



Influence of GA₃ and ZnSO₄ on Fruiting, Yield and Quality Parameters of Litchi (*Litchi chinensis* S.) cv. Dehradun

Viveka Nand^{a++*}, A. K. Dwivedi^{a#} and V. K. Tripathi^{bt}

^a Department of Fruit Science, C. S. Azad University of Agriculture and Technology, Kanpur, India.

^b Department of Horticulture and Fruit Science, C. S. Azad University of Agriculture and Technology, Kanpur, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was carried out at Horticulture Garden, Department of Fruit Science, C. S. Azad University of Agriculture and Technology, Kanpur (U.P.) during two consecutive years 2020 and 2021. Factorial Completely Randomized Design was used with three replications with sixteen treatments viz., four levels each of GA (0, 30, 60 and 90 ppm) and zinc (0, 0.3, 0.5 and 0.7%) and their combination, spraying of these were done twice i.e., before flowering (07 Feb.) and at pea stage (05 April) during both the years. This study for to assess the impact of GA and Zn to better flowering, decrease fruit cracking, better yield with qualitative fruits of litchi cv. Dehradun. From the results it is reported that the treatment of GA 60 ppm and Zinc 0.7 % improved fruit quality like; fruit count prior to foliar spray at pea stage (40.53 and 40.96), fruit count at pit hardening stage (28.79 and 30.36), fruit count at maturity stage (25.36 and 26.21), fruit count at ripening stage (22.23 and

⁺⁺ Research Scholar;

[#] Assistant Professor;

[†] Professor and Head;

*Corresponding author: E-mail: vivekcsjm9@gmail.com;

23.06), yield of marketable fruit (72.62 and 74.74 kg/plant) and also increase nutritional qualities of fruit such as total soluble solids (21.47 and 22.60^oBrix), total sugars (14.31 and 14.34%), juice content (61.86 and 61.91 %), sugar acid ratio (28.89 and 29.91%), ascorbic acid (40.83 and 42.03mg) per 100g fruit pulp, organoleptic test (84.15 and 85.09) and reduction in number of cracked fruits at harvesting (2.45 and 2.11) with reduced titratable acidity (0.431 and 0.427%). It was concluded that the application of GA and Zinc resulted in to significant improvement in yield and quality of litchi with maximum fruit set and retention as well as yield attributing characters such weight of fruit which ultimately increased the yield per plant and thereby per hectare in both GA 60ppm and Zinc at 0.7% in litchi cv. Dehradun in the plains of northern India.

Keywords: Litchi; GA; zinc; fruiting; yield and quality.

1. INTRODUCTION

The litchi (*Litchi chinensis* Sonn.) a most important sub-tropical ever green fruit tree belongs to the family Sapindaceae. Botanically it is a nut fruit which is commercially grown in Bihar, West Bengal, Assam, Orissa, Punjab, Tripura, Uttarakhand and to a limited scale in Himachal Pradesh.

Litchi fruits are delicious and luscious having attractive red colour, good taste and sweet aroma. It is an arillate fruit with sweet white, translucent, juicy flesh and one large seed. The flavour of the fresh pulp is musky. When dried, it is acidic and very sweet. It is a rich source of sugars, vitamins and minerals like Magnesium, Iron, Calcium, Copper, Phosphorous and Potassium. It is processed into juice, wine, pickles, jam, jelly, ice cream and yoghurt.

Over the years plant growth regulators (PGRs) and micronutrient have been consistently used to augment maximum and sustained economic benefits in litchi production through altering the behavior of fruit or fruit plants. Yield and quality of litchi fruit have been positively influenced by both micronutrients and plant growth regulators. Application of PGRs results in increased flowering, fruiting and retention of fruit.

Micronutrients applied in optimum concentrations results in better plant growth which leads to higher yield, better flowering and higher fruit set. Plants require a substantial amount of the total requirement of certain micronutrients to be fed through foliar application which results in improved fruit quality. Metabolic activities of plants greatly depend on zinc. Zinc primarily functions as a metal activator of enzymes like dehydrogenase (Pyridine nucleotide, glucose-6 phosphodiesterase, carbonic anhydrase etc.).

