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Effect of zinc and zinc based biostimulants on physical quality of aonla (*Emblica officinalis*) cv. Chakaiya

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Abstract
The present field investigation entitled "Effect of Foliar Application of Zinc and Zinc Based Biostimulants on Quality of Aonla (*Emblica Officinalis* Gaertn.) cv. Chakaiya" was conducted during year *i.e.* 2024-25 at Research Farm, Krishi Vigyan Kendra (KVK), Rajsamand, Rajasthan. The experiment was laid out in randomized block design with three replications. Fifteen-year-old aonla plants were applied various treatments comprised of seven treatment with different combination consisting of water spray (control), $ZnSO_4$ @ 0.25%, 0.5%, 0.75% and $ZnSO_4$ + chitosan @ 0.25%, 0.5%, 075% were used in the present study. The first, foliar spray was applied in the month of August at marble stage and 2nd spray was done after one month of first spray and uniform cultural schedule was followed in all the treatments during the course of investigation. The results revealed that application of chitosan + $ZnSO_4$ @ 0.75% (T_7) significantly increased the fruit length (4.29 cm), fruit diameter (4.34 cm), fruit weight (41.87 g fruit^{-1}) and minimum seed weight (1.80 g), maximize pulp weight (44.42 g), pulp/ seed ratio (24.74) and fruit firmness (11.13 kg/cm^2).

Keywords: Zinc, fruit quality, aonla, foliar spray, chitosan

Introduction
Aonla (*Emblica officinalis* Gaertn.) or Indian gooseberry is the second richest fruit of vitamin C after Barbados Cherry. It is grown throughout the nation under a variety of agroclimatic conditions (Tiwari *et al.*, 2007) [10]. A significant fruit of the twenty-first century, aonla is tough, drought-resistant, prolific, and profitable even with little care. Its high productivity, nutritional and medicinal qualities, and appropriateness for processing a variety of value-added products make it a valuable crop (Pathak, 2003) [6]. India is the world's top producer with the majority of its production occurring in Uttar Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka, Tamil Nadu, and Himachal Pradesh. An estimated 1,090 thousand metric tonnes of fruit are produced per year on a total area of about 93,000 hectares under production (Sawant *et al.*, 2022) [7]. The state of Rajasthan produced 6000 MT of aonla on 5000 hectares of land (Anonymous, 2002) [1]. In agriculture, fertilizer application is crucial for higher crop yields. The fact that a lot of fertilizers are wasted in various ways, harming the environment and increasing production costs, is one of the main challenges in crop fertilization. One significant new development in reducing the environmental impact of applied fertilizers is the use of nano-fertilizers. Zinc is a crucial micronutrient for humans, animals, and plants to grow normally and healthy. Numerous important plant physiological pathways pertaining to the synthesis of sugar and photosynthesis, proteins and hormones, seed production, and disease resistance are primarily mediated by it (Bayvordi, 2006) [2]. Thus, zinc shortage decreased plant growth and production. There are numerous significant research findings supporting the usage of zinc in the form of nano fertilizer, including an increase in plant growth and development described in details about the utilization of chitosan in coping with biotic and abiotic stresses, improving the physiological attributes of plants, post-harvest quality of fruits and vegetables and reducing the use of inorganic fertilizer [Sharif *et al.*, 2018] [8]. Considering above facts this study "Effect of Foliar Application of Zinc and Zinc based Biostimulants on Quality of Aonla (*Emblica officinalis* Gaertn)" was conducted.

2. Materials and Methods

The present study was carried out at Research Farm, KVK, Rajasmand, Rajasthan. It is located in Rajasthan's Sub-Humid Southern Plain and Aravalli Hills, which are part of Agro-climatic Zone IV-A. Uniform fifteen-years-old aonla cv. 'Chakiya' trees planted at distance 8m x 8 m (row x plant) were selected for the study. The experiment included seven different combinations of treatments *viz*. Water spray (control-T_1), $ZnSO_4$ @ 0.25% (T_2), $ZnSO_4$ @ 0.5% (T_3), $ZnSO_4$ @ 0.75% (T_4), Chitosan + $ZnSO_4$ @ 0.25% (T_5), Chitosan + $ZnSO_4$ @ 0.5% (T_6), Chitosan + $ZnSO_4$ @ 0.75% (T_7). First, foliar spray done at marble stage and 2nd spray after one month. The fruit qualities of fruit were determined as per standard procedure. The data obtained for various characters were pooled together and subjected to randomized Block Design (RBD) analysis and interpretation of the data was carried out in accordance to [Panse *et al.*, 1985].

A. Fruit weight (g): Fruit weight of five fruits was recorded with the help of electronic digital balance and average was expressed in gram.

B. **Seed and pulp weight (g):** The weight of stone was recorded with the help of physical balance and the average stone weight was calculated and expressed in gram (g). Pulp weight was obtained by deducting the weight of seed (stone) and peel and expressed in gram.

C. Fruit diameter (cm): Fruit diameter of five randomly selected fruits in each treatment was recorded at equatorial with the help of vernier callipers in centimetre and the average was calculated.

D. Fruit length (cm): Fruit length of five randomly selected fruits in each treatment were recorded longitudinally with the help of vernier callipers in centimetres.

E. Fruit firmness (kg/cm^2): The firmness of aonla fruits was determined with Texture Analyser using a 2 mm diameter SS probe with the following testing modes: Pre-test speed-2 mm/s, Test speed-2 mm/s, Post-test speed-10 mm/s and Distance-5.0 mm.

F. Pulp/seed ratio: The ratio was obtained by dividing the weight of pulp with weight of seed from each treatment per replication.

