Original Research Article

Effect of NAA and Zinc sulphate on Marketable Yield and Physical Parameters of Litchi (*Litchi chinensis* Sonn.) cv. Rose Scented

ABSTRACT

An experiment was conducted in the Garden, Department of Fruit Science, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.) during two continuous years *i.e.,* 2022 and 2023 to assess the effect of NAA (Naphthylacetic acid) and zinc sulphate on marketable yield and physical parameters of litchi (*Litchi chinensis* Sonn.) cv. Rose Scented fruits. For this experiment, sixteen treatments including four levels of NAA (0, 25, 50 and 75 ppm), zinc sulphate (0, 0.2, 0.4 and 0.6 %) and their combinations were applied in Factorial-CRD in three replications. The foliar application of these treatments was done on January 28 and March 16 during 2022 and 2023, before flowering and again during fruit setting (pea stage). NAA (Naphthylacetic acid) was substituted by a carboxymethyl group at position 1. It has a role as a synthetic auxin. It is a conjugate acid of a 1-naphthaleneacetate. 1-Naphthylacetic acid is a natural product found in Humulus lupulus, Rehmannia glutinosa, and other organisms with data available. The results of the experiment clearly show that plants treated with NAA @ 50ppm and zinc sulphate @ 0.4% significantly increased yield of marketable fruits of 79.11 and 83.17 kg/plant, respectively during both years of investigations. Simultaneously, the highest fruit length (3.57 and 3.60 cm), largest fruit diameter (3.22 and 3.20 cm) and fruit weight (19.99 and 20.54 g) were also recorded which were produced from the plants treated with the combination of NAA @ 50 pm and $ZnSO_4$ @ 0.4%. This treatment (NAA @ 50 pm and $ZnSO_4$ @ 0.4%) also gave blend results in respect to seed physiology and results in decreasing seed length (1.17 and 1.30 cm), seed diameter (1.23 and 1.25 cm) and produced minimum seed weight (3.34 and 3.37 g). The same treatment also showed a simultaneous increase in pulp weight (13.45 and 13.98 g) and pulp: seed proportion (4.02 and 4.08) with reduced rind weight (3.20 and 3.19 g) in litchi fruits in the north Indian plains.

Keywords: *Litchi, NAA, Zinc sulphate, marketable yield, physical parameters.*

1.0 INTRODUCTION

In India, litchi was introduced through Burma in the 18th century and quickly spread to other countries. 91% of the world's litchi production is produced in India and China, however it is primarily sold locally. In India, it is grown in 98000 ha of an area with a production of 724000 MT [1].

The litchi (*Litchi chinensis* Sonn.) is one of the most important sub-tropical evergreen tree which is a member of the family Sapindaceae. Botanically, the mature fruit of the litchi is a nut and the edible part is its juicy aril. It is sour and quite sweet when dried. It is a good source of minerals like magnesium, iron, calcium, copper, phosphorous and potassium as well as carbohydrates, vitamins and other nutrients. It can be transformed into various value-added products such as juice, wine, pickles, jam, jelly, ice cream and yogurt. It is available in the market from May through June when there are many other fresh fruits available. However, despite the availability of different other fruits in the market, the demand for fresh litchi is still very high due to its unique taste, flavour and colour.

Over the years, plant growth regulators (PGRs) and micronutrients have been systematically used to increase the maximum and long-term economic benefits of litchi production by modifying the behaviour of fruit or fruiting trees. The yield and quality of litchi fruit are positively influenced by the use of plant growth regulators and micronutrients. PGR application leads to increased flowering, fruit set and fruit retention. The cell sap supply pathway to the fruit is severed by the formation of the dermis and the thin cork cells gradually separate, resulting in increased fruit drop. Early researchers reported that gibberellin affects both cell division and expansion [21]. Adjuvants such as naphthalene acetic acid (NAA) greatly influence plant growth; however, their effectiveness depends on application, time and concentrations used.

Micronutrients perform an important function in improving the growth, yield and quality of litchi. Zinc inadequacy adversely affects flowering, fruit size, weight and quality. The metabolic activities of plants are highly dependent on zinc. Zinc principally acts as a metal activator of enzymes such as dehydrogenase (pyridine nucleotide, glucose-6 phosphodiesterase, carbonic anhydrase, etc.). Tryptophan, a precursor of IAA, is highly dependent on zinc for its synthesis and is involved in the absorption and retention of water in the plant body. So, for the production of more marketable fruits having better quality is the prime objective during this experimentation period.

