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Effect of nutrients on yield and chemical characteristics of aonla (*Emblica officinalis* Gaertn) cv. chakiya

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Abstract
The present investigation entitled on Effect of nutrients on yield and chemical characteristics of aonla (*Emblica officinalis* Gaertn) cv. Chakiya was carried out at Department of Horticulture and Post-Harvest technology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal during the year 2016-17. The experiment was conducted over 27 trees which are Planted at spacing of 10m×10m having nine treatments consisting of various level of nutrients concentration [T_1 – Borax @0.25%, T_2– Borax @0.50%, T_3 – $ZnSO_4$ @0.40%, T_4 – $ZnSO_4$ @0.60%, T_5 – Borax @0.25%+ $ZnSO_4$ @0.40%, T_6 – Borax @0.25%+ $ZnSO_4$ @0.60%, T_7 – Borax @0.50%+ $ZnSO_4$ @0.40%, T_8 – Borax @0.50% + $ZnSO_4$ @0.60%, T_9 – Control (water spray)] in RBD design with 3 replications. Foliar application of Borax (0.25% and 0.50%), $ZnSO_4$ (0.40% and 0.60%) and their combination were sprayed during the flowering and pea stage of the fruits. Among different dose of nutrient treatments, T_8- Borax @0.50%+ Zinc @0.60% were found significantly superior over other treatments with respect to fruit yield, acidity, ascorbic acid, total sugar, TSS and reducing sugar of the fruit.

Keywords: aonla, nutrients, chemical characteristics, yield

Introduction
Aonla (*Emblica officinalis* Gaertn.) is also known as Indian gooseberry is one of the most important indigenous fruit of arid-tropics. It comes under the family Euphorbiaceae and originated from tropical region of South East Asia, particularly central and southern India (Morton, 1960) [9]. Aonla is second highest source of vitamin C, next to Barbados cherry, among all fruits (Shankar, 1969) [12]. The vitamin C content in aonla varies from 200-900 mg /100 g depending upon the variety and size of the fruit. The ascorbic acid and other constituents are well retained in dried aonla fruits and also have high content of tannins which is responsible for its antioxidant properties. Aonla fruit acquired wide popularity all over the world owing to its medicinal properties and therapeutic values as all parts of the tree and fruit can be used in one form or the other. The medicinal preparations from aonla have high potency in curing diseases such as dysentery, diarrhea, fever, common cold, anemia and jaundice because of acidic, cooling, diuretic and laxative properties of the fruit (Singh, 2003) [16]. Among the micronutrients deficiency of B and Zn has been noticed on a very large scale and response to its application has been very spectacular. Nutrition of micronutrients has brought many fold increase in the yield of orchard and its health depending upon the severity of the deficiency. Zinc and Boron play significant role in flowering and fruiting process, N metabolism, hormonal movement and cell division (Babu and Singh, 2001) [2]. Boron and Zinc increase the fruit set, reduce fruit drop and improve fruit quality in various fruit crops. Present investigation was carried out with the application of nutrients to study the effect of nutrients on the yield and fruit quality.

Materials and Methods
Eight years old aonla tree of chakiya cultivar uniform in size and vigour growing in Department of Horticulture and Post-Harvest technology, institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal were selected for the present investigation during 2016-17.The experiment was laid out in randomized block design with three replications. The treatment consisted two foliar applications of Zinc sulphate and Borax. These were T_1 – Borax @0.25%, T_2– Borax @0.50%, T_3 – $ZnSO_4$ @0.40%, T_4 – $ZnSO_4$ @0.60%, T_5 – Borax

@0.25%+ $ZnSO_4$ @0.40%, T_6 – Borax @0.25%+ $ZnSO_4$ @0.60%, T_7 – Borax @0.50%+ $ZnSO_4$ @0.40%, T_8 – Borax @0.50%+ $ZnSO_4$ @0.60%, T_9 – Control (water spray). The foliar sprays of micro-nutrient were applied two times. The first spray of nutrient was applied during flowering and second spray was applied at pea stage. For determination of chemical parameters of fruit, ten healthy fruits were selected randomly from each tree at full maturity stage. AOAC (1990) [1] method of ascorbic acid was followed. The total reducing sugar was estimated by Fehling solution method as advocated by Lane and Eynon (1943) [8].

Results and Discussion

The result obtained from the experiment, indicate that different combination of nutrients (Table-1) was significant as compared to non-treatments of plants. The maximum TSS (11.30 ºBrix) was recorded with T_8 (Borax @0.50% + Zinc @0.60%), followed by (11.20 ºBrix) in T_7 (Borax @0.50%+ Zinc @0.40%). The minimum TSS (9.17ºBrix) was noted in control. Similar results are also reported by Singh *et al.* (2012) [14], Khan *et al.* (2010) [5] and Verma *et al*. (2008) [18] in aonla, Prabu and singaram (2001) [1] in grapes. The increase in TSS due to spray of boron might be due to fact that boron helps in sugar transport and there by triggering the accumulation of more sugars in fruits. A notable characteristic of borax is that it directly affects photosynthesis activity of plants.

