Influence of GA_3 and $ZnSO_4$ on fruiting, yield and quality parameters of litchi (*Litchi chinensis* S.) cv. Dehradun

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 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^{0}Brix), 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 GA_3 (**Sinha *et al.,* (1999)** in litchi, **Kumar *et al.*, (2018)** in mango and **Pandey *et al.*, (2011)** in ber).

3.2 Fruit count at pit hardening stage

Interactive influence of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (29.96 and 31.15) fruit count at pit hardening closely followed by treatment G_3Z_2 (29.16 and 30.89). The maximum (24.16 and 25.14) fruit count at pit hardening 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 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 GA_3. These results are also in conformity with the findings of **Sinha *et al.,* (1999**) in litchi, **Sharma *et. al.*, (2011)** and **Pandey *et al.*, (2011)** in ber.

3.3 Fruit count at maturity stage

Correlative consequence of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (26.16 and 27.13) fruit count at maturity stage closely followed by treatment G_3Z_2 (25.95 and 26.65). The minimum (18.14 and 19.16) fruit count at maturity stage was presented with control (G_0Z_0) 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.,* (1999)** in litchi and **Pandey *et al.*, (2011)** in ber.

3.4 Fruit count at ripening stage

Interactive effect of GA and Zinc was found to be significant. Combined treatment of G_3Z_3 induced non-significantly maximum (23.18 and 24.11) fruit count at ripening stage closely followed by treatment G_3Z_2 (22.95 and 23.67). The minimum (17.14 and 18.13) fruit count at ripening stage was presented with control (G_0Z_0) 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 (GA_3) 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.,* (1999)** in litchi and **Pandey *et al.*, (2011)** 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 G_3Z_3 induced significantly minimum (2.11 and 1.90) number of cracked fruits at harvesting closely followed by treatment G_3Z_2 (2.44 and 2.06). The maximum (4.90 and 4.46) Number of cracked fruits at harvesting was presented with control (G_0Z_0) during both the years of experiments. The spraying of borax was found more effective than GA_3 and $ZnSO_4$. 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.,* (2021)** and **Gupta *et al.*, (2022)** in litchi.

3.6 Yield of marketable fruits(kg/plant)

Interactive influence of GA and Zinc was found to be non-significant treatment of G_3Z_3 induced significantly maximum (75.80 and 77.95 kg/plant) yield of marketable fruits closely followed by treatment G_3Z_2 (73.01 and 75.81kg/plant). The minimum (45.95 and 46.80kg/plant) yield of marketable fruits was presented with control (G_0Z_0) 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.,* (2021)** in litchi, **Singh *et al.,* (2017)** in mango and **Tripathi and Shukla (2008)** in strawberry.

3.7 Total Soluble Solid Content (^{0}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 ^{0}B) TSS closely followed by treatment G_3Z_2 (21.49 and 22.62 ^{0}B). The maximum (18.13 and 19.16 ^{0}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.,* (2011)**, **Tiwari *et al.,* (2017)** in aonla and **Gupta *et. al.*, (2022)** 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.,* (2011)**, **Tiwari *et al.,* (2017)** in aonla, **Kaur (2017)**, **Devaraja *et al.,* (2019)** 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 (2021)** 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.,* (2021)** and **Kaur (2017)** 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 (2017), Megu *et. al.,* (2021)** 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.

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.,* (2019)**, **Megu *et al.,* (2021) i**n 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.,* (2019)** 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.

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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	Zinc % (A)									
	GA ppm (B)	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**	**Zinc % (A)**									
	GA ppm (B)	**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	Zinc % (A)									
	GA ppm (B)	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 (^{0}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_0Control	A_1 0.3	A_2 0.5	A_3 0.7	Mean A	A_0Control	A_1 0.3	A_2 0.5	A_3 0.7	Mean A
Acidity content(%)	B_0Control	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_0Control	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_0Control	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	Zinc % (A)									
	GA ppm (B)	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		