2. MATERIALS AND METHODS

The trees were about 30 years old but properly maintained of litchi located at Horticulture Garden, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture & Technology Kanpur was selected for the present investigations during 2020 and 2021. During the course of the investigation the whole of the orchard was kept under clean and uniform cultivation. Sixteen uniform plants of litchi 'cultivar Dehradun' were selected for the experimentation. Factorial Completely Randomized Design was used with three replications and sixteen treatments viz., four levels each of GA (0, 30, 60 and 90 ppm) and zinc (0, 0.3, 0.5 and 0.7%) and their combination spraying of these were done twice i.e., before flowering (07 February) and at pea stage (05 April) during both the years. Three branches in uniform growth and vigor were selected on each tree.

Observations were recorded on various fruiting, yield and quality parameters. The total soluble solids (T.S.S.) of fruits was recorded with the assistance of an Erma hand refractometer. The total sugar (%) contents were determined by the techniques as recommended by AOAC (1980).

3. RESULTS AND DISCUSSION

3.1 Fruit Count Prior to Foliar Spray at Pea Stage

Connective impact of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (42.16 and 42.56) fruit count prior to foliar spray at pea stage closely followed by treatment G_3Z_2 (41.62 and 41.33). The maximum (32.15 and 33.18) fruit count prior to foliar spray at pea stage was presented with control (G_0Z_0) during both the years of experiments. The chemical significantly

increased the fruit set as compared to control however, the highest fruit set was obtained with the application of zinc sulphate and GA. It has been early reported that fruit set in pear can be promoted with application of plant bio-regulators like GA₃ [1] in litchi, Kumar et al. [2] in mango and Pandey et al. [3] in ber).

3.2 Fruit Count at Pit Hardening Stage

Interactive influence of GA and Zinc was found to be non-significant treatment of G₃Z₃ induced significantly maximum (29.96 and 31.15) fruit count at pit hardening closely followed by treatment G₃Z₂ (29.16 and 30.89). The maximum (24.16 and 25.14) fruit count at pit hardening was presented with control (G₀Z₀) during both the years of experiments. The chemical significantly increased the fruit set as compared to control however, the highest fruit set was obtained with the application of 0.2 per cent zinc sulphate + 90 ppm It has been early reported that fruit set in pear can be promoted with application of plant bio-regulators like GA₃. These results are also in conformity with the findings of Sinha et al. [1] in litchi, Sharma et al. [4] and Pandey et al. [3] in ber.

3.3 Fruit Count at Maturity Stage

Correlative consequence of GA and Zinc was found to be non-significant treatment of G₃Z₃ induced significantly maximum (26.16 and 27.13) fruit count at maturity stage closely followed by treatment G₃Z₂ (25.95 and 26.65). The minimum (18.14 and 19.16) fruit count at maturity stage was presented with control (G₀Z₀) during both the years of experiments. Zinc response was more positive which play an important role in translocation of carbohydrates, auxin synthesis and increased pollen viability and fertilization. Minimum fruit setting and fruit retention were recorded under control. Similar results were also observed in litchi. These results are in accordance to the finding of Sinha et al. [1] in litchi and Pandey et al. [3] in ber.

3.4 Fruit Count at Ripening Stage

Interactive effect of GA and Zinc was found to be significant. Combined treatment of G₃Z₃ induced non-significantly maximum (23.18 and 24.11) fruit count at ripening stage closely followed by treatment G₃Z₂ (22.95 and 23.67). The minimum (17.14 and 18.13) fruit count at ripening stage was presented with control (G₀Z₀) during both the years of experiments. This increase in fruit set

with borax and zinc application might be due to its effect on the process of fertilization and hormonal (GA₃) metabolism, which proved helpful in maintaining the better nutritional status of the tree and ultimately proved beneficial in improving the fruit set. These results are in accordance to the finding of Sinha et al. [1] in litchi and Pandey et al. [3] in ber.

