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Foliar application of zinc sulphate, magnesium sulphate and copper sulphate on the yield and quality of aonla (*Emblica officinallis* Gaerth L.) cv. "NA-7" under Garhwal Himalaya

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Abstract
The present investigation entitled "Effect of micro nutrient on yield and quality of Aonla (*Emblica officinallis* Gaertn L.) cv. NA-7" was carried out at the Horticulture Research Center, Department of Horticulture, HNB Garhwal University, Srinagar, Garhwal, Uttarakhand during the year 2013-2014. The experiment was conducted in Randomized Block Design with eight treatments and replicated in four times, considering one plant as a unit. The observations were recorded for Physico-chemicals and yield attributing characters of aonla fruits. The maximum fruit size, weight, volume and pulp: stone ratio was recorded with foliar application of Zinc sulphate, Magnesium sulphate and Copper sulphate (0.5 per cent each). Better quality fruits with respect to highest total soluble solids, sugars, ascorbic acid and low acidity percentage were recorded with combined spray of Zinc sulphate, Magnesium sulphate and Copper sulphate (0.5 per cent each). The fruit yield was also recorded maximum with the combined spray of Zinc sulphate, Magnesium sulphate and Copper sulphate (0.5 per cent each). Overall it can be concluded that combined application of Zinc sulphate, Magnesium sulphate and Copper sulphate (0.5 per cent each) judged the best for higher fruit yield, production and better fruit quality of aonla.

Keywords: Zinc sulphate, Magnesium sulphate, Copper sulphate, Aonla, Quality, Yield.

1. Introduction
The Indian gooseberry *(Emblica officinallis* Gaertn L.) belongs to Euphorbiaceae family it is an important indigenous and minor fruit. The aonla find mention in 'Vedas', Ramayana; Charak Samhita, Sushrat Samhita and other Ancient Indian literature describing its fruit highly valuable as food, medicine and hair dye. The commercial cultivation of aonla is expended from the home land of Uttar Pradesh to almost all over India including Maharashtra, Gujarat, Rajasthan Madhya Pradesh and Jharkhand Chhattisgarh, Andhra Pradesh, Karnataka, Haryana, and Himachal Pradesh. Aonla is also considered as 'wonder fruit for health' because of its unique qualities. It is a rich source of vitamin C (500-600mg/100gm) and its content is next to only that of Barbados cherry *(Malpighia glabra* L).
The role of growth regulator for improving the growth and development, fruit set, control of fruit drops, fruit maturation, fruit quality and cover coming of physiological and nutritional disorders have been well established in number of topical, sub-tropical and temperate fruit crops (Singh *et al.* (2007) [15, 19]. Among the foliar application of various level of nutrients viz. Zinc, copper and magnesium have been found more effective in improving the flowering, fruit set, fruit size, fruit yield and fruit quality in number of fruit crops. Similar studies on foliar application of growth regulator have earlier been under taken to find out the effect of fruit set, fruit size, fruit drop, fruit maturation, fruit yield, and fruit quality of aonla Singh *et al*. (2009) [7, 17]. A sporadic research work have been carried out so far to overcome the problem of heavy pre-harvest fruit drop, improving the fruit yield and quality of aonla cv. NA-7 grown under degraded sodic land having low soil fertility levels.

2. Materials and Methods
The experiment was conducted on 8 years old cv. NA-7 aonla tree at the Horticulture Research Center, Department of Horticulture, HNB Garhwal University, Srinagar, Garhwal, Uttrakhand, during 2012-13. The experiment was laid out in randomized block design with four replications. The treatment consisted two foliar application of Zinc sulphate, Copper sulphate, Magnesium sulphate. These were T_1 (Control Water spray), T_2 (Zinc sulphate @ 0.5%)**,** T_3