3. Results and Discussion

The data pertaining to effect of various nutritional treatments on physical properties of fruit are presented in Table 1, 2 and 3. On the basis of data analysis, the maximum fruit weight (41.87g/fruit) was recorded at T_7 treatment, followed by treatment T_6 *i.e.* chitosan + $ZnSO_4$ @ 0.5% per plant (40.11 g/fruit) and minimum fruit weight (32.04 g/fruit) was recorded at T_1 treatment. The foliar application of chitosan + $ZnSO_4$ @ 0.75% (T_7) significantly increased the fruit weight in aonla over rest of the treatments. Application of treatment T_7 chitosan + $ZnSO_4$ @ 0.75% exhibited maximum fruit diameter (4.34 cm), while minimum fruit diameter (3.15 cm) was recorded with the application of (T_1). This increase in fruit diameter (T_7) treatment was 37.77 percent higher over the T_1 treatment.

Table 1: Effect of foliar application of zinc and zinc based biostimulants on seed weight (g) and fruit weight (g) of aonla

Treatments	Fruit weight (g)	Seed weight (g)
T_1	32.04	1.79
T_2	34.13	1.68
T_3	36.11	1.57
T_4	37.20	1.52
T_5	38.48	1.49
T_6	40.11	1.34
T_7	41.87	1.03
SEm±	0.588	0.009
CD (p=0.05)	1.813	0.029

The application of chitosan + $ZnSO_4$ @ 0.75% per plant (T_7), exhibited maximum fruit length (4.29 cm), which was 32.4% higher than application of (T_1) *i.e.*3.24 cm. the recorded data showed that T_7 treatment (chitosan + $ZnSO_4$ @ 0.75% per plant) exhibited significantly higher fruit firmness (11.13 kg/cm^2). The minimum fruit firmness was observed at $ZnSO_4$ @ 0.25% per plant (T_1) treatment *i.e.* 9.17 kg/cm^2, the foliar application of zinc and zinc based biostimulants, as compared to control.

Table 2: Effect of foliar application of zinc and zinc based biostimulants on fruit diameter (mm), fruit length (cm) and pulp weight (g) of aonla

Treatments	Fruit diameter (mm)	Fruit length (cm)	Pulp weight (g)
T_1	3.15	3.24	30.21
T_2	3.46	3.54	32.45
T_3	3.63	3.72	34.54
T_4	3.84	3.85	35.68
T_5	4.01	3.96	36.99
T_6	4.23	4.09	38.77
T_7	4.34	4.29	40.84
SEm±	0.064	0.071	0.562
CD (p=0.05)	0.196	0.219	1.730

The maximum pulp weight (40.84g) with the treatment chitosan + $ZnSO_4$ @ 0.75% per plant (T_7) followed by (38.77 g) was recorded under treatment (T_6) $ZnSO_4$ @ 0.5% where the minimum pulp weight (30.21 g) being recorded under treatment (T_1) control. The foliar application of zinc and chitosan + zinc, as compared to control, the minimum weight of seed (1.03 g) with the treatment chitosan + $ZnSO_4$ @ 0.75% per plant (T_7) followed by (1.34 g) was recorded

under treatment (T_6) ZnSo4 @ 0.5% where the maximum weight of seed (1.79 g) being recorded under treatment (T_1) control.

Table 3: Effect of foliar application of zinc and zinc based biostimulants on fruit firmness (kg/ cm^2) and pulp/seed ratio of aonla

Treatments	Fruit firmness (kg/ cm^2)	Pulp/seed ratio
T_1	9.17	16.82
T_2	10.45	19.32
T_3	10.62	22.00
T_4	10.76	23.47
T_5	10.88	24.82
T_6	10.96	28.93
T_7	11.13	39.65
SEm±	0.085	0.439
CD (p=0.05)	0.262	1.353

The foliar application of zinc and chitosan + zinc as compared to control. The highest pulp/seed (39.65%) with the treatment (T_7) chitosan + $ZnSO_4$ @ 0.75% followed by (28.93%) was recorded under treatment (T_6) chitosan + $ZnSO_4$ @ 0.5% and were the minimum pulp/seed ratio (16.82%)) was record under treatment (T_1) control. The present finding is in conformity with the observations recorded in aonla cv. Banarasi (Singh *et al.*, 2012) [9]. The similar results have also been reported by (Dutta *et al.*, 2011) [3] in mango cultivar Dashehari. It is evident from the present finding that the increase in pulp weight and pulp: stone ratio in developing fruits might be due to the acceleration in biochemical activities and accumulation of metabolites in plant parts due to optimum level of nutrients status of plants. The present observation is also in accordance to observations recorded by (Meena *et al.*, 2005) [4] in guava.

Conflicts of Interest
Authors have no conflict of interest.

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Conclusion
On the basis of results obtained in the present investigation entitled "Effect of foliar application of Zinc and Zinc Based Biostimulants on Quality of Aonla (*Emblica Officinalis*)" it may be concluded that the application of chitosan + $ZnSO_4$ @ 0.75% (T_7) enhanced the physical parameters of aonla fruits *i.e.* seed weight, fruit diameter, fruit length, fruit weight, fruit firmness, pulp weight, pulp/seed ratio. Based on the above finding, it could be recommended that the aonla grower should apply chitosan + $ZnSO_4$ @ 0.75% to obtain the qualitative fruit production as first foliar spray at marble stage during the month of August and 2nd spray after one month of first spray under Agro-climatic Zone IV-A *i.e.* Sub Humid Southern plain and Aravalli hills of Rajasthan.

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