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Effect of plant bio-regulators on quality and yield of litchi (*Litchi Chinensis* Sonn.) Cv. Rose Scented

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Abstract
The experiment was conducted to study the effect of Plant bio-regulators *viz*., Gibberellic Acid (GA_3), Naphthalene Acetic Acid (NAA) and Benzyl Adenine (BA) on fruit drop, cracking, fruit yield and physico-chemical properties of litchi cv. Rose Scented. The plants were sprayed with different concentrations of GA_3 (50, 30 and 10 ppm), BA (50, 30 and 10 ppm), and NAA (50, 30 and 10 ppm), thrice (after fruit set, 15 days after Ist spray and 15 days after IInd spray). Application of three sprays of GA_3 @ 50 ppm was proved to be most effective in minimizing fruit drop and fruit cracking and improving the physico-chemical properties and yield of litchi.

Keywords: litchi quality, bioregulators, NAA, GA_3, Litchi, yield

1. Introduction
Litchi (*Litchi chinensis* Sonn.) is one of the important subtropical fruits of India. It is a member of the family Sapindaceae (or soapberry family) and sub-family Nepheleae, which has about 150 genera and more than 2000 species. India is the second largest producer of litchi in the world after China with an area and production of 86,000 ha and 552,000 tonnes, respectively during 2015-16. In India, Bihar, West Bengal, Jharkhand and Assam accounts for 64.2% of the total litchi production in the country. It is an important evergreen, subtropical fruit tree. Three types of flowers are commonly found in an inflorescence: Male hermaphrodite (functional as female) and pseudo hermaphrodite (Functional as male). Flowers of different sexes are on the panicle, do not open simultaneously Pandey and Sharma [13]. Low pseudo-hermaphrodite flower rate and high nutrient competition between organs are often associated with low yields in litchi BY Chang and Lin [6]. In the past, several workers have reported increase in fruit set and improvement in fruit quality of the litchi with the use of PBRs and micro-nutrients, Sharma *et al.* [15]. Fruit cracking is the major limiting factor for the successful cultivation of litchi, especially in early maturing cultivars. Fruit cracking is the major limiting factor for the successful cultivation of litchi, especially in early maturing cultivars. Inadequate moisture during the early period of fruit growth results in the hardening of skin and later on it laid high inelastic pressure on the fruit skin due to rapid aril growth enforced following irrigation. The cracked fruits are not fit for marketing. Improper balance of Plant bio-regulator (PBR) and short fluctuation in day and night temperature coupled with heavy irrigation after dry spell and temperature higher than 38 ^{0}C and relative humidity less than 60 per cent are favourable for cracking Kanwar and Nijjar [10]. Fruit drop is another problem in litchi cultivation, yet growers have to face a great deal of loss due to fruit drop at different stages of growth and development. Maximum fruit drop occurs during second and third week after fruit set. The disturbance in the endogenous hormonal level is one of the major contributing factors responsible for fruit drop Awasthi *et al.* [2]. Reduction in fruit drop with the application of growth substances was reported by Barua and Mohan [3]. So, keeping above point in view, the experiment was carried out in Litchi cv. Rose Scented with to study the effect of Plant bio-regulators on fruit drop, cracking, chemical quality and yield of litchi fruit.

2. Materials and Methods
The present study "Effect of Plant Bio-regulators (PBRs) on Quality and Yield in litchi (*Litchi chinensis* Sonn.) cv. Rose Scented" was conducted at Horticulture Research Centere, Patharchatta, Department of Horticulture, G.B. Pant University of Agriculture and

Technology, Pantnagar, U.S. Nagar, Uttarakhand. Seventeen years old litchi plants of uniform vigour and size were selected. The experiment was laid out in Randomized Block Design (RBD) and consisted of ten treatments, with three replications. The plants were sprayed with different concentrations of GA_3 (50, 30 and 10 ppm), BA (50, 30 and 10 ppm), and NAA (50, 30 and 10 ppm), thrice (after fruit set, 15 days after I^{st} spray and 15 days after II^{nd} spray). The stock solutions of different plant bio-regulators were prepared by dissolving them in few drops of appropriate solvents (1 N NaOH) and final volume of each dissolved plant bioregulators was made by adding distilled water gently to avoid precipitation. The stock solution thus prepared were stored in glass bottles and kept in refrigerator at $4\text{-}5^0$ temperature. Final volume was made with the addition of tube well water. The pH of all spray solutions was adjusted to 7 by N/10 NaOH and N/10 HCl. The data were analyzed according to the procedure of analysis for Randomized Block Design. The significance of variation among the treatments were observed by applying 'F' test and critical difference (CD) and 5% level was calculated to compare the mean values of the treatments for all the characters.

