

Original Research Article

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Influence of Plant Growth Regulators and Boron on Nutritional Quality and Shelflife of Aonla Fruit

J.S. Patel*, J.J. Dhruve, G.N. Motka and A.D. Patel

Department of Horticulture, B. A. College of agriculture, Anand Agricultural University,
Anand – 388 110(Gujarat), India

*Corresponding author

ABSTRACT

Aonla (*Emblica officinalis* Gaertn.) is an important crop indigenous to Indian subcontinent which is used in alternative medicine, health foods and herbal products. Plant growth regulators and micro nutrients play a vital role in growth, development, fruit retention and quality reported in many fruit crops. A field experiment was undertaken on Aonla (*Emblica officinalis* Gaertn.) at Horticultural Research cum Demonstration Farm, Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand in order to evaluate the performance of plant growth regulators (Gibberellic acid and Naphthalene acetic acid), micro nutrient (boron) alone and their combinations applied as foliar spray at pin head and pea stage for improvement of aonla fruit quality. The significant differences were observed for total soluble solids, total soluble sugars and ascorbic acids among all the treatments. The shelflife also increased and found to be significant among all the treatments. Whereas, the internal fruit necrosis, fibre, tannin and acidity content was significantly decreased in treated samples as compared to the control. Hence, these treatments could be useful to improved nutritional quality and storage life of aonla fruit.

Keywords

Aonla, Boron,
Nutrition,
PGR, Quality

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Introduction

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn.) is one of the important indigenous fruit of India, which belongs to family 'Euphorbiaceae', subfamily 'Phyllanthoidae' is native of Tropical South-East Asia, particularly in central and southern India. *Emblica* known by several vernacular names such as Amla, Chukna, Nelli, Sobju, Amlaki, Dhatriphala, Amlet, Amlay, Amolphal in different parts of the country. The fruit is known for Kayakalp (restore health and vitality) and has been recognized as 'Amrit Phal' in ancient Indian mythological literatures like Vedas, Puran,

Ramayana, Kadambari, Charak Shmhita, etc. It is regarded as sacred tree (Singh, 2012). Its commercial cultivation is common in India, particularly in Uttar Pradesh, Haryana, Punjab and Gujarat etc. In India, it is estimated that aonla is cultivated in about 108.00 thousand hectares with production of 1286 thousand MT with an average productivity of 11.73 MT ha⁻¹ (Anonymous, 2013). In Gujarat, it is estimated that aonla is cultivated in about 11.75 thousand hectares with production of 112.30 thousand MT with the main cultivated pockets are Kheda, Anand, Vadodara and Panchmahal districts (Anonymous, 2013).

Foliar feeding has been used as a means of supplying supplemental doses of nutrients, plant hormones, stimulants and other beneficial substances. Therefore, judging which foliar materials to apply and at what plant stage to spray are important principles to make best uses of this technique. The application of plant growth regulator (PGR) can provide significant economic advantages to citrus growers when used in appropriate situations as these have proven effective in stimulating a number of desired responses such as increase in fruit size and delay in fruit maturity. Fruit development is thought to be triggered by hormones that the endogenous gibberellins status of the developing citrus ovaries is the limiting factor for the initiation of fruit development. Foliar application of different levels of GA₃ (5, 50, 100 and 500 mg/l) to young fruit let's just after fruit set have been reported to clearly increase the fruit weight, peel thickness, juice content with improved taste. Various scientists (Talon *et al.*, 1990; Berhow, 2000; Sarad Gurung *et al.*, 2016) have reported that nutrient management is one of the most important factor in improving the plant growth and yield through increasing photosynthetic efficiency. Micronutrients deficiency in soil and plants is a worldwide nutritional problem and very severe in many countries.

In Gujarat, the nutrient deficiencies particularly micronutrients are common due to climate and nature of soil. By choosing appropriate fertilizer rates, the grower can drive a crop toward earlier and heavier fruit setting. Boron (B) is very important for optimal plant growth, physiological and biochemical pathways in citrus cultivation under agro-climatic conditions of Gujarat. The application of boron improves the citrus fruit yield and its juice quality. Foliar or soil application of zinc increases the biosynthesis of chlorophyll and carotenoid synthesis that are important for proper performance of photosynthetic process. There were very little

research work had been done on this aspect. Hence, the present experiment was undertaken to find out the effect of growth regulators and micronutrient for better quality and shelf life of anola fruit under the climatic conditions of middle Gujarat.