2.0 MATERIAL AND METHODS

The well-established healthy and uniform litchi cultivar Rose Scented trees, about 63 years old but properly maintained, located in the Garden, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture & Technology Kanpur, were selected for the present investigations during two subsequent years *i.e.,* 2022 and 2023. During the entire duration of the investigation, the whole orchard was kept under clean cultivation, and uniform practices were applied to all plants. Factorial Completely Randomized Design was used with three replications and sixteen treatments *viz.,* four levels each of NAA (0, 25, 50, and 75 ppm), zinc sulphate (0, 0.2, 0.4 and 0.6%) and their combinations were sprayed twice *i.e.,* before flowering (28 January) and at pea stage (16 March) during both the years. Three branches in uniform growth and vigor were selected on each tree for the recording of various observations.

The marketable yield was recorded at harvesting and length and diameter of fruits as well as seeds were determined with the help of vernier calipers and the fruit weight, pulp weight, seed weight, and rind weight of fruits were recorded with the help of an electronic balance/ weighing machine in a standard way.

3.0 RESULTS AND DISCUSSION

3.1 Marketable Yield: All the cracked and other blemished fruits were isolated from the overall yield of litchi fruit to calculate the yield of marketable fruits. The foliar spray of micronutrient i.e., zinc considerably increased the production of marketable fruits, and a significant maximum marketable fruits yield (64.98 and 67.97kg) per plant was documented in plants that were treated with 0.6 % zinc followed by 64.65 and 66.37kg per plant under 0.4% of zinc sulphate treated plants, whereas lowest yield of marketable fruits (58.19 and 60.39kg) per plant was obtained under control plants (Fig.1). The production of more fruits per tree in this treatment could be due to the facts that zinc acts as a catalyst in the oxidation and reduction process and is also of great importance in the sugar metabolism thus increasing the yield per tree.

Plants treated with NAA@ 50ppm produced a significant maximum yield of marketable fruits per plant (75.60 and 79.68kg) closely followed by plants treated with 75ppm of NAA (67.61 and 69.36kg) as compared to control plants which produced the minimum yield of marketable fruits (47.09 and 49.64kg) per plant (Fig.1). The benefit caused by NAA application may be related to its physiological actions in the plants, which may have prevented fruit drop, reduced cracking, and significantly decreased the number of imperfect fruits, improving production thus increased in the production of marketable fruits yield. The above findings are in line with the reports of Tiwari et al. [33], Tripathi and Viveka Nand [39] in Aonla, Kumar et al. [12] in Phalsa; and Babu and Tripathi [5] in Guava. The interactive influence of NAA and zinc was found to be non-significant for the yield of marketable fruits during both years of experiments.

3.2 Fruit Size: Perusal of data from Table 1 shows that during the present investigation, fruit size (length and diameter) was significantly increased with the foliar use of plant NAA and micronutrients. Significant maximum length (3.52 and 3.49cm) and diameter of fruit (3.18 and 3.08cm) were documented in fruits that were produced from the plant treated with NAA @ 50ppm, closely followed by 3.38 and 3.17cm of fruit length and 3.02 and 2.91cm of diameter from fruits produced in NAA @ 75ppm treated plants. The minimum fruit length (2.76 and 2.77cm) and diameter (2.45 and 2.57cm) were noted in the fruits produced from the plants kept under control without any application (Table 1). The results are per the findings of Kumar et al. [14] in Mango; Tiwari et al. [33] in aonla, Lal et al. [16] in Kinnow mandarin; Tripathi et al. [37], Verma et al. [40] in strawberry, Badal and Tripathi [6] in guava, Tripathi et al. [38] in aonla, Maurya et al. [17] in mango, Shahay et al. [28] in litchi.

When the effect of zinc sulphate application is studied, the maximum length (3.30 and 3.20cm) and diameter of fruit (2.92 and 2.88cm) were noted in fruits that were produced from the plants treated with zinc sulphate @ 0.6%), closely followed by (3.27 and 3.16cm) fruit length and fruit diameter (2.90 and 2.88cm) from zinc sulphate @ 0.4% treated plants. The minimum fruit length (3.10 and 3.01cm) and diameter (2.74 and 2.74cm) were recorded in the fruits which were produced from the plants kept under control without any treatment (Table 1). As a micronutrient, zinc may have a substantial impact on fruit size enhancement due to its participation in promoting cell elongation and expansion, which led to a desired increase in the size of litchi fruits. The results are under the findings of Kumar et al. [14] in mango; Singh et al. [31] in Indian gooseberry; Lal et al. [16] in kinnow mandarin; Tripathi et al. [37] in strawberry; Tripathi et al. [38] in aonla, and Maurya et al. [17] in mango.