3.5 Number of Cracked Fruits at Harvesting

Collective impact of GA and Zinc was found to be non-significant in first year and significant in second year of treatment of G₃Z₃ induced significantly minimum (2.11 and 1.90) number of cracked fruits at harvesting closely followed by treatment G₃Z₂ (2.44 and 2.06). The maximum (4.90 and 4.46) Number of cracked fruits at harvesting was presented with control (G₀Z₀) during both the years of experiments. The spraying of borax was found more effective than GA₃ and ZnSO₄. It is well known that borax and zinc spray regulate auxin in the plants which might have increased the synthesis of tryptophan and indirectly also regulated water relations in plants reported that zinc in combination with gibberellin affect the activity of cellulase, thereby maintain cell wall rigidity reduced the fruit cracking. These results are in accordance with the reports of Megu et al. [5] and Gupta et al. [6] in litchi.

3.6 Yield of Marketable Fruits (kg/plant)

Interactive influence of GA and Zinc was found to be non-significant treatment of G₃Z₃ induced significantly maximum (75.80 and 77.95 kg/plant) yield of marketable fruits closely followed by treatment G₃Z₂ (73.01 and 75.81kg/plant). The minimum (45.95 and 46.80kg/plant) yield of marketable fruits was presented with control (G₀Z₀) during both the years of experiments. Increasing yield due to GA or zinc sprays may be attributed to their effects on increasing levels of IAA more than increasing fruit set. Rapid fruit development and the greater mobilization of food materials from the site of production to storage organs under the influence of zinc and GA. These results are in accordance with the reports of Megu et al. [5] in litchi, Singh et al. [7] in mango and Tripathi and Shukla [8] in strawberry.

3.7 Total Soluble Solid Content (°Brix)

Relative to different GA and Zinc concentrations on initial TSS are an expression the plants which

was influenced by GA and Zinc growth regulators over control. The associated consequence of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (21.83 and 22.96 °B) TSS closely followed by treatment G_3Z_2 (21.49 and 22.62 °B). The maximum (18.13 and 19.16 °B) TSS was presented with control (G_0Z_0) during both the years of experiments. The reason for increase in total soluble solids content of fruit may be due to fact that nutrients and plant growth regulators played important role on photosynthesis which ultimately led to the accumulation of carbohydrates and attributed to increase in T.S.S. of fruit. These results are in similar with the finding of $ZnSO_4$ and GA_3 may be attributed to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to developing fruits.

These results are in accordance with the reports of Shukla et al. [9], Tiwari et al. [10] in aonla and Gupta et al. [6] in litchi.

3.8 Total Sugar Content (%)

In respect to different GA and Zinc concentrations on initial total sugar are an expression the plants which was influenced by GA and Zinc growth regulators over control. Joint effect of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (14.50 and 14.55%) total sugar closely followed by treatment G_3Z_2 (14.43 and 14.45%). The maximum (12.10 and 12.13%) total sugar was presented with control (G_0Z_0) during both the years of experiments. Decrease in acidity with foliar application of $ZnSO_4$ and GA_3 might be due to increase in translocation of carbohydrate and increase metabolic conversion from acidity to sugars. These findings are in accordance with the reports of Shukla et al. [9], Tiwari et al. [10] in aonla, Kaur [11], Devaraja et al. [12] in litchi.

3.9 Juice Content (%)

In relation to different GA and Zinc concentrations on initial juice are an expression the plants which was influenced by GA and Zinc growth regulators over control. Interactive effect of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (63.18 and 63.24%) juice closely followed by treatment G_3Z_2 (62.48 and 62.56%). The maximum (53.16 and 54.18%) juice content were

presented with control (G_0Z_0) during both the years of experiments. This increase may be ascribed to enhance synthesis of metabolites, increased absorption of water and mobilization of sugars and minerals in the expanded cells and intercellular space of mesocarp. These enhancements of above physiological activities are accelerated possibly due to growth promoter as well as nutrients also. Improvement in juice content with the use of GA_3 and $ZnSO_4$ has been observed. These results are in accordance with the reports of Priyadarshi and Hota [13] in litchi.

