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# Effect of potassium nitrate (KNO3) and gibberellic acid (GA3) on root and shoot growth of aonla (*Emblica officinalis* L.)

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**Abstract**

The present investigation entitled impact of potassium nitrate (KNO3) and gibberellic acid (GA3) on root and shoot growth of Aonla (*Emblica officinalis* L.) cv. NA-4 was conducted at the Green House, Department of Horticulture, Allahabad Agricultural Institute - Deemed University, Allahabad, in 2007. Seeds were sown in polybags. Polybags were filled in with well-mixed soil, sand and farmyard manure. The ratio of soil, sand and FYM was 1:2:1, respectively. The seeds were sown 2 cm deep from. the surface. The experiment was conducted by adopting completely randomized design (CRD) with 13 treatments each replicated three times. Treatment $T_9$ ($GA_3$ 400 ppm) recorded the maximum length of root, diameter of shoot, fresh weight of shoot, fresh weight of root, dry weight of shoot and dry weight of root, thereby emerging as significantly superior to all other treatments.

**Keywords:** Potassium nitrate, gibberellic acid, growth, root, shoot

## Introduction

The fruit is highly nutritive. It is one of the richest sources of vitamin-C, next to Barbados cherry. It contains 500 to 1500 mg of ascorbic acid per 100 g of pulp. Maximum vitamin-C content in aonla is found in mature fruits rather than immature. The fruit juice contains nearly 20 times as much vitamin-C as in orange juice and a single fruit is equal in anti-ascorbic value to two oranges. The fruit contains a chemical substance called Leucoanthocyanin or polyphenols, which retards the oxidation of vitamin-C. The fruit is also rich in pectin and minerals like iron, calcium and phosphorus.

Besides the vitamin content, aonla fruits have immense nutritive value; the pulp contains Proteins (0.05%), Fats (0.01%), Minerals (0.71%), Fibres (3.4%), Carbohydrate (14.1%), Calcium (0.05%), Phosphorus (0.2%), Iron (1-2 mg/g) with a high amount of pectin. Tannin if found in high quantity in barks, leaves and seeds.

The aonla fruit is valued high among indigenous medicines in India. It is probably the only fruit to fill the gap of astringent food recommended by the Ayurvedic system of medicine for a balanced diet and sound health. Aonla is the main ingredient in Chavanprash. It is one of the important nutritive fruits besides its medicinal values. Dried fruit is useful in haemorrhage, diarrhoea, chronic dysentery, diabetes, cough, jaundice, etc.

Aonla fruit is small, round, six lobed with hard pulp and is not commonly consumed in fresh form because of its astringent taste. Astringency in aonla fruit is due to tannin containing gallic acid, ellagic acid having glucose in their molecules, which retards the oxidation of ascorbic acid. It is therefore, not popular as table fruit. The excellent nutritive and therapeutic values of fruit offer great potentiality for processing it into several quality products like pickles, preserves (murabba), candy, jellies, etc.

Aonla is propagated by seeds as well as by budding. Aonla seeds are very poor in germination. This poor germination may be either due to hard seed coat or due to presence of certain inhibitors in the seed. Raising of rootstock is a major constraint in propagation of aonla. Many freshly harvested seeds also do not respond to better germination.

Although aonla fruit is of great economic importance and wssess a considerable nutritive value, till now very little is known about the distinguished physico-chemical characters in different cultivars, which can provide better knowledge to the horticulturists. There were no standard cultivars of aonla especially in Allahabad agro-climatic conditions. They were mostly known based on shape and size or after the names of places. The standardisation of a cultivar is necessary before taking up any systematic work.

The crop is normally multiplied by seeds. For dry land horticultural plantation programme, seedlings have to be raised and quick and enhanced germination has to be secured.