The interaction effect for the combined application of NAA and zinc sulphate (Table 1), maximum length of fruit (3.57 and 3.60cm) and diameter (3.22 and 3.20cm) was recorded in fruits which were produced from the plants treated with the combined concentration of NAA @ 50ppm + zinc sulphate @ 0.4%), while the fruits in plants kept under control results in minimum and values of length (2.54 and 2.62cm) and diameter (27.67 and 27.53), respectively, during both the years of experimentation. It is also notable that with the reduction in plant bioregulator and micronutrient concentration, fruit size gets reduced significantly. This increase in the size of fruits might be attributed to the greater mobilization of water into fruits, and food materials from the site of their production to the storage organs under the influence of applied zinc sulphate and NAA. The results are per the findings of Kumar et al. [14] in mango; Singh and Singh [31]; Tiwari et al. [33] and Tripathi et al. [38] in Aonla, Lal et al. [16] in Kinnow Mandarin; and Tripathi et al. [37] in strawberry; Maurya et al. [17] in mango.

3.3 Fruit weight (g): Fruits with higher weight (19.85 and 22.01g) were documented, which were produced from the plants treated NAA @ 50ppm, closely followed by 19.22 and 21.38g, from NAA @ 75ppm treated plants. The minimum fruit weight (17.30 and 19.59g) was found in fruits that were produced from the control treatment (Table 1). This increase in fruit weight with NAA application might be due to the accumulation of more food materials in fruit trees which ultimately transferred to the fruits during their growth and developmental stage which also increased their size. These results are by the findings of Singh and Singh [31], Tiwari et al. [33] in aonla and Tripathi et al. [35], Tripathi et al. [36] in strawberry and Gupta et al. [8] in litchi.

When the influence of zinc sulphate application is studied, it was found that fruit having maximum weight (18.97 and 21.19g) was produced from zinc sulphate @ 0.6% treated plants, closely followed by 18.80 and 21.02g fruit weight from zinc sulphate @ 0.4% treated plants. Fruits having minimum weight (18.37 and 20.59g) was documented under control-treated plants (Table 1). This significant increase in fruit weight might be due to the result of cell division and cell elongation with zinc treatments which helps in the synthesis of more photosynthates in the plants which later on transferred to the developing fruits, which ultimately result in increased weight of fruits. These results are in accordance with the findings of Tiwari et al. [33] in aonla and Tripathi et al. [35]; Tripathi et al. [36] in strawberry and Gupta et al. [8], Nand et al. [21] in litchi.

The interaction effect for the combined use of NAA and zinc sulphate significantly affected fruits weight and fruit with maximum weight (20.12 and 22.28g) was documented under the combination of NAA @ 50ppm + zinc sulphate @ 0.4%, while the plants kept under control produce fruits having minimum weight (16.92 and 19.21g) during both the years of experimentation (Table 1). This increase in the weight of fruits might be due to the better supply of nutrients which results in the production of more amount photosynthates in plants treated with the foliar application of zinc and NAA which results in the rapid synthesis of metabolites particularly carbohydrates along with their fast translocation to the fruits from the site of synthesis causing relatively greater pulp content. The results of the experiment are under the findings of Singh and Singh [31], Tiwari et al. [33] in aonla and Tripathi et al. [35], Tripathi et al. [36] in strawberry and Gupta et al. [8], Nand et al. [21] in litchi.

3.4 Seed Size: Minimum length (1.25 and 1.35cm) and diameter of seed (1.29 and 1.30cm) was found in fruits which are produced from the plants treated NAA @ 50ppm, closely followed by 1.45 and 1.48cm seed length and seed diameter (1.43 and 1.35cm) from fruits which are produced under NAA@75ppm treated plants (Table 2). The minimum seed length (1.73 and 1.66cm) and seed diameter (1.64 and 1.49cm) were recorded in fruits which were produced from the plant kept under control treatment. The superiority in the length of fruits as indicated in NAA treatments might be due to its involvement in cell division, cell elongation and decreased volume of intracellular space in the monocarpic cells which could have boosted plant health thereby producing healthy and larger fruits NAA treatment also resulted in an increase in the growth rate of fruits which results in bigger fruit size along with small size of stone. These findings are in line with the reports of Meena et al. [18], Bal et al. [4], Ram et al. [25], Tripathi et al. [34], Arora et al. [3], Kumar et al. [11] in Ber, Rathod et al. [27] in Aonla, Patil et al. [22] in Mango, Kumar et al. [15] in Guava.