Materials and Methods

The present investigation entitled “influence of plant growth regulators and boron on nutritional quality and shelf-life of anola fruit was carried out during the year 2012-2013 and 2013-2014 under field conditions at the Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand. The treatments comprised combination of plant growth regulators and boron T₁: Control *i.e.* water spray, T₂:NAA 20 mg/l, T₃: NAA 40 mg/l, T₄: GA₃ 25 mg/l, T₅: GA₃ 50 mg/l, T₆: Boron 0.25 %, T₇: Boron 0.50 %, T₈: NAA 20 mg/l + GA₃ 25 mg/l, T₉: NAA 40 mg/l + GA₃ 50 mg/l, T₁₀: NAA 20mg/l + GA₃ 25 mg/l + Boron 0.25% and T₁₁: NAA 40 mg/l + GA₃ 50 mg/l + Boron 0.50% at pin head (1st week of August) and pea stage (1st week of September) on yield and fruit quality characters. The experiment was laid out in a Completely Randomized Design with eleven treatment combinations and repeated thrice. The total soluble solids (TSS) were recorded in percentage with help of hand refractometer. The small pieces of head were crushed out and a drop of juice was put on the glass prism of refractometer and observations were recorded from eyepiece and average reading of total soluble solids was worked out. The ascorbic acid and acidity (Ranganna, 1979), total soluble sugars (Dubois *et al.*, 1956), fiber (Maynard, 1970), tannin (Saini *et al.*, 2001) contents were analysed.

Results and Discussion

The total soluble solids was found significantly higher in treatment T₁₁(17.44⁰),

which was at par with T₁₀ (17.00⁰). Significantly the minimum total soluble solids (Table 1) was found in treatment T₁(13.22⁰), which was at par with treatment T₄ (13.97⁰). The increase in total soluble solid might be due to rapid transformation of complex carbohydrates into soluble sugars and also fast mobilization of metabolites from source to sink under influence of growth substances like GA₃ which promote quick metabolic transformation of starch and pectin into soluble sugars and rapid mobilization of photosynthetic metabolites and minerals from other parts of the plant. Similarly NAA increase the TSS which might be due to synthesis of auxin in plant, it increase the physiological activities leading to increased TSS in fruits. Boron treatment ascribed due to auxin synthesis which in term increase the metabolites available for TSS. The results are also in opinion with the findings of Singh *et al.*, (2002) in ber, Srivastava and Jain (2006) in mango, Ghosh *et al.*, (2009), Srivastava *et al.*, (2009), Yadav *et al.*, (2010), Singh *et al.*, (2007) and Shukla *et al.*, (2011) in aonla.

The analysis of aonla fruit revealed a significant ($p < 0.05$) variation (4.79 to 6.12%) in aonla total soluble sugar content among all treatments (Table 1). The total soluble sugars was found significantly higher in treatment T₁₁ (6.12%), which was followed by T₁₀ (5.60%), T₉ (5.59%), and T₃ (5.28%). The spray application of GA₃ had shown significant increase in the total sugars of aonla fruits. This might be due to activation of enzymes which affect the physiological processes, which in turn hydrolyzed the starch and helps in metabolic activity during the change in available starch into sugar and soluble solid content. NAA had shown significant increase in the total sugar of aonla fruits and this might be due to synthesis of auxin in plant, it increased the physiological

activities. The results are also in accordance with the findings of Bhati and Yadav (2003) in ber, Ghosh *et al.*, (2009), Srivastava *et al.*, (2009), Yadav *et al.*, (2010) and Shukla *et al.*, (2011) in aonla.

The influence of different plant growth regulators and boron on ascorbic acid content was found significant (Table 1). Significantly the maximum and minimum ascorbic acid content was found in treatment T₁₁ (901mg/100g) and T₁ (740 mg/100g), respectively. The non significant difference was found among treatment T₈ (876), T₉ (885) and T₁₀ (896). The increase in ascorbic acid might be due to catalytic influence of growth regulators on its bio-synthesis from its precursor glucose-6-phosphates throughout the development of fruits which is thought to be precursor of vitamin- C. The application of gibberellic acid, NAA and boron may have favorably influenced the metabolic activities possibly due to their increased endogenous level which increased the ascorbic acid of aonla fruit. The results are also in accordance with the findings of Srivastava and Jain (2006) in mango, Shukla *et al.*, (2011), Srivastava *et al.*, (2009) and Yadav *et al.*, (2010) in aonla fruit.

The shelf life of aonla fruits was extended up to 16 days at room temperature when the treatment was given in combination of plant growth regulators and boron *i.e.* NAA 40 mg/l+ GA₃ 50 mg/l+ Boron 0.50% at pin head and pea stage (Table 1). It might be due to antagonistic effect of GA₃ which inhibit ethylene production and delayed the conversion of starch to sugar. The results are also in view with the findings of Srivastava and Jain (2006) in mango. Yadav and Shukla (2009) in aonla.