(Copper sulphate @ 0.5%), T4 (Magnesium sulphate @ 0.5%), T_5 (Zinc sulphate @ 0.5% + Magnesium sulphate @ 0.5%), T_6 (Zinc sulphate @ 0.5% + Copper sulphate @ 0.5%), T_7 (Copper sulphate @ 0.5% + Magnesium sulphate @ 0.5%), T_8 (Zinc sulphate @ 0.5% + Magnesium sulphate @ 0.5% + Copper sulphate @ 0.5%). The foliar sprays of micro-nutrient were applied two times after fruit set. The first spray of nutrient were applied in the mid of June 2012 and second spray were applied after one month of first spray i.e. mid of July at the time of fruit development stage. For recording various growth parameters of fruit viz. (A) Flowering and fruiting behavior – Per cent fruit drop, Per cent fruit retention (B) Physical characters- Size of fruits, Weight of the fruit, Pulp weight, Stone weight, Pulp stone ratio (C) Chemical characteristics of fruits- Total soluble solids, Acidity, Ascorbic acid (Vitamin C), Sugars (a) Reducing sugar, (b) Non-reducing sugar, (c).Total sugars, (D) Fruit yield, diameter were noted using the vernier caliper, volume of fruit was recorded by water displacement method and weight of fruit, weight of stone, pulp weight, pulp stone ratio, yield was recorded using electronic weigh balance. For determination of chemical parameters of fruit viz. acidity, total soluble solids (TSS), acidity. ten healthy fruits were selected randomly from each tree at full maturity stage. Hand refractometer was used for determination of T.S.S. in ^{0}Brix. Acidity was estimated by simple acid–alkali titration method (A.O.A.C., 1970). Assay method of ascorbic acid was followed given by Ranganna (1977). The total reducing sugar was estimated by Fehling solution method as advocated by Lane and Eynon (1943) [8].

3. Results and Discussion

The maximum fruit drop (81.62 %) was recorded under T_1 (control) treatment. The minimum fruit drop (70.11 %) was observed with combined spray of T_8 (Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%). The spray of urea and zinc sulphate proved efficacious to reduce the fruit drop of ber cv. Banarasi Karaka (Rao *et al.*, 2004). Singh *et al.* (2012) [16, 20] also reported that application of zinc sulphate, borax and copper sulphate was most effective to minimize fruit drop in aonla cv. Banarasi. Also similar results with application of urea and zinc sulphate have been found in fruit drop of mulberry (Singh *et al*., 2007) [19, 15].

Fruit retention was improved appreciably by all the treatment over control. However, maximum (24.45%) was observed with the combined spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%). It is close conformity with the findings of Sharma *et al.* (2005) [11] similar results were obtained with spray of calcium nitrate and zinc sulphate in maximum fruit retention in peach cv. Flordasum Kaul and Mathew (1989) [6].

The results clearly indicated that fruit size was markedly improved by all the nutrients over control. The maximum fruit size in terms of fruit length (3.42 cm) was recorded with combined spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%. And maximum breadth (3.93 cm) was recorded with combined spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%). The result is in closely conformity with the finding of Banik *et al.* (1997) [3] and Singh *et al*. (2001) [14, 18]. The beneficial effect of zinc It improvement in quality might be due to the fact that Zinc improves quality in many fruit crops but characteristics involvement in synthesis and transport of photosynthate and subsequent conversion into carbohydrate and protein. Reduction in fruit drop may be due to the fact that zinc is present in several dehydrogenase and proteinase enzymes and involved in the bio synthesis of auxin, which promotes flowering and fruit setting of many plants.

The resign for increase in fruit size with spraying of zinc might be attributed to efficient absorption and consequently more luxuriant vegetative growth in the initial stage which influenced the activity of metabolism in plant which attributed to better development of fruit. The present findings have also been confirmed by application of calcium nitrate, boric acid and zinc sulphate to improve the fruit size of guava cv. Sardar Goswami *et al.* (2009). The zinc sulphate and urea spray also increase the size of aonla cv. NA-6 Khan *et al.* (2009) [7].

The volume and weight of fruit was improved appreciably by all the nutrients over control. However, the maximum impact (30.49 cm^3, 31.52g) was recorded with the combined spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%, whereas minimum fruit volume recorded in control plants. The involvement of zinc directly in growth and magnesium indirectly through translocation of food material might be responsible to improve the weight and volume of fruits. These results are in close conformity with the findings of Ghosh *et al.* (2009) [2, 4] have also reported that foliar spray of zinc sulphate to increase fruit weight of aonla, similarly Singh *et al.* (2012) [16, 20] with the spray of Boron, zinc and copper in aonla fruit cv. Banarasi.