When the influence of zinc sulphate application is studied, the minimum length of seed (1.45 and 1.48cm) and diameter of seed (1.47 and 1.37cm) were noted under zinc sulphate @ 0.6% treatments, closely followed by 1.48 and 1.49cm of seed length and 1.47 and 1.37cm of seed diameter from zinc sulphate @ 0.4% treated plants, whereas the minimum seed length (1.57 and 1.56cm) and seed diameter (1.49 and 1.41cm) was recorded in plants kept under control treatment (Table 2). The increase in the size of fruits with an application of zinc might be due to the significant increase in cell division and cell elongation associated with active performance in photosynthesis in the plants and photosynthetes were translocated to the fruits which possibly caused an increase in fruit size and decrease in stone size. This outcome might be linked to the plant's active photosynthesis, which allowed the pigments to be transferred to the stone and increase in size.

When the interaction effect among various concentrations of NAA and zinc sulphate was studied, it was reported that the minimum length of seed (1.18 and 1.30cm) and diameter of seed (1.23 and 1.25cm) produced in fruits which were harvested from the plant treated with the combination of NAA @ 50ppm + zinc sulphate @ 0.4%, while the fruits produced from control plants results in maximum values of seed length (1.78 and 1.68cm) and seed diameter (1.68 and 1.51cm), respectively, during both the years of experimentation (Table 2). The increased fruit length that results from NAA and zinc treatment may be attributable to the compound's role in cell proliferation, elongation, and reduction of intracellular space in monocarpic cells. These processes may have improved plant health and led to the production of larger and healthier fruits. NAA speeds up fruit growth, resulting in larger fruits, which may result in smaller stones. This outcome might be linked to the plant's active photosynthesis, which allows the pigments to be transferred to the fruit causing an increase in size. These findings are in line with reports of Arora *et al.* [3], Bal *et al.* [4], Ram *et al.* [25], Tripathi *et al.* [34], Meena *et al.* [18] in ber, Rathod *et al.* [27] in aonla, and Kumar *et al.* [15] in guava.

3.5 Seed weight (g): The minimum seed weight (3.43 and 3.46g) was found in fruits which were produced from the plants treated with NAA @ 50ppm closely followed by 3.67 and 3.70g from NAA @ 75ppm treated plants (Table 3). The minimum fruit weight (3.91 and 3.95g) were harvested from the plant which were kept under control without any treatment. Application of NAA enhanced metabolism which reduces stone size. Increased cell flexibility and plasticity brought about by NAA encouraged cell wall stretching and increased water uptake, both of which may have increased pulp weight while decreasing seed weight. These results are in close conformity with the findings of Kaur [9], Saraswat et al. [29], Kumar et al. [10], Priyadarshi et al. [24] in Litchi and Vijendla et al. [41] in Mango.

In zinc sulphate treated plants, the minimum seed weight (3.66 and 3.69g) was noted in fruits that were harvested from the plants treated with zinc sulphate @ 0.6% closely followed by 3.67 and 3.70g of seed weight produced from the plants treated with zinc sulphate @ 0.4%, whereas, the minimum seed weight (3.77 and 3.81g) was recorded under control-treated plants (Table 3). Zinc application increased the pulp content in litchi fruit, which may have led to a reduction in the weight of the seeds in the litchi fruits.

These results are in close conformity with the findings of Singh et al. [32] in aonla and Saraswat et al. [29], Priyadarshi et al. [24], Kumar et al. [10] in litchi.

The interaction effect among various concentrations of NAA and zinc sulphate, the minimum seed weight (3.34 and 3.37g) was recorded in fruits, which were harvested from the plants kept treated with the combination of NAA @ 50ppm + zinc sulphate @ 0.4%, while the plants kept under control, produced fruits with maximum values of seed weight (3.95 and 3.99g) during both the years of experimentation (Table 3). Application of NAA enhances metabolism which reduces stone size. The decrease in stone weight may be due to the fact that auxins induced parthenocarpy effect to some extent thereby resulting in lesser stone weight. Zinc increased the pulp content in litchi fruit, which may have led to a reduction in the weight of the seeds in the litchi fruits. These results are in close conformity with the findings of Kaur [9] in litchi; Priyadarshi et al. [24] in litchi and Vejendla et al. [41] in Mango; Singh et al. [32] in aonla and Saraswat et al. [29], Kumar et al. [10] in litchi.