The lowest acidity (1.95%) was recorded with T_8 (Borax @0.50%+ $ZnSO_4$@0.60%), followed by (2.01%) in T_7 (Borax @0.50% + $ZnSO_4$ @0.40%). It was highest (4.22%) in control. These results are in close conformity with the findings of Khan *et al*. (2010) [5]. The reduction in content of acid in fruit with borax treatment might be due to hastening process of ripening during which degradation of acid might have occurred and helped in preventing excessive polymerization of sugar and accumulation of more sugar in the cells of plant. It also appears that total soluble solids increase at the expense of acidity in tropical and subtropical fruit. The acid under the influence of borax might have been fastly converted into sugars and their derivatives by the reaction involving the reversal of glycolytic pathway or might have been used in respiration.

There was significant dissimilarity in ascorbic acid content of the fruit during present investigation. The highest (464.06 mg/100g) ascorbic acid content was recorded with T_8 (Borax @0.50%+ $ZnSO_4$ @0.60%), followed by (450.16 mg/100g) in T_7 (Borax @0.50% + $ZnSO_4$ @0.40%). It was lowest (382.71mg/100g) in control. The higher concentrations of boron and zinc increased the ascorbic acid content of fruit. The similar result also been reported by Singh *et al.* (2012) [14], Khan *et al.* (2010) [5] and Verma *et al*. (2008) [18]. It may be due to the possible influence of these micronutrients on biosynthesis of ascorbic acid from sugars or inhibition of oxidative enzymes or both.

The maximum total sugars of (5.63%) was recorded with T_8 (Borax @0.50%+ $ZnSO_4$ @0.60%). It was minimum (3.48%) under control. Similar observations were recorded by Yadav *et al.* (2011) [19] and Singh *et al.* (2007) [13]. The reasons for increase in total sugar 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 total sugar of fruits.

The maximum reducing sugar (3.16%) was recorded with T_8 (Borax @0.50%+ $ZnSO_4$ @0.60%) followed by (3.05%) in T_7 (Borax @0.50% + $ZnSO_4$ @0.40%), the reducing sugar % was found less in control where value was only (2.06%). The results are in close conformity with the findings of Yadav *et al*. (2011) [19] Singh *et al.* (2007) [13]. The reasons for increase in reducing sugar 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 reducing sugars of fruits.

Non-reducing sugar under different levels of zinc and boron ranged from (1.52 %) to (2.47 %). It was not significant. However, the maximum non-reducing sugar was recorded with the application of T_8 (Borax @0.50% + $ZnSO_4$ @0.60%), while minimum non-reducing sugar was noticed with T_7 (Borax @0.50% + $ZnSO_4$ @0.40%).

The foliar application of micro-nutrients has shown better responses to improve the fruit yield in aonla. The highest yield per tree (12.20 kg) was recorded with the spray of T_8 (Borax @0.50 % + $ZnSO_4$ @0.60%). The lowest fruit yield (7.60 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.

Table 1: Effect of nutrients on TSS, acidity, ascorbic acid, total sugar, reducing sugar, non-reducing sugar and yield of aonla cv. Chakiya

Treatments	TSS (ºBrix)	Acidity (%)	Ascorbic acid (mg/100gm)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Yield (kg/tree)
T_1-Borax (0.25%)	9.63	3.51	389.87	3.72	2.20	1.52	8.90
T_2-Borax (0.50%)	9.77	3.06	392.17	4.05	2.29	1.75	9.50
T_3-Zinc Sulphate (0.40%)	10.13	2.65	397.36	4.20	2.43	1.77	9.70
T_4-Zinc Sulphate (0.60%)	10.60	2.24	429.22	4.29	2.43	1.86	10.40
T_5- Borax (0.25%) + Zinc Sulphate (0.40%)	10.73	2.11	439.67	4.30	2.44	1.86	11.50
T_6-Borax (0.25%) + Zinc Sulphate (0.60%)	10.97	2.03	447.29	4.47	2.62	1.85	12.00
T_7- Borax (0.50%) + Zinc Sulphate (0.40%)	11.20	2.01	450.16	5.09	3.05	2.04	12.10
T_8-Borax (0.50%) + Zinc Sulphate (0.60%)	11.30	1.95	464.06	5.63	3.16	2.47	12.20
T_9 -Control (water spray)	9.17	4.22	382.71	3.48	2.06	1.42	7.60
CD (P=0.05)	1.22	0.36	6.61	0.90	0.35	NS	1.18

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