Table.1 Influence of different plant growth regulators and boron on total soluble solids, total soluble sugars, ascorbic acid, physiological loss in weight and shelf-life at maturity stage of aonla fruit cv. Gujarat Aonla

Treatment	Total Soluble Solids (⁰ B)	Total sugars (%)	Ascorbic acid (mg/100 g pulp)	Shelf-life (Days)	Physiological loss in weight (%) at 12 th day of storage	Physiological loss in weight (%) at 24 th day of storage
T ₁ : Control (Water spray) at pin head and pea stage	13.22	4.82	739.79	11.13	14.10	26.90
T ₂ : NAA 20 mg/l at pin head and pea stage	15.23	5.01	844.72	12.89	14.06	24.28
T ₃ : NAA 40 mg/l at pin head and pea stage	15.18	5.28	879.21	13.61	12.20	23.97
T ₄ : GA ₃ 25 mg/l at pin head and pea stage	13.97	5.00	815.58	12.47	12.89	22.90
T ₅ : GA ₃ 50 mg/l at pin head and pea stage	14.73	4.80	852.23	13.57	12.95	23.87
T ₆ : Boron 0.25 % at pin head and pea stage	13.30	4.79	748.23	14.34	12.97	23.40
T ₇ : Boron 0.50 % at pin head and pea stage	14.05	5.05	786.87	13.51	13.14	21.88
T ₈ : NAA 20 mg/l + GA ₃ 25 mg/l at pin head and pea stage	16.37	5.23	876.11	13.88	12.49	23.05
T ₉ : NAA 40 mg/l + GA ₃ 50 mg/l at pin head and pea stage	16.56	5.59	885.54	14.15	14.17	24.62
T ₁₀ : NAA 20mg/l+ GA ₃ 25 mg/l+ Boron 0.25% at pin head and pea stage	17.00	5.60	896.39	15.85	11.58	22.81
T ₁₁ : NAA 40mg/l+ GA ₃ 50 mg/l+ Boron 0.50% at pin head and pea stage	17.44	6.12	901.89	16.13	10.75	19.81
S. Em _±	0.41	0.22	13.61	0.50	0.62	0.68
C. D. @ 5%	1.17	0.62	38.80	1.42	1.94	1.94
Interaction effect						
Y X T (year x treatment)	NS	NS	NS	NS	NS	NS
C.V. %	6.62	10.23	3.98	8.83	7.94	7.13

Table.2 Influence of different plant growth regulators and boron on internal fruit necrosis, fibre, tannin and acidity at maturity stage of aonla fruit cv. Gujarat Aonla-1

Treatment	Internal fruit necrosis (%)	Fibre content (%)	Tannin content (%)	Acidity (%)
T ₁ : Control (Water spray) at pin head and pea stage	13.14	3.05	2.63	1.96
T ₂ : NAA 20 mg/l at pin head and pea stage	12.57	2.88	2.39	1.78
T ₃ : NAA 40 mg/l at pin head and pea stage	11.15	2.54	2.49	1.76
T ₄ : GA ₃ 25 mg/l at pin head and pea stage	12.00	2.45	2.45	1.86
T ₅ : GA ₃ 50 mg/l at pin head and pea stage	11.46	2.55	2.43	1.80
T ₆ : Boron 0.25 % at pin head and pea stage	7.86	2.68	2.68	1.89
T ₇ : Boron 0.50 % at pin head and pea stage	4.83	2.59	2.39	1.89
T ₈ : NAA 20 mg/l + GA ₃ 25 mg/l at pin head and pea stage	11.43	2.47	2.47	1.63
T ₉ : NAA 40 mg/l + GA ₃ 50 mg/l at pin head and pea stage	9.49	2.29	2.30	1.52
T ₁₀ : NAA 20mg/l+ GA ₃ 25 mg/l+ Boron 0.25% at pin head and pea stage	5.16	2.37	2.22	1.47
T ₁₁ : NAA 40mg/l+ GA ₃ 50 mg/l+ Boron 0.50% at pin head and pea stage	3.02	1.96	1.79	1.44
S. Em ₊	0.40	0.11	0.21	0.04
C. D. @ 5%	1.14	0.31	0.67	0.12
Interaction effect				
Y X T (year x treatment)	NS	NS	NS	NS
C.V. %	10.54	10.41	10.07	5.75