3.6 Pulp weight (g): Significantly more weight of pulp (13.18 and 13.67g) with minimum rind weight (3.21 and 3.20g) was recorded in fruits which were harvested from the plant treated with NAA @ 50ppm, closely followed by (12.53 and 13.00g of pulp and 3.03 and 3.02g of rind from NAA @ 75ppm treated plants (Table 3). The minimum pulp weight (10.75 and 11.56g) and maximum rind weight (3.39 and 3.37g) were recorded in fruits which were produced from the plants kept under control treatment. This increase in pulp with the reduction in rind weight might be due to more absorption of water due to the influence of plant bio-regulators and micronutrients which increase the volume of inter-cellular spaces in the pulp causes an increase in pulp weight. The results are by the findings of Kumar et al. [14], Maurya et al. [17] in mango.

Plants treated with zinc sulphate at 0.6% produced fruits having maximum pulp weight (12.35 and 12.84g) and minimum rind weight (3.05 and 3.03g), closely followed by 12.20 and 12.84 g of fruit weight and 3.28 and 3.27g of rind weight from zinc sulphate @ 0.4% treated plants (Table 3). The minimum pulp weight (11.72 and 12.19g) and maximum rind weight (3.33 and 3.31g) was recorded under control treatment. The results are in support with the findings of Anushi et al. [2] and Kumar et al. [14], Moazzam et al. [20], Maurya et al. [17] in mango, Meena et al. [19] in ber.

Further investigation for the interaction effect among various combinations of NAA and zinc sulphate shows that the maximum pulp weight (3.20 and 3.19g) and minimum rind weight (3.20 and 3.19g) were recorded under concentrations of NAA @ 50ppm + zinc sulphate @ 0.4% combination, while the plants under control results fruits with minimum pulp weight (27.67 and 27.53) and maximum rind weight (27.67 and 27.53) during both the years of experimentation (Table 3). Auxin cell wall is one source of evidence, which enhanced its elasticity and flexibility. As a result, the cell size increased and the cell wall would be able to flex, which would ultimately increase pulp weight in the litchi fruits. The results are the following the findings Yadav et al. [42] in ber, Vejendla et al. [41], Moazzam et al. [[20] in mango and Saraswat et al. [29], Kaur [9], Priyadarshi et al. [24], Kumar et al. [10], and Radha et al. [26] in litchi.

3.7 Pulp /stone ratio: The significant maximum pulp: stone ratio (3.83 and 3.96) was found with the application of NAA @ 50ppm in comparison to various other concentrations, closely followed by of 3.40 and 3.70 from NAA @ 75ppm, whereas, the minimum pulp: stone ratio (2.74 and 2.95) was recorded in fruits which were harvested from the plants kept under control without any application (Table 3). This increase in pulp/stone ratio might be due to an increase in the amount of pulp per cent, volume of inter-cellular spaces and decrease in stone size. The results are in support with the findings of Anushi et al. [2] Kumar et al. [14] in mango, Meena et al. [18] in Ber; and Tiwari et al. [33], Tripathi et al. [38], Bhadauria et al. [7] in aonla.

In the case of zinc sulphate application, the maximum pulp: stone ratio (3.38 and 3.59) was noted under zinc sulphate @ 0.6% treated plants, closely followed by 3.34 and 3.56 from NAA @ 75ppm treated plants (Table 3). The minimum pulp: stone ratio (3.11 and 3.31) was recorded under control plants.

The interaction effect among various concentrations of NAA and zinc sulphate reveals thar the maximum pulp: stone ratio (4.02 and 4.08) was recorded in fruits which are harvested from the plants treated with the combination of NAA @ 50ppm + zinc sulphate @ 0.4%, while the plants under control produced fruits with minimum values (2.61 and 2.72) during both the years of experimentation (Table 3). This improvement in pulp/stone ratio may be due to more accumulation of food substances in elongated cells and intercellular space of the mesocarp. The results are in support with the findings of Anushi et al. [2] Kumar et al. [14] in mango, Meena et al. [19]; Pratap et al. [23] in ber and Tiwari et al. [33] Tripathi et al. [38], Bhadauria et al. [7] in aonla.

