Original Research Article

Effect of Growth Regulator and Anti-oxidant on Fruit Quality of Litchi cv. Bombai Grown in New Alluvial Zone of West Bengal

ABSTRACT

An investigation was carried out at the Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal to evaluate the impact of growth regulators as well as anti-oxidant on the fruit quality and yield of 15 years old litchi plants cv. Bombai.The experiment was set up using a Randomized Block Design (RBD) with 7 treatments [GA_3 (20 ppm), GA_3 (40 ppm), Citric Acid (200 ppm), Citric Acid (400 ppm), NAA (25 ppm), NAA (50 ppm), Control (Water spray)] and 3 replications.The spray solutions of several plant growth regulators and antioxidant were applied immediately after flowering. Results revealed that treatment with growth regulator NAA and antioxidant Citric acid considerably increased the physical and bio-chemical quality of fruits over the Control treatment. Among the different treatments, NAA 50 ppm is considered to be the best treatment considering all the quality parameters, i.e., maximum fruit weight (24.92 g), fruit length (4.82 cm) as well as diameter (3.99 cm),fruit retention at harvest (23.77 panicle^{-1}) and yield (94.82 kg plant^{-1}). This treatment also showed maximum TSS (19.6°Brix), total sugar (14.11%), reducing sugar (11.12%) and TSS: acidity (81.66). Finally, it can be concluded that NAA 50 ppm applied immediately after flowering was found to be the most superior in improving the morphological characters and bio-chemical constituents of fruits that can be selected for further improvement.

Keywords: Growth regulator, anti-oxidant, fruit quality, yield, litchi

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.*)*, known as 'Queen of fruit crops' belongs to the Sapindaceae family (Trong *et al*., 2021; Lal *et al*., 2020). It is originated in Southern China and is an evergreen subtropical fruit tree popular owing to its excellent taste, pleasant aroma and juicy sweet aril. It is a rich source of Vitamin B1, riboflavin, protein, fats, carbohydrate, calcium, minerals, iron, phosphorus, Vitamin-C and can be eaten fresh frozen or canned (Singh *et al*., 2016; Wall, 2016). Litchi also contains some phenolic compounds and antioxidants but their concentration may be decreased on harvesting (Taylor,1993). It was introduced in India through Burma and later spread to different countries (Ghosh, 2000). India is the 2nd largest producer of

litchi after China (Sahni *et al*., 2020). Litchi is commercially cultivated in Bihar, West Bengal, Jharkhand, Uttar Pradesh and is also growing well in Punjab, Himachal Pradesh, Assam, Jammu and Kashmir Tripura, Karnataka and Tamil Nadu (Pandey and Sharma, 1989). Bombai is a very important cultivar of litchi and a commercial variety of West Bengal bearing obliquely heart shaped fruit and matures during the 2nd week of May. It is popular due to its attractive carmine red color and mainly grown for table purpose.

Flower and fruit drop is a major concern in litchi and it occurs due to failure of fertilization, nutritional and hormonal imbalance (mainly auxin) and external biotic (fruit borer and heavy mite attack) and abiotic factors (wind, humidity and temperature). The initial fruit set of litchi is very high but only 2-18% reach to the final maturity (Singh *et al*., 2016) as fruit drop is common due to the deficiency of auxin, gibberellin and cytokinin along with high level of growth inhibitors like abscisic acid and ethylene. The major cause for low productivity is improper nutrient management that causes biennial bearing and poor fruit retention during the hot and dry weather (Menzel and Simpson, 1990). Growth regulators like NAA, GA_3 significantly reduced the fruit drop in litchi; fruit color and quality of litchi is markedly improved by the application of NAA and GA_3 (Khan *et al*., 1976). It was found that GA_3 also enhanced the yield and various quality parameters like total soluble solids, reducing sugar, total sugar and ascorbic acid in fruits like litchi (Devaraja *et al*., 2019) as well as mango (Oosthuyse, 1993). Application of GA_3 also found to increase the fruit size in litchi (Manoj *et al*., 2009). Organic acids as antioxidants (such as citric acid) play a growth and important role in plant metabolism (Mansour *et al*., 2008). Citric acid has an auxinic action and positive effect on flowering and fruiting and it is used instead of synthetic auxins for enhancing growth and fruiting of fruit trees (Maksoud *et al*., 2009). The effect of growth regulators on other fruits has been established from several research works done in the past but scanty information found on the effect of antioxidants on litchi. Keeping this in view the present experiment was undertaken to evaluate the effect of growth regulators and antioxidants on fruit quality and yield of litchi cv. Bombai.