3.10 Titratable Acidity (%)

Regarding different GA and Zinc concentrations on titratable acidity at harvesting are an expression the plants which was influenced by GA and Zinc growth regulators over control. United impact of GA and Zinc was found to be significant in first year and non-significant in second year of treatment G_3Z_3 induced significantly minimum (0.41 and 0.40%) acidity at harvesting closely followed by treatment G_2Z_3 (0.42 and 0.42%). The maximum (0.63 and 0.63%) acidity at harvesting was presented with control (G_0Z_0) during both the years of experiments. These findings are in accordance with the reports of Megu et al. [5] and Kaur [11] in litchi. This means that the presence of GA at the high concentration with zinc sprays tended to decrease juice acidity. This is may be due to the effect of GA on delaying maturity.

3.11 Sugar Acid Ratio (%)

With regards to different GA and Zinc concentrations on initial sugar acid ratio are an expression the plants which was influenced by GA and Zinc growth regulators over control. Interactive influence of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (30.16 and 31.65%) sugar acid ratio closely followed by treatment G_3Z_2 (29.33 and 30.13%). The maximum (19.65 and 20.13%) sugar acid ratio were presented with control (G_0Z_0) during both the years of experiments. These findings are in accordance with the reports of Kaur [11], Megu et al. [5] in litchi and Singh et al, (2017) in mango. Decrease in acidity with foliar application of $ZnSO_4$ and GA_3 might be due to increase in translocation of carbohydrate and increase metabolic conversion from acidity to sugars.

Table1. Effect of foliar application of GA, zinc and their interaction on fruit count pea stage, fruit count pit hardening stage, fruit count maturity in litchi

Parameter	Doses GA ppm (B)	Zinc % (A)									
		2020					2021				
		A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A	A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A
Fruit count at pea stage	B ₀ Control	32.15	32.62	33.28	33.76	32.95	33.18	33.76	34.72	34.86	34.13
	B ₁ 10	34.18	34.56	35.18	35.86	34.94	35.22	35.63	36.17	36.67	35.92
	B ₂ 20	36.13	36.74	37.14	37.46	36.86	37.26	37.69	38.40	38.88	38.05
	B ₃ 30	38.36	39.98	41.62	42.16	40.53	39.34	40.63	41.33	42.56	40.96
	Mean A	35.20	35.97	36.80	37.31		36.25	36.92	37.65	38.24	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.293	0.293	0.585			0.263	0.263	0.527		
C.D. at 5%	0.847	0.847	NS			0.762	0.762	NS			
SE (d) ±	0.414	0.414	0.828			0.372	0.372	0.745			
Fruit count at pit hardening stage	B ₀ Control	24.16	24.16	24.53	24.86	24.42	25.14	25.59	25.93	26.14	25.70
	B ₁ 10	25.18	25.43	25.65	26.13	25.59	26.37	26.67	27.18	27.46	26.92
	B ₂ 20	26.56	26.86	27.15	27.55	27.03	27.90	28.15	28.54	28.74	28.33
	B ₃ 30	27.92	28.15	29.16	29.96	28.79	29.14	30.28	30.89	31.15	30.36
	Mean A	25.70	26.15	26.62	27.12		27.13	27.67	28.13	28.37	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.176	0.176	0.353			0.208	0.208	0.415		
C.D. at 5%	0.510	0.510	1.021			0.601	0.601	NS			
SE (d) ±	0.249	0.249	0.499			0.294	0.294	0.587			
Fruit count at maturity stage	B ₀ Control	18.14	18.66	19.25	19.53	18.89	19.16	19.33	20.66	20.94	20.02
	B ₁ 10	20.56	20.66	21.33	21.79	21.08	21.36	21.87	22.18	22.78	22.04
	B ₂ 20	22.33	22.69	23.24	23.56	22.95	23.24	23.74	24.28	24.89	24.03
	B ₃ 30	24.55	24.78	25.95	26.16	25.36	25.27	25.80	26.65	27.13	26.21
	Mean A	21.39	21.69	22.44	22.76		22.25	22.68	23.44	23.93	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.172	0.172	0.344			0.133	0.133	0.266		
C.D. at 5%	0.498	0.498	NS			0.385	0.385	NS			
SE (d) ±	0.244	0.244	0.487			0.188	0.188	0.377			