4.0 CONCLUSION

Based on results acquired in the current experiment it could be presumed that NAA @ 50 ppm with zinc sulphate @0.4% performed better in producing high marketable yield and physical quality parameters of litchi crediting characters such as length, diameter and weight of fruit with reduced seed length, diameter and weight, which increase the yield per plant under the combination of NAA @ 50ppm and zinc sulphate @ 0.4%. This treatment inversely reduced fruit cracking which enhanced a greater number of marketable fruits and affected seed physiology by decreasing the length, diameter and weight of seed in litchi fruit. The application of plant bio-regulators (NAA) and micronutrients ($ZnSO_4$) played a significant role in enhancing pulp weight. Thus, given the above results 50ppm of NAA in combination with 0.4% of zinc sulphate is recommended to the litchi growers for increasing the yield and physical quality parameters of litchi fruits under the plains of North India.

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AUTHOR CONTRIBUTIONS

The planning and execution of the experiments along with the preparation and manuscript was proofreading of manuscript was done by the author and submitted to the journal.

Competing Interests

The author declares no conflict of interest and the manuscript has not been submitted for publication in other journals.

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Table 1: Effect of foliar sprays of NAA, Zinc and their interactions on fruit length, diameter and weight.

Parameter	Doses	Zinc % (B)									
	NAA ppm (A)	2022					2023				
		B_0 Control	B_1 0.2	B_2 0.4	B_3 0.6	Mean A	B_0 Control	B_1 0.2	B_2 0.4	B_3 0.6	Mean A
Fruit length	A_0 Control	2.540	2.680	2.873	2.950	2.761	2.620	2.743	2.830	2.897	2.773
	A_1 25	3.083	3.180	3.253	3.280	3.199	2.947	2.980	3.053	3.073	3.013
	A_2 50	3.470	3.517	3.577	3.547	3.528	3.420	3.447	3.600	3.520	3.497
	A_3 75	3.333	3.350	3.410	3.440	3.383	3.087	3.110	3.183	3.330	3.178
	Mean B	3.107	3.182	3.278	3.304		3.018	3.070	3.167	3.205	
	Factors	**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**			**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**		
	A	0.076	0.037	0.026			0.065	0.032	0.023		
	B	0.076	0.037	0.026			0.065	0.032	0.023		
	A × B	NS	0.074	0.052			NS	0.064	0.045		
Fruit Diameter	A_0 Control	2.280	2.460	2.520	2.540	2.450	2.400	2.563	2.650	2.670	2.571
	A_1 25	2.630	2.750	2.823	2.850	2.763	2.700	2.720	2.730	2.797	2.737
	A_2 50	3.140	3.160	3.220	3.207	3.182	3.020	3.050	3.200	3.080	3.088
	A_3 75	2.940	3.023	3.047	3.107	3.029	2.873	2.877	2.950	2.977	2.919
	Mean B	2.748	2.848	2.903	2.926		2.748	2.803	2.883	2.881	
	Factors	**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**			**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**		
	A	0.068	0.033	0.023			0.061	0.030	0.021		
	B	0.068	0.033	0.023			0.061	0.030	0.021		
	A × B	NS	0.066	0.047			NS	0.060	0.042		
Fruit Weight	A_0 Control	16.920	17.183	17.380	17.750	17.308	19.210	19.470	19.670	20.040	19.598
	A_1 25	17.960	18.260	18.460	18.780	18.365	20.250	20.550	20.750	21.070	20.655
	A_2 50	19.650	19.780	20.120	19.873	19.856	21.810	21.940	22.280	22.030	22.015
	A_3 75	18.960	19.223	19.247	19.480	19.228	21.120	21.380	21.410	21.640	21.388
	Mean B	18.373	18.612	18.802	18.971		20.598	20.835	21.028	21.195	
	Factors	**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**			**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**		
	A	0.372	0.182	0.129			0.380	0.186	0.131		
	B	0.372	0.182	0.129			0.380	0.186	0.131		
	A × B	NS	0.364	0.257			NS	0.371	0.263		

Table 2: Effect of foliar sprays of NAA, Zinc and their interactions on seed length, diameter and weight.