The seeds of aonla are impermeable due to hard seed coat. Impermeability and dormancy mostly associated with hard coated seeds acting as barriers in their germination and have handicapped their rapid spread even when favourable conditions subsisted. It has been reported that water soaking and heat through water is the simplest agency overcoming impermeability of seed coats and secure in increased germmation. Aonla seeds exhibit dormancy. It has been reported that application of gibberellins breaks dormancy of seeds and results in early and enhanced seed germination. On the other hand, the increased germination and vigorous seedlings or both have been reported in many fruit crops with soaking seeds in gibberellins. The work on pre-germination seed treatment with gibberellins, water soaking, heat through water in aonla is lacking.

Plant growth regulators are often used to improve the seed germination and enhance the root and shoot growth of a number of horticultural crops. These growth regulators not only increase the percentage of germination but also accelerate the growth of the seedlings. Several workers have reported that treatment of seeds with hemicals have improved the germination as well as reduce the time taken for germination.

Keeping in view the above facts, the present experiment entitled Effect of potassium nitrate (KNO3) and gibberellic acid (GA3) on seed germination and seedling growth of Aonla *(Emblica officinalis* L.) cv. NA-4" was undertaken at Crop Research Farm, Department of Horticulture, Allahabad Agricultural Institute - Deemed University, Allahabad.

## Materials Methods

The present experiment was conducted at the Green House, Department of Horticulture, Allahabad Agricultural Institute - Deemed University, Allahabad, from February to May 2007, to study the effect of plant growth regulators on growth of root and shoot of Aonla. The Allahabad district is situated in the southern part of Uttar Pradesh at an elevation of 78 metres above mean sea level, at 25.8°N latitude and 81.56°E longitude. The climate is subtropical with both the extremes of temperature during summer and winter. During December and January, the temperature may drop down to as low as L – 2 °C while it may exceed 48 °C during May and June. Frost duringer and hot winds during summer are common occurrences. The age annual rainfall is about 102 cm with its maximum concentration during July to September with occasional showersng winter. Aonla seeds of var. NA-4 were procured from the local market of Allahabad. Seeds were sown in polybags. Polybags were filled in with well-mixed soil, sand and farmyard manure. The ratio of soil, sand and FYM was 1:2:1, respectively. The seeds were sown 2 cm deep from the surface. One gram of gibberellic acid was weighed on a chemical balance and was transferred to a beaker with the help of soft brush to prepare half litre of stock solution of 1000 ppm. To dissolve this, 5 - 10 ml of absolute alcohol was added and shaken well. Therefore, to make the stock solution of half litre of 1000 ppm, distilled water was added with the help of measuring cylinder to make the volume. Stock solution of potassium nitrate was also prepared in the same manner, as for gibberellic acid. For preparing the other required concentrations of these growth regulators, dilution method was adopted.

## Result and Discussion

### Length of root (cm)

Longest roots (28.00 cm) were recorded with treatment $T_9$ i.e. $GA_3$ 400 ppm followed by 27.00 cm with treatment $T_2$ i.e. $KNO_3$ 1.00% and the shortest roots (15.00 cm) were recorded with $T_0$ (control). Treatments $T_7$ and $T_{11}$ ($GA_3$ 100 and 800 ppm); $T_8$ and $T_{10}$ ($GA_3$ 200 and 600 ppm) were, however, found statistically at par.

The fresh seeds contain higher $GA_3$ which would have accelerated the germination process and possibly also due to increase in cytochrome activity by $KNO_3$, which would have ultimately broken the post-harvest dormancy. Gibberellic acid treatment further induced the amylase and protease enzymes through *de-novo* synthesis, which participate in the break down of the stored starch to simple sugars. These sugars are then translocated to the growing embryo where they provide energy for growth and development, thereby resulting in higher number of leaves per seedling. These results are in close conformity with the findings of Wagh *et al.* (1999) and Rahemi and Baninasab (2000) [4].