The different plant growth regulators and boron exhibited significant influence on physiological loss in weight of aonla fruits. Among the different treatments, combination of plant growth regulators and boron treatment *i.e.* NAA 40 mg/l+ GA₃ 50 mg/l+ Boron 0.50% at pin head and pea stage was found significantly superior over the rest of the treatments and lowest physiological loss in weight after 12th and 24th day storage period for aonla fruit. Similar trend was also recorded after 24th day storage period (Table 1). The reduction of weight loss in the fruits treated with GA₃ might be due to its anti-senescence action. The plant growth regulators and boron treatment resulted in to decrease in the tissue permeability and

thereby reduces the rate of water loss. The reduced PLW in fruits during storage is mainly due to reduced rate of transpiration and respiration. The results are also in accordance with the findings of Srivastava and Jain (2006) in mango, Yadav and Shukla (2009) in aonla fruits.

The physiological disorders like internal necrosis are a very dangerous for the aonla cultivation. The minimum internal fruit necrosis (3.02) was measured with foliar the application of NAA 40 mg/l + GA₃ 50 mg/l + Boron 0.50% at pin head and pea stage (T₁₁) and maximum internal fruit necrosis was recorded under control (Table 2). It may be due to the fact that boron has significant role

in mobilization of food material from source to sink as a result accumulate the photosynthates which control fruit necrosis. The results are also in line with the findings of Singh *et al.*, (2001) in aonla.

The influence of different plant growth regulators and boron on fibre content was found significant (Table 2). Significantly the minimum and maximum fibre content was found in treatment T₁₁ (1.96%) and T₁ (3.05%), respectively. This might be due to activation of enzymes which affect the physiological processes and in turn hydrolyzed the starch and helped in reducing fruit fibre. The results are also in accordance with the findings of Singh *et al.*, (2007) in aonla.

The analysis of aonla fruit revealed a significant ($p < 0.05$) variation (1.79 to 2.68%) in aonla total tannin content among all treatments (Table 2). Significantly higher tannin content was recorded in treatment T₆ (2.68%) which was followed by treatments T₁ (2.63%) T₃(2.49%), T₄ (2.45%) and T₅(2.43%). However lower tannin content was found in treatment T₁₁ (1.79). This might be due to activation of enzymes which affect the physiological processes, which improve the bio-chemical substances in fruit. The results are also in accordance with the findings of Singh *et al.*, (2007) in aonla.

Significantly higher and lower titratable acidity was found in treatment T₁ (1.96%) and T₁₁ (1.44%), respectively (Table 2). However, the non significant difference was found among treatments T₉ (1.52%), T₁₀ (1.47%) and T₁₁ (1.44%). This may be due to PGR's and nutrients which might have either been fastly converted into sugar and their derivatives by reactions involving reversal of glycolytic pathway which activated bio-chemical processes for sugar accumulation in

the fruits and thus acidity percentage was decreased in fruits. Similarly, boron also resulted in lower acidity which might be due to the fact that mineral compounds reduced the acidity in fruits, since it is neutralized in parts during metabolic pathways which used in the respiratory process as substrate leading to decreased acidity in fruits. The results are also in opinion with the findings of Singh *et al.*, (2002) and Bal *et al.*, (2007) in ber, Srivastava *et al.*, (2009, Yadav *et al.*, (2010) and Shukla *et al.*, (2011) in aonla.

Among different plant growth regulators and boron treatments, the treatment T₁₁ (Sprays of NAA 40 mg/l + GA₃ 50 mg/l + Boron 0.50 % at pin head and pea stage) recorded maximum net realization of 2, 48, 987 ` ha⁻¹ with BCR 1: 3.55 as compared to treatment T₁ *i.e.* control (Water spray at pin head and pea stage) recorded the lowest net realization 1, 31,151 ` ha⁻¹ with BCR 1: 2.70, respectively.

From the foregoing discussion and the results obtained from this investigation, it can be concluded that foliar spray of NAA 40 mg/l + GA₃ 50 mg/l + Boron 0.50% at pin head and pea stage in aonla fruits found beneficial for better fruit quality *i.e.* increased in total soluble solids, total soluble sugars, ascorbic acid and decreased in internal fruit necrosis, fibre, tannin and acidity content and ultimately acidity percentage was decreased in fruits.

Significantly minimum physiological loss in weight and maximum shelf-life of fruit was also found with same treatment. Thus overall it can be concluded that spraying NAA 40 mg/l + GA₃ 50 mg/l + Boron 0.50% was useful to improved nutritional quality and storage life of aonla fruit and found significantly superior along with maximum net realization 2, 48, 987 ha⁻¹ with BCR 1: 3.55.

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