The pulp stone ratio was improved by all chemicals over control. The maximum pulp stone ratio (19.69g) was recorded with the combined spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%, whereas minimum pulp stone ratio (14.23g) was recorded under control. There is little information available for pulp stone ratio of aonla but Singh *et al.* (2004) reported that spray of urea, magnesium sulphate and zinc sulphate increase the pulp stone ratio of aonla fruit. The increase in pulp: stone ratio might be due to the acceleration in biochemical activities and accumulation of metabolites in plant parts, which is probably due to synergistic effect of Zinc and Copper on conversion and translocation of total sugars and minerals during the process of fruit development and fruit maturation. Similar observations were recorded by Singh *et al.* (1993) [13] in aonla.

The maximum accumulation of (12.25%) total solids content in aonla fruit was found with combined spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%. However, the promoting effect was also observed by almost all nutrients over control. Role of calcium to increase membrane permeability in many fruits is well known. Thus, it seems logical that an increase in permeability permitted the acid particular citric acid stored in cell vacuoles for break down by respiration at faster rate. During ripening carbohydrate converts into simplest form of sugars which may ultimately increase the TSS content of fruits. The results are close conformity with the finding of Ghose *et al.* (2009) also reported that spray of Zinc (0.5%) increase the total soluble solids in aonla cv. NA-10.

All the treatments of nutrients were found to reduce the acid content of fruits as compared to control. The lowest acid content (1.70%) was observed with combined spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%. Such type of results might due to transformation of organic acid into sugars at the time of ripening. Likewise similar results were obtained with combined application of zinc sulphate to decrease the acidity in pear, *cv*. Patharnakh. (Shandhu *et al*., 1994) [10] and Singh *et al*. (2001) [14, 18] also reported that combined spray of zinc Similar observations were findings of Singh *et al*. (2012) [16, 20] with the spray of zinc sulphate to reduce the acidity of aonla fruit, *cv*. Banarasi.

Ascorbic acid content was significantly influenced by spraying of nutrients as compared to control. Significantly maximum

ascorbic acid (791 mg/100 g pulp) content was recorded with application of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%. And the minimum ascorbic acid (690 mg/100 g pulp) content found in control. The increase in ascorbic acid content of fruit juice was due to increase synthesis of catalytic enzymes and co-enzyme which are represented ascorbic acid and synthesized.

These results are in close conformity with the findings of Ghosh *et al*. (2009) [2, 4] that the spray of zinc sulphate and borax increase ascorbic acid in aonla. Singh *et al*. (2001) [14, 18] with ZnSO4, CuSO4 and Borax in aonla it is evident from the result that vitamin-'C' content in fruit might be improved with application of micro-nutrients. The application of urea, magnesium and zinc sulphate increase ascorbic acid in aonla *cv*. Banarasi (Singh *et al*., 2012) [16, 20].

Total sugars, reducing sugars and non-reducing sugar contents were found in aonla fruit as influenced by different treatments. The maximum sugars (5.88%, 3.41%, 2.47%) have been recorded with the spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%. The reasons for increase in TSS content of fruit may be due to fact that nutrients play important role on photosynthates which ultimately lead to the accumulation of carbohydrate and attributed to increase in TSS of fruits. The results are in closed conformity with the findings of Yadav *et al*. (2011) [21] that maximum ascorbic acid recorded with the application of zinc sulphate and borax in guava fruits cv. L 49, (Singh *et al*., 2004) also reported that spray of urea and potash increased the sugars content in aonla fruits. (Singh *et al.,* 2007) [15, 19] have also reported that combined spray of zinc, copper and NAA increased the sugar contents in aonla fruits cv. NA-10.

The yield attributing characters in aonla are number, size and weight of fruits, which are highly influenced by nutritional levels of tree and soil. The supplementary doses of nutrients apply through foliar application use of different chemicals and have been well established in number of fruits for improving the yield. The foliar application of micro-nutrients has shown better responses to improve the fruit yield in aonla. The highest yield per tree (58.64 kg) was recorded with the spray of Zinc sulphate 0.5% + Magnesium sulphate 0.5% + Copper sulphate 0.5%. The lowest fruit yield (46.04 kg) was recorded in control. The present finding is possibly due to their directly or indirectly involvement in the setting, retention, reduction in fruit drops as well as growth and development of fruits. These activities improve number of fruit, length of fruits, breadth of fruits and weight of fruit ultimately increases the total yield of fruit. The maximum fruit yield was recorded with combined application of Mg + Cu + Zn in mandarin orange (Ram *et al.*, 2000) [9] foliar spray of calcium nitrate, boric acid and zinc sulphate have also improved the fruit yield of guava cv. Sardar. (Goshwami *et al.*, 2012), foliar application of urea, $ZnSO_4$ and magnesium sulphate and growth regulators significantly increased fruit yield of ber (Sharma *et al.*, 2011) [12].