Parameter	Doses	Zinc % (B)									
	NAA	2022					2023				
	ppm (A)	B_0 Control	B_1 0.2	B_2 0.4	B_3 0.6	Mean A	B_0 Control	B_1 0.2	B_2 0.4	B_3 0.6	Mean A
Seed length	A_0 Control	1.780	1.753	1.720	1.673	1.732	1.677	1.673	1.650	1.640	1.660
	A_1 25	1.657	1.617	1.590	1.550	1.603	1.620	1.600	1.580	1.550	1.588
	A_2 50	1.333	1.270	1.177	1.220	1.250	1.440	1.380	1.300	1.317	1.359
	A_3 75	1.523	1.470	1.450	1.380	1.456	1.540	1.500	1.457	1.450	1.487
	Mean B	1.573	1.528	1.484	1.456		1.569	1.538	1.497	1.489	
	Factors	**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**			**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**		
	A	0.038	0.019	0.013			0.033	0.016	0.011		
	B	0.038	0.019	0.013			0.033	0.016	0.011		
	A × B	NS	0.037	0.026			NS	0.032	0.022		
Seed Diameter	A_0 Control	1.680	1.657	1.630	1.610	1.644	1.517	1.490	1.483	1.470	1.490
	A_1 25	1.577	1.570	1.547	1.520	1.553	1.450	1.423	1.413	1.390	1.419
	A_2 50	1.350	1.310	1.230	1.277	1.292	1.330	1.320	1.250	1.297	1.299
	A_3 75	1.383	1.423	1.450	1.490	1.437	1.370	1.363	1.350	1.340	1.356
	Mean B	1.498	1.490	1.474	1.472		1.417	1.399	1.374	1.374	
	Factors	**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**			**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**		
	A	0.032	0.016	0.011			0.030	0.014	0.010		
	B	NS	0.016	0.011			0.030	0.014	0.010		
	A × B	0.064	0.031	0.022			NS	0.029	0.020		
Seed Weight	A_0 Control	3.953	3.930	3.900	3.873	3.914	3.990	3.970	3.940	3.910	3.953
	A_1 25	3.853	3.820	3.780	3.760	3.803	3.890	3.860	3.820	3.800	3.843
	A_2 50	3.567	3.450	3.340	3.380	3.434	3.600	3.480	3.370	3.410	3.465
	A_3 75	3.730	3.690	3.660	3.630	3.678	3.760	3.720	3.690	3.660	3.708
	Mean B	3.776	3.723	3.670	3.661		3.810	3.758	3.705	3.695	
	Factors	**C.D. at 5%**	**S.E.(d) ±**	**S.E.(m) ±**			**C.D. at 5%**	**S.E.(d) ±**	**S.E.(m) ±**		
	A	0.069	0.034	0.024			0.083	0.041	0.029		
	B	0.069	0.034	0.024			0.083	0.041	0.029		
	A × B	NS	0.067	0.048			NS	0.081	0.057		

Table 3: Effect of foliar sprays of NAA, Zinc and their interactions on pulp weight, rind weight and pulp seed ratio.

Pulp Weight	A_0 Control	10.340	10.560	10.870	11.250	10.755	10.780	11.560	11.870	12.060	11.568
	A_1 25	11.450	11.670	11.840	12.050	11.753	12.120	12.160	12.290	12.350	12.230
	A_2 50	12.940	13.120	13.450	13.230	13.185	13.320	13.680	13.980	13.720	13.675
	A_3 75	12.160	12.440	12.650	12.880	12.533	12.570	12.950	13.230	13.260	13.003
	Mean B	11.723	11.948	12.203	12.353		12.198	12.588	12.843	12.848	
	Factors	**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**			**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**		
	A	0.274	0.134	0.095			0.294	0.144	0.101		
	B	0.274	0.134	0.095			0.294	0.144	0.101		
	A × B	NS	0.268	0.189			NS	0.287	0.203		
Rind Weight	A_0 Control	3.420	3.400	3.390	3.370	3.395	3.400	3.380	3.370	3.350	3.375
	A_1 25	3.360	3.340	3.330	3.310	3.335	3.340	3.320	3.310	3.290	3.315
	A_2 50	3.240	3.210	3.200	3.200	3.213	3.230	3.200	3.190	3.190	3.203
	A_3 75	3.300	3.290	2.280	3.260	3.033	3.290	3.280	2.270	3.250	3.023
	Mean B	3.330	3.310	3.285	3.050		3.315	3.295	3.270	3.035	
	Factors	**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**			**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**		
	A	0.057	0.028	0.020			0.061	0.030	0.021		
	B	0.057	0.028	0.020			0.061	0.030	0.021		
	A × B	0.114	0.056	0.039			0.122	0.059	0.042		
Pulp: Seed Ratio	A_0 Control	2.610	2.677	2.783	2.900	2.743	2.720	2.960	2.980	3.143	2.951
	A_1 25	2.970	3.047	3.130	3.200	3.087	3.177	3.230	3.390	3.440	3.309
	A_2 50	3.620	3.800	4.020	3.910	3.838	3.843	3.937	4.080	3.980	3.960
	A_3 75	3.260	3.370	3.450	3.543	3.406	3.500	3.680	3.800	3.820	3.700
	Mean B	3.115	3.223	3.346	3.388		3.310	3.452	3.563	3.596	
	Factors	**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**			**C.D. at 5%**	**S.E.(d)±**	**S.E.(m)±**		
	A	0.059	0.029	0.021			0.077	0.038	0.027		
	B	0.059	0.029	0.021			0.077	0.038	0.027		
	A × B	NS	0.058	0.041			NS	0.075	0.053		