Table 2. Effect of foliar application of GA, zinc and their interaction on fruit count ripening stage, no. of cracked fruit, yield in litchi

Parameter	Doses GA ppm (B)	Zinc % (A)									
		2020					2021				
		A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A	A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A
Fruit count at ripening stage	B ₀ Control	17.14	17.44	17.88	18.23	17.67	18.13	18.39	18.66	19.14	18.58
	B ₁ 10	18.53	18.66	19.16	19.36	18.92	19.46	19.83	20.33	20.58	20.05
	B ₂ 20	19.53	20.44	20.66	20.86	20.37	20.86	21.34	21.45	21.96	21.40
	B ₃ 30	21.33	21.46	22.95	23.18	22.23	22.13	22.33	23.67	24.11	23.06
	Mean A	19.13	19.50	20.16	20.40		20.14	20.47	21.02	21.44	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.127	0.127	0.254			0.158	0.158	0.317		
C.D. at 5%	0.367	0.367	NS			0.459	0.459	NS			
SE (d) ±	0.179	0.179	0.359			0.224	0.224	0.448			
No. of cracked fruit	B ₀ Control	4.90	4.76	4.65	4.35	4.66	4.46	4.26	4.18	4.08	4.245
	B ₁ 10	4.23	4.16	3.88	3.76	4.00	3.94	3.86	3.38	3.23	3.603
	B ₂ 20	3.63	3.43	3.26	3.13	3.36	3.14	3.06	2.94	2.64	2.945
	B ₃ 30	2.70	2.56	2.44	2.11	2.45	2.30	2.21	2.06	1.90	2.117
	Mean A	3.86	3.72	3.55	3.33		3.46	3.34	3.14	2.96	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.022	0.022	0.044			0.023	0.023	0.046		
C.D. at 5%	0.063	0.063	NS			0.066	0.066	0.132			
SE (d) ±	0.031	0.031	0.062			0.032	0.032	0.065			
Yield (kg/plant)	B ₀ Control	45.95	47.76	49.53	51.68	48.73	46.80	48.92	50.99	53.02	49.93
	B ₁ 10	53.70	55.90	57.85	59.77	56.80	55.37	57.80	59.90	61.25	58.58
	B ₂ 20	61.46	63.52	65.33	67.29	64.40	63.77	65.95	67.30	69.95	66.74
	B ₃ 30	69.86	71.81	73.01	75.80	72.62	71.35	73.87	75.81	77.95	74.74
	Mean A	57.74	59.74	61.43	63.63		59.32	61.63	63.50	65.54	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.495	0.495	0.990			0.528	0.528	1.056		
C.D. at 5%	1.432	1.432	NS			1.528	1.528	NS			
SE (d) ±	0.700	0.700	1.400			0.747	0.747	1.494			

Table 3. Effect of foliar application of GA, zinc and their interaction on T.S.S. content, total sugar content and juice content in litchi

