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Effect of Micronutrients on Yield and Quality of Aonla (*Emblica officinalis* Gaertn.) cv. NA-7

Y.C. Abhijith[1*], J. Dinakara Adiga[2], H. Kishor[3] and C. Sindhu[4]

[1]Department of Fruit Science, College of Horticulture, UHS campus, Bengaluru - 560065, Karnataka, India
[2](Hort-Fruit Science), ICAR-DCR, Puttur - 574 202, India
[3]Aeroponics Centre, PRS Horticulture farm, Chickaballapura, Karnataka, India
[4]Division of Food Science and Post Harvest Technology, IARI, Pusa Campus, New Delhi, India

**Corresponding author*

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A B S T R A C T

The major problem associated with Aonla (*Emblica officinalis* Gaertn.), a minor fruit crop, suitable for rain-fed horticulture, having potential medicinal properties due to which it has become a most sought after fruit for ayurvedic preparations, is the reduced yield and quality due to many reasons. In this context, an investigation was taken up at College of Horticulture Bengaluru, to exploit the possibility of improving the fruit yield and enhancing the fruit quality through foliar application of micronutrients in aonla cultivar NA-7. The study revealed that the foliar spray of micronutrient combination of 0.5 % $ZnSO_4$ + 0.5 % $FeSO_4$ + 0.25 % Borax) significantly increased yield (6.93 tonnes/ha). The yield was almost double as compared to control in the said combination of micronutrients as result higher benefit cost ratio (3.60) was recorded. Further, the quality parameters of fruits such as higher total sugar, reducing sugar and non-reducing sugar content of fruits was significantly improved without reducing the vitamin C (483.71 mg/100 g) with the above said combination of nutrients. Hence, the micronutrient combination of 0.5 % $ZnSO_4$ + 0.5 % $FeSO_4$ + 0.2 5% Borax holds immense potential as a foliar spray in arresting fruit drop and doubling up the yield in aonla under rain-fed conditions of southern dry zone of Karnataka.

Introduction

Aonla (*Emblica officinalis* Gaertn.), is an indigenous, minor, sub-tropical fruit crop which is also known as Fruit of 21st century and Indian gooseberry, belongs to family Euphorbiaceae; subfamily phyllanthoidae (Khan *et al.*, 2009) and is native to Central and Southern India. The crop is been cultivated in Sri Lanka, Malaysia and China etc. In India, it is being cultivated in an area of about 85,000 ha with an annual production of 1094000 MT (Anon., 2015-16), particularly in the in the salt affected districts of Uttar Pradesh, arid and semiarid parts of Maharashtra, Gujarat, Rajasthan, Karnataka

etc,. It is a rich source of vitamin 'C' (500-600 mg/100g) among fruits and ranks second after Barbados cherry (*Malpighia glabra* L.) (Asengo, 1953). Besides vitamin C, aonla fruit contains 81.20 % moisture, 0.50 % protein, 14.10-21.89 % carbohydrate, 3.40 % fiber, 0.05 % calcium, 0.02 % phosphorus, 1.20 % iron, 59/100g calorific value and vitamin B content of 30 mg/100g pulp. It also contains phyllamblin, gallic acid, ellagic acid and tannins which retard the oxidation of vitamin C (Yadav and Shukla, 2009). It is most often preferred fruit for its medicinal and nutritional properties, particularly in Indian system of medicine, like Ayurveda and Unani. Triphala and chyavanprash are well-known indigenous medicines in Indian ayurvedic system using aonla. It is also considered as 'wonder fruit for health' because of its unique qualities.

The plant exhibits phyllanthoid branching habit producing short determinate and long indeterminate shoots. The flowers are unisexual flowers are produced as axillary cymules on determinate shoots. Sex ratio in aonla varies from 28.7:1 to 355.5:1 in different cultivars. Fruit is capsular which exhibits zygodormancy. Seed is capsule with two to three locules.

The Aonla growers are experiencing the problem of reduced yield and sometimes reduced quality due to necrosis and fruit drop which is associated with deficiency of boron and other micronutrients. The micronutrients like boron, zinc and iron play a vital role in fruit growth and development and their application is found effective to solve these problems. Keeping this in mind the present study was conducted to study the response of foliar application of micronutrients on yield and quality of aonla at the Regional Horticultural Research and Extension Centre (RHREC), University of Horticultural Sciences, GKVK campus, Bengaluru, Karnataka-560065.