3. Results and Discussion

In litchi, more flowers were produced but only few developed into fruits (primarily due to premature flower abscission). In present investigation, Table 1 showed that fruit set varied significantly over control. All the treatments showed significantly higher fruit set than control. It was ranged from 52.20 per cent (minimum) in control to 65.08 per cent (maximum) in GA_3 (50 ppm). An investigation conducted by Dixit *et al.* [7]. in litchi orchard to assess the effect of micronutrients and growth regulators on fruiting in Litchi cv. Ambika Litchi-1 and found that treatment of GA_3 was effective to increase fruit set. The data regarding to fruit retention at the time of harvesting showed that maximum fruit retention (61.95 % and 61.20 %) was observed in GA_3 50 ppm and NAA 50 ppm respectively which were statistically at par with each other. Minimum fruit retention (33.09 %) was found in control and all the treatments were statistically significant over control. Dixit *et al.* [7] reported that GA_3 10 ppm was found effective treatment to increase fruit retention in litchi fruits. Singh and Bal [16] conducted an investigation on nineteen years old trees of ber cultivar Umran growing at Ladhowal Farm of Punjab Agriculture University, Ludhiana and concluded that spray of 20 ppm NAA at fruit set stage give maximum fruit retention. The data pertaining to the influence of different concentrations of PBRs significant effect the fruit length. Maximum fruit length 3.66 cm, 3.57 cm, 3.54 cm and 3.53 cm was recorded in T_5, T_8, T_6 and T_3 respectively. Minimum fruit length 3.29 cm was observed in control. The data on average weight showed significant variations. Fruits of T_1 (control) showed minimum fruit weight of 19.44 g. Whereas, maximum fruit weights of 25.14 g in T_5 followed by 22.29 gm in T_8. The foliar spray of various concentrations of PBRs had pronounced effect on fruit cracking. At the time of crop maturity fruit cracking is a serious problem in litchi due to hot winds. Kanwar and Nijjar [10] reported that diametrical fruit growth has direct influence on fruit cracking. The slow increase in the early stages, followed by a rapid increase might be associated with cell division in early stages and cell elongation in later stages. Comparatively low endogenous level of auxin in the initial stages may be another factor for this depressed growth. Mishra *et al.* [12] also reported reduced fruit cracking with GA_3 at 20 and 40 ppm litchi cv. Rose Scented. Dixit *et al.* [7] observed that GA_3 reduced fruit cracking in litchi.

Table 1: Effect of Plant Bio-regulators on physico-chemical quality of Litchi

Treatments	Fruit Set (%)	Fruit Retention (%)	Fruit length (cm)	Fruit weight (g)	Fruit Cracking (%)	TSS (ºBrix)	Ascorbic Acid(mg/100 g)
T_1 (control)	52.203	33.093	3.287	19.440	18.203	16.523	23.923
T_2 (BA 50 ppm)	62.300	50.793	3.323	21.580	15.310	19.187	25.917
T_3 (BA 30 ppm)	59.820	46.153	3.533	22.027	15.090	19.527	26.783
T_4 (BA 10 ppm)	60.400	46.573	3.477	21.443	15.400	18.827	25.977
T_5 (NAA 50ppm)	62.493	61.200	3.667	25.147	14.477	20.317	25.560
T_6 (NAA 30 ppm)	62.103	57.663	3.540	22.030	14.120	18.963	26.230
T_7 (NAA 10 ppm)	59.890	57.597	3.520	21.617	14.997	18.483	25.793
T_8 (GA_3 50 ppm)	65.087	61.950	3.573	22.297	11.033	19.883	31.233
T_9 (GA_3 30 ppm)	60.200	58.103	3.357	21.743	14.243	22.450	29.463
T_{10} (GA_3 10 ppm)	61.127	56.897	3.443	21.977	14.137	20.693	26.343
C.D. at 5%	3.101	3.183	0.136	1.404	2.636	1.696	1.449
SE(m)	1.036	1.063	0.045	0.469	0.880	0.567	0.484