Parameter	Doses GA ppm (B)	Zinc % (A)									
		2020					2021				
		A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A	A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A
Total soluble solids (°Brix)	B ₀ Control	18.13	18.26	18.33	18.66	18.34	19.16	19.28	19.36	19.68	19.37
	B ₁ 10	19.14	19.53	19.63	19.73	19.50	20.16	20.56	20.68	20.78	20.54
	B ₂ 20	20.14	20.38	20.68	20.76	20.49	21.18	21.42	21.76	21.88	21.56
	B ₃ 30	21.13	21.46	21.49	21.83	21.47	22.26	22.56	22.62	22.96	22.60
	Mean A	19.63	19.90	20.03	20.24		20.69	20.95	21.10	21.32	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.167	0.167	0.334			0.141	0.141	0.282		
C.D. at 5%	0.483	0.483	NS			0.409	0.409	NS			
SE (d) ±	0.236	0.236	0.472			0.200	0.200	0.399			
Total sugar content (%)	B ₀ Control	12.10	12.33	12.46	12.58	12.36	12.13	12.36	12.49	12.61	12.39
	B ₁ 10	12.68	12.78	13.16	13.24	12.96	12.71	12.80	13.18	13.26	12.98
	B ₂ 20	13.36	13.48	13.59	13.78	13.55	13.38	13.51	13.63	13.82	13.58
	B ₃ 30	14.10	14.22	14.43	14.50	14.31	14.13	14.26	14.45	14.55	14.34
	Mean A	13.06	13.20	13.41	13.52		13.08	13.23	13.43	13.56	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.085	0.085	0.171			0.106	0.106	0.212		
C.D. at 5%	0.247	0.247	NS			0.306	0.306	NS			
SE (d) ±	0.121	0.121	0.121			0.150	0.150	0.300			
Juice content(%)	B ₀ Control	53.16	53.58	54.60	54.66	54.00	54.18	54.42	54.51	54.68	54.44
	B ₁ 10	55.19	55.76	56.22	56.88	56.01	55.21	55.78	56.34	56.94	56.06
	B ₂ 20	57.19	57.73	58.33	59.66	58.22	57.23	57.78	58.36	59.71	58.27
	B ₃ 30	60.35	61.44	62.48	63.18	61.86	60.38	61.48	62.56	63.24	61.91
	Mean A	56.47	57.12	57.90	58.59		56.75	57.36	57.94	58.64	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.373	0.373	0.746			0.500	0.500	1.000		
C.D. at 5%	1.079	1.079	NS			1.447	1.447	NS			
SE (d) ±	0.528	0.528	1.055			0.707	0.707	1.414			

Table 4. Effect of foliar application of GA, zinc and their interaction on acidity, sugar: acid ratio and vitamin-C in litchi

Parameter	Doses GA ppm (B)	Zinc % (A)									
		2020					2021				
		A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A	A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A
Acidity content(%)	B ₀ Control	0.638	0.632	0.628	0.622	0.630	0.633	0.628	0.626	0.621	0.627
	B ₁ 10	0.618	0.590	0.578	0.566	0.588	0.616	0.588	0.572	0.563	0.585
	B ₂ 20	0.554	0.518	0.596	0.486	0.539	0.549	0.515	0.488	0.485	0.509
	B ₃ 30	0.456	0.436	0.423	0.410	0.431	0.449	0.433	0.421	0.403	0.427
	Mean A	0.566	0.544	0.556	0.521		0.562	0.541	0.527	0.518	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.004	0.004	0.008			0.005	0.005	0.009		
	C.D. at 5%	0.012	0.012	0.024			0.013	0.013	NS		
SE(d)±	0.006	0.006	0.012			0.007	0.007	0.013			
Sugar:acid ratio(%)	B ₀ Control	19.65	19.98	20.26	20.65	20.13	20.13	20.65	21.14	21.66	20.89
	B ₁ 10	21.46	21.75	22.26	23.44	22.22	22.44	22.96	23.26	24.14	23.20
	B ₂ 20	25.65	25.88	26.16	26.68	26.09	26.66	26.87	27.18	27.69	27.10
	B ₃ 30	27.44	28.65	29.33	30.16	28.89	28.66	29.23	30.13	31.65	29.91
	Mean A	23.55	24.06	24.50	25.23		24.47	24.92	25.42	26.28	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.169	0.169	0.338			0.214	0.214	0.428		
	C.D. at 5%	0.489	0.489	NS			0.619	0.619	NS		
SE(d)±	0.239	0.239	0.478			0.302	0.302	0.605			
Ascorbic acid content(%)	B ₀ Control	33.16	33.56	34.15	34.58	33.86	34.15	34.58	35.18	35.62	34.88
	B ₁ 10	35.18	35.69	36.28	36.73	35.97	36.22	36.72	37.32	37.76	37.00
	B ₂ 20	37.12	37.53	38.13	38.83	37.90	38.18	38.56	39.16	39.86	38.94
	B ₃ 30	39.16	40.42	41.65	42.10	40.83	40.18	41.84	42.68	43.44	42.03
	Mean A	36.15	36.80	37.55	38.06		37.18	37.92	38.58	39.17	
	Factors	A	B	A X B			A	B	A X B		
	SE(m)±	0.328	0.328	0.656			0.313	0.313	0.625		
	C.D. at 5%	0.949	0.949	NS			0.905	0.905	NS		
SE(d)±	0.464	0.464	0.928			0.442	0.442	0.884			