Materials and Methods

Six year old uniform plants of aonla *cv*. Neelum (NA-7) was used which are spaced at 6 m x 6 m (277 plants/ha). Fertilizers are applied uniformly as per the recommendations; FYM 25.00 kg/plant (2.5 tonnes/ha) + 75:50:50 g NPK/ plant (7.5:5.0:5.0 kg/ha). Treatment included use of three different nutrients at different combinations; T_1 (Control, water spray), T_2 (0.5 % $ZnSO_4$), T_3 (0.5 % $FeSO_4$), T_4 (0.25 % Borax), T_5 (T_2+ T_3), T_6 (T_2+ T_4), T_7 (T_3+ T_4), T_8 (T_2 + T_3 + T_4). Two sprays were taken; one is at the time of flushing and second at sixty days after flushing which coincides with flowering.

The total cumulative yield per plant was recorded with a weighing machine and expressed in kilograms and the yield per hectare was computed by multiplying the yield per plant with the number of plant that can be accommodated in one hectare and was expressed in tonnes per hectare. For determination of fruit chemical parameters of fruit viz., titrable acidity (%), total soluble solids (TSS in ^{o}B), sugars (total, reducing and non-reducing sugars in per cent), ascorbic acid (mg/100 g pulp) content, five healthy fruits from each tree at full maturity stage. Hand refractometer was used for determination of total soluble solids, simple acid-alkali titration method was used for titrable acidity (Ranganna, 1977). Sugars in fruit juice and ascorbic acid (2, 6-dichlorophenol indophenols visual titration method) contents were determined as described by Ranganna (1986).

The experiment was laid out in a completely randomized block design with three replications. Three plants for each treatment were sampled for plant growth, reproductive and yield components. Five fruits were randomly selected for evaluating fruit physical

and chemical features. The data were analysed in a completely randomized block design using analysis of variance (ANOVA).

Results and Discussion

The foliar application of micronutrients had significant influence on yield of aonla. The highest fruit yield (24.96 kg tree^{-1} and 6.93 tonnes ha^{-1}) was recorded with the combined application of $ZnSO_4$ 0.5 %, $FeSO_4$ 0.5 % and Borax 0.25 % (T_8) which is 67.40 per cent higher than control (Table 1). The increase in yield might due to direct or indirect involvement of micronutrients in photosynthesis, fruit setting, retention, reduction in drop as well as growth and development of fruits caused by foliar sprays of zinc, iron and boron.

These activities improve number of fruits, length of fruits, breadth of fruits and weight of fruits and ultimately the higher yield levels. The application of zinc and boron might have caused rapid synthesis of protein and translocation of carbohydrate which ultimately led to increase in fruit weight which is directly correlated with total yield (Singh *et al.,* 2012). Similar results have been reported in aonla (Ram *et al.,* 1977; Dashora *et al.,* 2005; Panwar *et al.,* 1995) and in litchi (Babu and Singh, 2001).

The treatment combination of $ZnSO_4$ 0.5 %, $FeSO_4$ 0.5 % and Borax 0.25 % (T_8) resulted in highest cost benefit ratio (3.60) when compared to control (2.51) and other micronutrient combinations (Table 1). The highest cost benefit ratio obtained may be attributed to reduction in fruit drop and nearly two fold increase in the overall yield per plant. The earlier reports on ber (Meena *et al.,* 2014) and guava (Waskela *et al.,* 2013) also revealed higher cost benefit ratio of 4.40 and 5.02 respectively, consequent to the combined application of $ZnSO_4$, $FeSO_4$ and boron.

TSS, titrable acidity and TSS: acid ratios were found statistically non-significant, whereas the higher ascorbic acid content (486.88 mg/100g) was recorded from nutrient combination of zinc 0.5 % and iron 0.5 % (T_5) (Table 2). The vitamin C of fruits was appreciably influenced by synthesis of catalytic enzymes stimulated by zinc application. The increase in ascorbic acid might be due to catalytic influence of micronutrients on its bio-synthesis from its precursor glucose 6- phosphate or inhibition of its conversion to dehydroxy ascorbic acid by enzyme ascorbic acid oxidase or both. The present observations are in close agreement with the reports of Pandey *et al.,* (1998) in guava and Singh *et al.,* (2007a) in aonla.