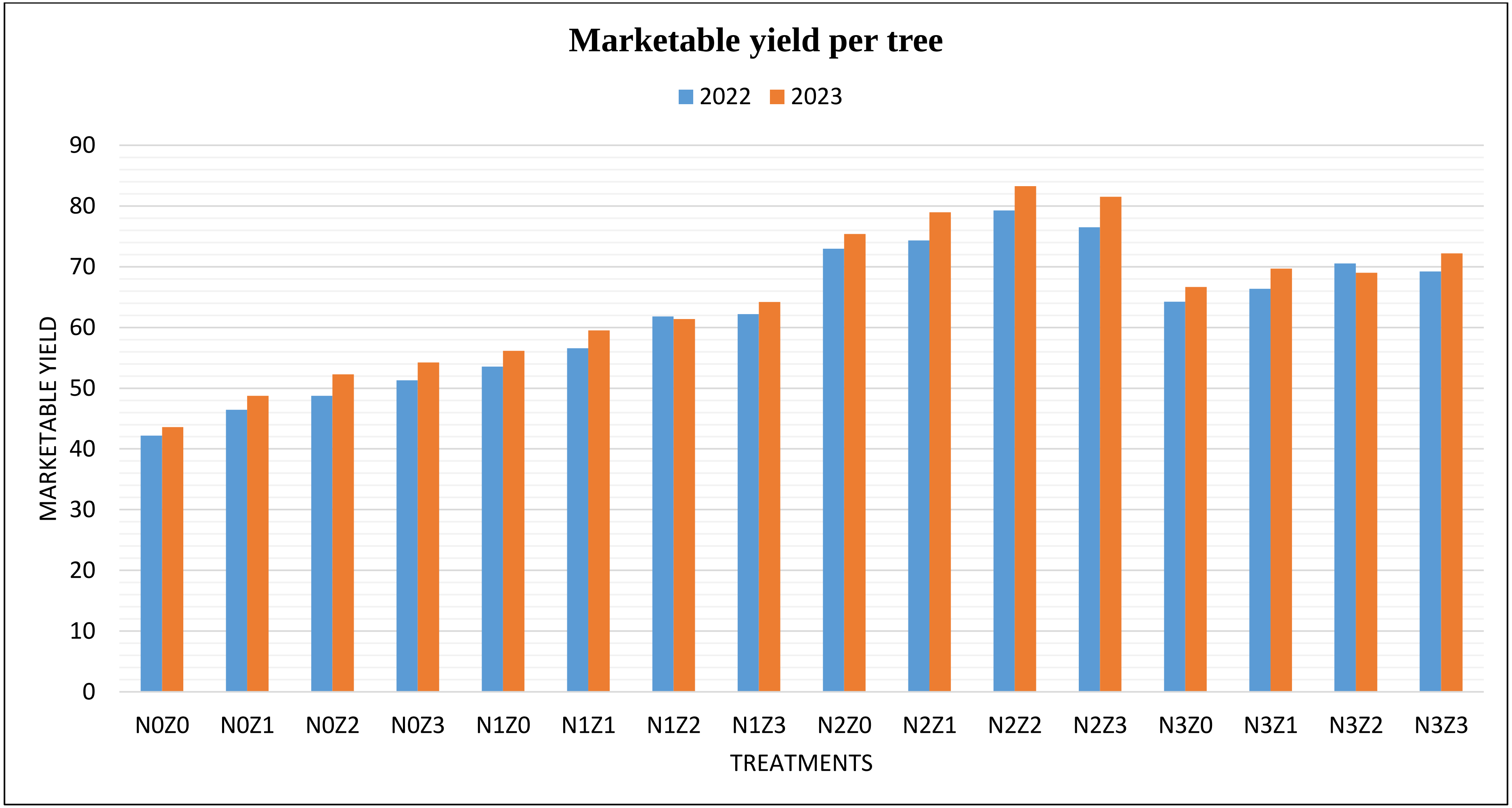

Fig. 1: Effect of foliar sprays of NAA, Zinc and their interactions on marketable yield