The data on average weight showed significant variations. Fruits of T_1 showed minimum fruit weight of 19.44 g. Whereas, maximum fruit weights of 25.14 g in T_5 followed by 22.29 gm in T_8. The foliar spray of various concentrations of PBRs had pronounced effect on fruit cracking. At the time of crop maturity fruit cracking is a serious problem in litchi due to hot winds. Kanwar and Nijjar [10] reported that diametrical fruit growth has direct influence on fruit cracking. The slow increase in the early stages, followed by a rapid increase might be associated with cell division in early stages and cell elongation in later stages. Comparatively low endogenous level of auxin in the initial stages may be another factor for this depressed growth. Mishra *et al.* [12] also reported reduced fruit cracking with GA_3 at 20 and 40 ppm litchi cv. Rose Scented. Dixit *et al.* (2013) observed that GA_3 reduced fruit cracking in litchi. Mishra *et al.* [11] also reported that GA_3 and BA reduced the fruit cracking in litchi. Rani and Brahmachari [5] reported that foliar application of 50 and 100 ppm GA_3 reduced fruit cracking over control in litchi cv. China. Data regarding TSS revealed that although all the treatments improved the TSS in comparison to control. High TSS was found in GA_3 @ 30 ppm (22.45 ºBrix). Mishra *et al.* [11] reported improvement in TSS with the application of GA_3 in form of spray in litchi. Mishra *et al.* [12] also reported improved ascorbic acid with GA_3 at 20 and 40 ppm in litchi cv. Rose Scented.

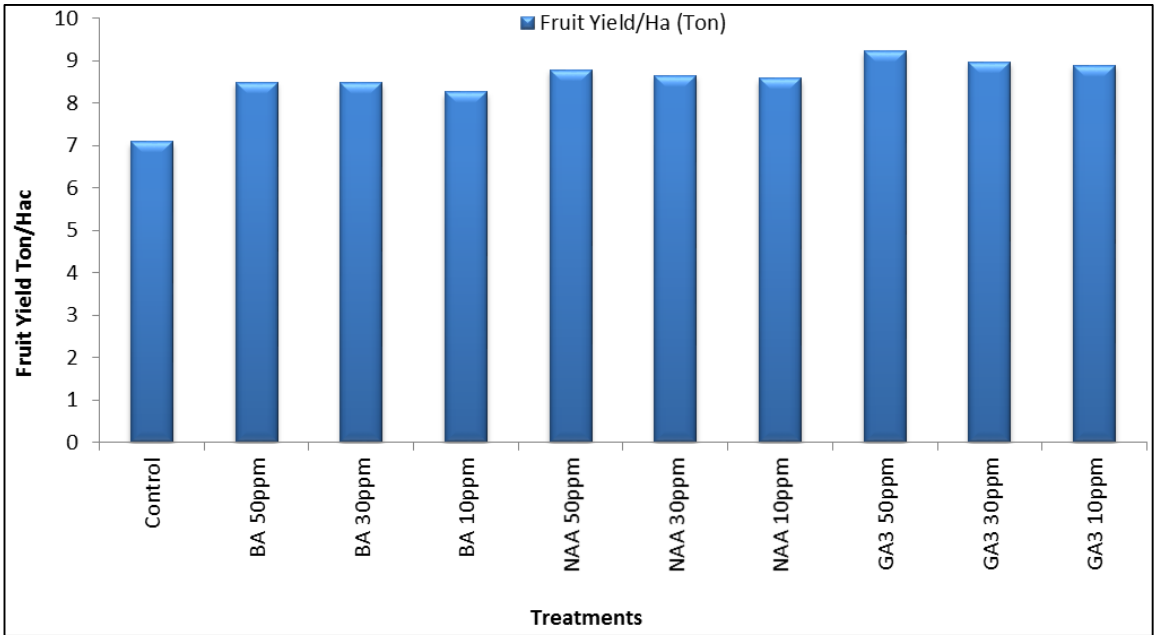

Fig 1: Effect of Plant Bio-regulators on fruit Yield

Highest fruit yield 9.2 ton per hectare and 8.9 ton per ha were recorded with the application of GA_3 @ 50 ppm and GA_3 @ 30 ppm respectively with the least in control 7.09 ton per ha. In the present study the plant growth regulators used may favour the yield promoting factors such as higher fruit set, higher fruit retention and higher fruit size which may promote the increase in yield. One of the other possible reasons for increased yield may be due to de novo biosynthesis of auxin and other growth regulating or promoting chemicals at initial stage due to additional stimulus produced by external application of PBRs. Hizazi *et al*. [9] also observed that 50 and 200 ppm GA_3 sprayed after 30 days of fruit set or 60 days of fruit set resulted in increase in fruit number and yield in pear. Sakhyuni *et al*. [14] observed that application of 50-100 ppm GA_3 increased the yield of pear. Same results were also observed by El-Hammady *et al*. [8] reported highest yield in Balady mandarin with the spray of 100 ppm @ GA_3.

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