MATERIALS AND METHODS

2.1. Details of the experimental site and treatment specifications

The experiment was carried out at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal (22.56°N, 88.32°E) during 2021-22. The soil of the experimental site has a pH value 6.6 and is sandy loam in nature with good drainage and water holding capacity having 0.69% Organic carbon. The

region has a subtropical climate with minimum and maximum temperatures ranging from 17° to 32°C and an average rainfall of 1200-1400 mm. The experiment was conducted on litchi plants cv. Bombai which were 15 years old and vegetatively propagated planted at a spacing of 10 m × 10 m. Seven treatments were used in the trial, which included three replications and was set up using a Randomized Block Design (RBD).

GA_3 and citric acid spray solutions were prepared by dissolving directly in the water; NAA solution was prepared by dissolving in alcohol (ethanol). The spray solution of different plant growth regulators and antioxidant were applied on the trees with the help of foot sprayer to wet the developing fruits and foliage completely without causing runoff immediately after flowering and the treatments comprised of T_1: GA_3 (20 ppm), T_2:GA_3 (40 ppm), T_3: Citric Acid (200 ppm), T_4: Citric Acid (400 ppm), T_5: NAA (25 ppm), T_6: NAA (50 ppm) and T_7: Control (Water spray).

2.2. Observations recorded and statistical analysis

Ten fruiting branches of equal length were selected and marked in every possible direction and the number of flowers and fruits were counted. The data on yield of fruits (kg plant^{-1}) was recorded at the time of harvest by weighing the total fruits on top pan balance. The fruit weight (g fruit^{-1}) was recorded by weighing the selected fruits on top pan balance. Fruit length, as well as diameter (cm), was measured using Vernier calipers. Total soluble solids (°Brix) were measured using a Hand Refractometer (0-32°B). Other bio-chemical parameters like total sugar (%), titratable acidity (%) and reducing sugar (%) were estimated by the technique described in A.O.A.C. (2000). According to Panse and Sukhatme (1985), the obtained data was statistically analyzed using the analysis of variance method and the significance of various causes of variation was assessed using the Error Mean Sum of Squares by Fischer “F” test of probability level of 0.05%.

RESULTS AND DISCUSSION

The treatments with different growth regulators and antioxidant significantly enhanced the physical and bio-chemical parameters of litchi fruit as compared to the control treatment. Data presented in Table 1 revealed that different treatment of growth regulators and antioxidant significantly increased fruit weight (g) and among the different treatments, NAA 50 ppm (T_6) showed maximum fruit weight (24.92 g) followed by NAA 25 ppm (24.77 g) while GA_3 20 ppm recorded minimum value (22.14 g). Like fruit weight, fruit length and diameter also increased by different treatment of growth regulators and antioxidant. Maximum fruit length (4.82 cm) was obtained with treatment NAA 50 ppm and minimum (4.32 cm) was recorded with GA_3

20 ppm. Maximum fruit diameter (3.99 cm) was obtained from plants treated with NAA 50 ppm and minimum (3.67 cm) was recorded from Control treatment. Data revealed that the fruit yield was also affected using the different treatments of growth regulators and antioxidants and the maximum yield (94.82 kg plant^{-1}) was recorded with NAA 50 ppm (T_6) whereas the minimum (84.22 kg plant^{-1}) was recorded in the Control treatment. Similar results were found by Oosthuyse (1993) in 'Tommy Atkins' mango where it was observed that NAA and GA_3 significantly increased fruit retention and yield. Mansour *et al*. (2008) found that a significant improvement was detected on yield and fruit quality when nutrients and citric acid were applied together. The number of fruits per panicle varied between 18.30 to 23.77 due to different treatments. Maximum (23.77 number panicle^{-1}) fruits at harvest recorded from NAA 50 ppm treated fruits while the Control treatment recorded minimum fruits (18.30). The obtained results of NAA regarding their positive effects on fruit set, fruit retention, number of fruits per tree and yield are in harmony with findings of Chattha *et al*. (1999) where NAA application had high positive effect on reducing fruit drop.The enhancement effect of NAA sprays on fruit set and fruit retention percentage, number of fruits per tree and yield maybe due to Auxin is well known as inhibitors for abscissic acid and ethylene which cause fruit drop. The use of NAA may regulate fruit set in many fruit crops and spraying mango trees with NAA increased fruit set and fruit retention percentage (Oksher*et al*., 1980; Singh and Ram, 1983), Which reflected on increased of number of fruits per tree and yield.