Table 5. Effect of foliar application of GA, zinc and their interaction on organoleptic test in litchi

Parameter	Doses GA ppm (B)	Zinc % (A)									
		2020					2021				
		A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A	A ₀ Control	A ₁ 0.3	A ₂ 0.5	A ₃ 0.7	Mean A
Organoleptic test	B ₀ Control	71.12	71.66	72.34	73.66	72.19	72.15	72.84	73.36	74.68	73.25
	B ₁ 10	74.56	75.68	76.16	77.85	76.06	75.58	76.72	77.75	78.89	77.23
	B ₂ 20	78.58	79.73	80.33	81.44	80.02	79.16	80.66	81.65	82.69	81.04
	B ₃ 30	82.66	83.74	84.95	85.25	84.15	83.43	84.58	85.66	86.69	85.09
	Mean A	76.73	77.70	78.44	79.55		77.58	78.70	79.60	80.73	
Factors		A	B	A X B			A	B	A X B		
SE(m)±		0.594	0.594	1.188			0.717	0.717	1.433		
C.D. at 5%		1.719	1.719	NS			2.073	2.073	NS		
SE (d) ±		0.840	0.840	1.680			1.013	1.013	2.027		

3.12 Ascorbic Acid Content (mg/100g)

Regarding different GA and Zinc concentrations on initial ascorbic acid are an expression the plants which was influenced by GA and Zinc growth regulators over control. Collective effect of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (42.10 and 43.44 mg) per 100g fruit pulp of ascorbic acid closely followed by treatment G_3Z_2 (41.65 and 42.68mg) per 100g fruit pulp. The minimum (33.16 and 34.15 mg) per 100g fruit pulp of ascorbic acid was presented with control (G_0Z_0) during both the years of experiments. Interactive effect GA and Zinc in the ascorbic acid content of litchi fruits might be due to increased synthesis of metabolites which can stimulate the synthesis of the ascorbic acid precursor. These findings are in accordance with the reports of Devaraja et al. [12], Megu et al. [5] in litchi.

3.13 Organoleptic Test

About the different GA and Zinc concentrations on initial organoleptic test are an expression the plants which was influenced by GA and Zinc growth regulators over control. Interactive impact of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (85.25 and 86.69) organoleptic test closely followed by treatment G_3Z_2 (84.95 and 85.66). The maximum (71.12 and 72.15) organoleptic test was presented with control (G_0Z_0) during both the years of experimentation. These findings are in accordance with the reports of Devaraja et al. [12] in litchi.

4. CONCLUSION

On the basis of results obtained in the present investigation it may be concluded that the application of GA and Zinc resulted in to significant improvement in yield and quality of litchi with maximum fruit set and retention as well as yield attributing characters such weight of fruit which ultimately increased the yield per plant and thereby per hectare in both GA 60ppm and Zinc 0.7%. This treatment also improved nutritional qualities of fruit such as increased total soluble solids, reduction in acidity, and improvement in ascorbic acid content and total sugars content of fruits. The use of plant bio-regulator (GA) and micro-nutrients (Zn) assumes a significant part in increasing the yield and quality fruits with the reduction in cracking along with increased fruit set, retention as well as number of fruits. Since

litchi is an important fruit crop all over the world in sub-tropical climate. That's why in the future, more studies can be carried out on other cultivars alone or in the combination of both i.e., plant bio-regulator and micro-nutrients on more parameters to standardize doses specific to the particular regions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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