Table 1: Physical character

Treatments	Fruit drop (%)	Fruit retention (%)	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Fruit volume (cm^3)	Pulp stone ratio
T_1 Control (Distilled spray)	81.62	17.95	2.89	3.06	22.42	21.55	14.23
T_2 Zinc sulphate @ (0.5%)	75.83	22.13	3.12	3.43	27.70	26.95	17.65
T_3 Copper sulphate @ (0.5%)	76.62	21.90	3.08	3.31	24.00	25.75	16.98
T_4 Magnesium sulphate @ (0.5%)	76.74	20.66	3.06	3.26	23.10	25.70	16.38
T_5 Zinc sulphate @ (0.5%) + Magnesium sulphate @ (0.5%)	73.30	23.02	3.24	3.77	27.45	28.13	18.21
T_6 Zinc sulphate @ (0.5%) + Copper sulphate @ (0.5%)	72.31	23.89	3.22	3.60	29.74	29.13	18.82
T_7 Copper sulphate @ (0.5%) + Magnesium sulphate @ (0.5%)	74.04	23.58	3.21	3.50	26.25	27.95	18.75
T_8 Zinc sulphate @ (0.5%) + Magnesium sulphate @ (0.5%) + Copper sulphate @ (0.5%)	70.11	24.35	3.32	3.97	32.50	30.40	19.70
C.D. at 5%	0.613	0.773	0.161	0.158	2.610	2.013	1.43

Table 2: Chemical character

Treatments	TSS (ºBrix)	Acidity (%)	Ascorbic acid (mg/100g pulp)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Yield (kg/tree)
T_1 Control (Distilled spray)	9.75	2.61	690.00	2.63	2.08	4.71	46.04
T_2 Zinc sulphate @ (0.5%)	11.00	2.44	735.00	2.77	2.30	5.14	54.27
T_3 Copper sulphate @ (0.5%)	10.50	2.50	730.00	2.97	2.26	5.23	52.53
T_4 Magnesium sulphate @ (0.5%)	10.20	2.50	718.00	2.76	2.21	4.97	50.07
T_5 Zinc sulphate @ (0.5%) + Magnesium sulphate @ (0.5%)	11.25	2.29	744.00	3.01	2.33	5.34	56.89
T_6 Zinc sulphate @ (0.5%) + Copper sulphate @ (0.5%)	12.00	1.90	754.25	3.16	2.37	5.53	57.29
T_7 Copper sulphate @ (0.5%) + Magnesium sulphate @ (0.5%)	11.70	2.40	740.00	3.11	2.34	5.45	56.44
T_8 Zinc sulphate @ (0.5%) + Magnesium sulphate @ (0.5%) + Copper sulphate @ (0.5%)	12.30	1.70	792.00	3.42	2.38	5.75	59.70
C.D. at 5%	0.813	0.12	31.43	0.235	0.097	0.240	1.089

4. Conclusion

Thus, it may be concluded from the above highlighted experimental findings of the present investigation due to effect of foliar spray of nutrients revealed that the combined foliar application of $ZnSO_4$ (0.5%) + MgSO4 (0.5%) + CuSO4 (0.5%) was found to be most effective in reducing the intensity of fruit drop, high fruit retention, improving the fruit size and fruit weight, pulp: stone ratio, increase of Vitamin-C content and highest fruit yield as compared to other treatments.