Table 1: Effect of growth regulators and anti-oxidant on physical parameters and yield of litchi cv. Bombai at harvest

Treatment	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit retention at harvest (no. panicle^{-1})	Yield (kg plant^{-1})
T_1	22.14	4.32	3.70	22.11	93.11
T_2	22.32	4.39	3.71	22.41	93.70
T_3	23.12	4.66	3.71	22.71	93.92
T_4	23.17	4.67	3.74	22.84	93.99
T_5	24.77	4.73	3.92	22.91	94.27
T_6	24.92	4.82	3.99	23.77	94.82
T_7	23.77	4.70	3.67	18.30	84.22

S.Em(±)	0.004	0.003	0.008	0.004	0.003
CD(*p*=0.05)	0.012	0.091	0.024	0.012	0.009

Like the physical parameters, bio-chemical constituents were also affected by the application of growth regulators and antioxidant in litchi plants. Maximum TSS content(19.60°Brix) was recorded with NAA 50ppm (T_6) whereas the Control treatment recorded the minimum value. Exogenous application of growth regulators and antioxidant also influenced the total sugar content and the maximum value of total sugar (14.11%) was estimated in the treatment with NAA 50ppm and the minimum was recorded from Controltreatment (13.29%). Acidity did not significantly vary with different treatments. However, NAA 50ppm showed the minimum acidity (0.24%) while maximum (0.40%) was recorded with the Control treated fruits. Data in Table 2 shows that the maximum reducing sugar (11.12%) was obtained from the fruits of the plants treated with NAA 50ppm and the Control treatment recorded the minimum value (10.11%). The maximum TSS: acid (81.66) was recorded from the plant treated with the treatment T_6 whereas control treatment recorded the minimum value (46.00). The outcomes closely match those of Hamdy's (2017) research. According to the research, spraying Washington Navel orange with GA_3 and NAA had a greater impact than the Control treatment on biochemical parameters like TSS as well as total acidity.

Unlike NAA, the antioxidant citric acid also showed significant enhancement in the physical and chemical properties of litchi. Citric acid successfully increased the fruit retention at harvest and yield as compared to the control treatment. Biochemical parameters like TSS, total sugar, reducing sugar and TSS: acid was also improved using citric acid as compared to the control treatment. Citric acid plays a crucial part in plant metabolism, which explains why it has an enhancing effect on fruit set, fruit retention, the quantity of fruits per tree as well as yield. Citric acid's observed effects on fruit set, fruit retention, quantity of fruits per tree and yield are consistent with those of Ahmed and Abdelaal (2007) on Anna apple and Mansour et al. (2008) on Le-Conte pear. They mentioned that citric acid treatment improved fruit set and yield of the aforementioned fruit species.

Table 2: Impact of growth regulators and anti-oxidant on bio-chemical parameters of litchi cv. Bombai at harvest

Treatment	TSS	Total sugar	Reducing	Titratable	TSS:

	(°Brix)	(%)	sugar (%)	acidity (%)	acidity
T_1	18.60	13.82	10.88	0.39	47.69
T_2	18.70	13.87	10.89	0.29	64.48
T_3	18.90	13.91	10.90	0.29	65.17
T_4	19.00	13.92	10.92	0.24	79.16
T_5	19.20	13.94	11.00	0.27	71.11
T_6	19.60	14.11	11.12	0.24	81.66
T_7	18.40	13.29	10.11	0.40	46.00
S.Em(±)	0.002	0.004	0.011	0.008	1.734
CD(*p*=0.05)	0.006	0.012	0.033	0.024	5.202

CONCLUSION

Exogenous application of growth regulators and antioxidants effectively influenced all the physico-chemical properties of litchi cv.Bombai. Citric acid was found to be effective in enhancing the physical as well as biochemical properties of litchi as compared to the control treatment. Among the different treatments under study, NAA 50 ppm (T_6) applied immediately after flowering was found to be the most superior in improving the morphological characters and bio-chemical constituents of fruits that can be selected for further improvement.

Conflict of interests:

The authors have declared no conflict of interests exist.

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