The highest total sugars (4.94 %) were recorded in micronutrient combination of $ZnSO_4$ 0.5 %, $FeSO_4$ 0.5 % and Borax 0.25 % (T_8) (Table 3). The increase in total sugars of fruit was may be due to significant action of micronutrients on translocation of carbohydrates and photosynthates. This is in conformity with the results of Singh *et al.,* (2002) and Singh *et al.,* (2012), who reported that increase in sugars fraction by the foliar feeding of zinc and boron might be due to their involvement in photosynthesis of metabolites and rapid translocation of sugars from other part of the plants to developing fruits.

The per cent increase in reducing sugars was highest with micronutrient combination of $ZnSO_4$ 0.5 %, $FeSO_4$ 0.5 % and Borax 0.25 % (T_8). Increase in reducing sugars have direct link with beneficial effect of micronutrients on conversion of polysaccharides to simple sugars. The similar results were also found from the experiments of Kumar and Shukla (2010), who reported direct and indirect effects of micronutrients on quality of fruits. On the other hand, the highest non reducing sugar was recorded with combined application of $ZnSO_4$ 0.5 % and Borax 0.25 % (T_6).

Table.1 Effect of foliar application of micro-nutrients on fruit yield and benefit: cost ratio of aonla *cv.* NA-7 (Neelum)

Treatments	Yield (kg. tree^{-1})	Yield (tonnes ha^{-1})	Increase in yield over control (%)	B: C ratio
T_1	14.91	4.14	-	2.51
T_2	18.56	5.15	24.48	3.04
T_3	15.96	4.43	7.04	2.38
T_4	18.28	5.07	22.60	2.97
T_5	19.63	5.45	31.65	2.86
T_6	22.21	6.16	48.96	3.52
T_7	21.07	5.85	41.31	3.06
T_8	24.96	6.93	67.40	3.60
S. Em. ±	1.66	0.46	-	-
CD @ 5%	5.04	1.40	-	-

Table.2 Effect of micronutrients on quality of fruits of aonla *cv.* NA-7 (Neelum)

Treatments	TSS (^{0}B)	Titrable acidity (%)	TSS:Acid ratio	Vitamin C (mg/100g)
T_1	8.39	1.03	8.96	477.48
T_2	8.42	1.07	7.99	483.78
T_3	8.97	1.02	9.71	484.03
T_4	8.58	1.38	6.52	483.51
T_5	8.76	1.15	8.87	486.88
T_6	8.61	1.22	7.33	481.65
T_7	8.51	1.57	5.47	479.17
T_8	8.23	1.20	7.94	483.71
S. Em. ±	0.34	0.24	1.62	1.47
CD @ 5%	NS	NS	NS	4.45

Table.3 Effect of micronutrients on quality of fruits of aonla *cv.* NA-7 (Neelum)

Treatment	Total sugar (%)	Reducing sugars (%)	Non reducing sugars (%)	Sugar:Acid ratio	Storage life (Days) (at room temperature)
T_1	3.78	2.31	1.47	4.05	5.33
T_2	4.29	2.30	1.99	3.96	7.00
T_3	3.95	2.29	1.66	4.22	6.67
T_4	4.40	2.37	2.03	3.31	6.33
T_5	3.93	2.51	1.42	4.04	5.67
T_6	4.86	2.69	2.17	4.16	7.67
T_7	4.42	2.72	1.70	2.85	6.67
T_8	4.94	3.01	1.93	4.91	7.33
S. Em. ±	0.23	0.06	0.23	-	-
CD @ 5%	0.68	0.18	0.70	NS	NS

The dual effect of these micronutrients on per cent non reducing sugars was mainly attributed to increased translocation of polysaccharides in mature fruits. These results are in close conformity with the findings of Singh *et al.,* (2012).

This may be concluded from the above highlighted experimental findings of the present investigation due to effect of foliar spray of nutrients revealed that, mmicronutrient combinations of $ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.25 % (T_8) was found to be most effective for overall increment of yield, highest cost benefit ratio and quality attributes. The fruit yield was almost double as compared to control. Hence, the above said nutrient combination holds immense potential as a foliar spray for doubling up the yield and to improve quality in aonla.

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