5. References

1. AOAC. Official method of analysis. Association of Official Analytical Chemists (12th ed.), Washington, D.C., 1990.
2. Animesh, Sarkar, Ghosh, Bikash. Effect of foliar application of micronutrient on retention, yield and quality of fruit in litchi cv Bombai. Environment and Ecology 2009; 27(1):89-91.
3. Banik BC, Mitra SK, Sen SK, Bose TK. Interaction effect of zinc, iron and boron on physic-chemical composition of mango fruit cv.Fazli. the Oriss J Hort. 1997; 25(1):5-9.
4. Ghosh SN, Bera B, Roy S, Kundu A, Roy SKD. Effect of nutrients and plant growth regulators on fruit retention, yield and physico-chemical characteristics in aonla cv. NA-10. Journal of Horticultural Sciences. 2009; 4(2):164-166.
5. Goswami AK, Shukla HS, Kumar P, Mishra DS. effect of pre-harvest application of micro-nutrients on quality of guava (Psidium guajava L.) cv. Sardar. Hort. Flora Research Spectrum 2012; 1(1):60-63.
6. Kaul OP, Mathew AK. Effect of foliar spray of calcium nitrate, zinc sulphate and ethrel on the fruit characteristics of Flordasum peach (Prunus persica Batch). Advances in Plant Sci. 1989; 120(2):577-518.
7. Khan Shamashad, Singh HK, Vishwanath, Pratap, Bhanu. Impact of foliar application of micro-nutrients and thiourea on growth, fruit yield and quality of aonla (Emblica officinalis Gaertn) cv. Narendra Aonla-6. Annals of Horticulture. 2009; 2(1):83-85.
8. Lane JH, Eynon L. Determination of reducing sugar by fehling solution with mehylene blue as indicator. J Soc. Chemi. Ind. 1943; 42:327.
9. Ram RA, Bose TK.. Effect of foliar application of magnesium and micro-nutrient on growth, yield and quality of mandarin orange fruit (Citrus reticulata Blanco). Indian Journal of Horticulture. 2000; 57(3):215-220.
10. Shandhu AS, Singh SS, Grewal MGP, Sagar D. Influence of sources of zinc on growth and nutrient status of sand pear (Pyrus pyrifolia Braum Nobai.), Sixth International Symp. On pear growing Med. Ford, Oregon, U.S.A., 12-14, 1993, Acta Hort 1994; 367:323-328.
11. Sharma P, Singh AK, Sharma RM. Effect of plant bio-regulators (PBRs) and Micro nutrients on fruit set and quality of litchi cv. Dehradun. Indian Journal of Horticulture. 2005; 62:(1)24-26.
12. Sharma, Jeetram, Sharma SK, Panwar RD, Gupta RB. Fruit retention, yield and leaf nutrient content of ber as influence by foliar application of nutrients and growth regulators; Environmen and ecology. 2011; 29:(1):627-631
13. Singh IS, Pathak RK, Dwivedi R, Singh HK. "Technical bulletin on aonla production and post-harvest technology" published by Department of Horticulture, NDUAT, Kumarganj-Faizabad (U.P.), 1993.
14. Singh HK, Srivastava AK, Dwivedi R, Kumar P. Effect of foliar application on internal fruit necrosis of aonla (Emblica officinalis Gaertn.) cv. Francis. Progressive Horticulture. 2001; 33(1):80-83.
15. Singh JK, Prasad J, Singh HK. Effect of micro-nutrients and plant growth regulators on yield and physico-chemical characteristics of aonla fruit in cv. Narendra Aonla-10. Indian Journal of Horticulture. 2007; 64(2):216-218.
16. Singh PC, Gangwar RS, Singh VK. Effect of micronutrients spray on fruit drop, fruit quality and yield of aonla cv. Banarasi. Hort Flora Research Spectrum. 2012; 1(1):73-76.
17. Singh DM, Singh HK. Vishwanath and Pratap Bhanu Effect of foliar feeding of nutrients on yield and quality of aonla fruits (Emblica officinalis Gaertn.) Annals of Horticulture. 2009; 2(1):95-97.
18. Singh HK, Srivastava AK, Dwivedi R, Kumar P. Effect of foliar application on internal fruit necrosis of aonla (Emblica officinalis Gaertn.) cv. Francis. Progressive Horticulture. 2001; 33(1):80-83.
19. Singh JK, Prasad J, Singh HK. Effect of micro-nutrients and plant growth regulators on yield and physico-chemical characteristics of aonla fruit in cv. Narendra Aonla-10. Indian Journal of Horticulture. 2007; 64(2):216-218.
20. Singh PC, Gangwar RS, Singh VK. Effect of micronutrients spray on fruit drop, fruit quality and yield of aonla cv. Banarasi. Hort Flora Research Spectrum. 2012; 1(1):73-76.
21. Yadav HC, Yadav AL, Yadav DK, Yadav PK. Effect of foliar application of micro-nutrients and GA3 on yield and quality of rainy season guava (Psidium guajava L.) cv. L-49 Plant Archives. 2011; 11:(1):147-149.