	22.4	29.10	22.14
4. NAA 50 ppm	22.5	30.11	25.24
5. Kinetin 25 ppm	21.9	28.92	20.72
6. Kinetin 50 ppm	22.0	24.11	20.92
7. Control	20.4	23.14	20.12
SEm ±	-	1.39	0.90
C.D. at 5%	-	4.81	3.12

Table 3 Effect of growth regulators on leaf mineral content of litchi cv. Bombai.

Treatment	N (% dry wt.)	P (% dry wt.)	K (% dry wt.)
1. GA_3 50 ppm	1.80	0.23	0.79
2. GA_3 100 ppm	1.92	0.24	0.82
3. NAA 25 ppm	1.83	0.32	0.87
4. NAA 50 ppm	1.87	0.37	0.92
5. Kinetin 25 ppm	1.82	0.30	0.84
6. Kinetin 50 ppm	1.81	0.32	0.79
7. Control	1.76	0.27	0.76
SEm ±	0.02	0.11	0.13
C.D. at 5%	0.06	0.33	0.41

CONCLUSION

Litchi plants treated with 50 mg/L NAA or 100 mg/L GA_3 produced good quality fruit having increased leaf N, P and K content.

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