### Diameter of shoot (cm)

Maximum diameter of shoot (0.89 cm) was recorded with treatment $T_9$ i.e. $GA_3$ 400 ppm closely followed by 0.87 cm with treatment $T_{10}$ i.e. $GA_3$ 600 ppm and the minimum (0.60 cm) remained with $T_0$ (control). Treatments $T_3$ and $T_4$ ($KNO_3$ 2.00% and 3.00%); $T_{10}$ and $T_{11}$ ($GA_3$ 600 and 800 ppm) were found statistically at par. Seed treatment with $GA_3$ 600 and 400 ppm were significantly superior to all other treatments due to the increased activity of nicotinamide adenine dinucleotide phosphate -reduced (NADPH2) by $K^+$ ions and the triggered hydrolytic enzyme activities during germination by $GA_3$. Further, gibberellic acid treatment also induced the amylase and protease enzymes participating in the break-down of the stored starch to simple sugars and its translocation to the growing embryo providing energy for growth and development of seedlings. These results are in conformity with the findings of Wagh *et al.* (1999), Gholap *et al.* (2000) [5] and Rajamanickam *et al.* (2002).

### Diameter of root (cm)

Maximum diameter of root (0.44 cm) was recorded with treatment $T_2$ i.e. $KN0_3$ 1.00% closely followed by 0.42 cm with treatment $T_3$ i.e. $KNO_3$ 2.00%, whereas, the minimum (0.25 cm) remained with $T_0$ (control). Treatments $T_1$ and $T_6$ ($KN0_3$ 0.50% and 5.00%) were, however, found statistically at par. Seed treatment with $KNO_3$ 1.00% and 2.00% were found significantly superior to all other treatments in relation to length of roots of aonla, which might be due to the fact potassium nitrate which has been reported to raise the ambient oxygen level by making less oxygen available for the citric acid cycle. Potassium nitrate also accelerated the growth at the meristematic region of the seedlings. Rajamanickam and Anbu (2001) [2], Rajamanickam *et al.* (2002) and Purvey and Meghwal (2005) also reported similar results.

### Fresh weight of shoot (g)

Maximum fresh weight of shoot (24.00 g) was recorded with treatment $T_9$ i.e. $GA_3$ 400 ppm closely followed by 23.50 g with treatment T\`$_8$ i.e. $GA_3$ 200 ppm, whereas, the minimum (10.00 g) recorded with control ($T_0$). Treatments $T_{10}$ and $T_{11}$ ($GA_3$ 600 ppm and 800 ppm) were, however, found statistically at par.

Seed treatment with $GA_3$ 200 ppm and 400 ppm were significantly superior to all other treatments, which might be due to the fact that gibberellic acid treatment induced the amylase and protease enzymes participating in the break-down of the stored starch to simple sugars and its translocation to the growing embryo where they provide energy for growth and development resulting in higher fresh weight of shoot of Aonla. These results are in conformity with the findings of Dhankar and Singh (1996) [1].

**Fresh weight of root (g)**

Maximum fresh weight of root (17.34 g) was recorded with treatment $T_9$ i.e. $GA_3$ 400 ppm followed by 16.00 g with treatment $T_{10}$ i.e. $GA_3$ 600 ppm and the minimum fresh weight of root (8.00 g) remained with control ($T_0$). Treatments $T_{10}$ and $T_{11}$ (GA3 600 ppm and 800 ppm) were, however, found statistically at par.

Fresh weight of root shows that seed treatment with $GA_3$ 400 and 600 ppm was significantly superior to all other treatments due to amylase and protease enzymes induced by gibberellic acid, providing energy for growth and development of seedlings resulting in higher fresh weight of roots of aonla. Dhankar and Singh (1996) [1] also reported similar results.

**Dry weight of shoot (g)**

Dry weight of shoot recorded under different treatments shows that the dry weight of shoot of aonla was significantly was significantly superior to all other treatments with regard to dry weight of shoot, which might be due to amylase and protease enzymes induced by gibberelfic acid, providing energy for growth and development of seedlings. These results are in close conformity with Dhankar and Singh (1996) [1].

**Dry weight of root (g)**

Maximum dry weight of root (12.50 g) was recorded with treatment $T_9$ i.e. $GA_3$ 400 ppm followed by 12.00 g with treatment $T_{10}$ i.e. GA3 600 ppm, whereas, the minimum (6.00 g) remained with control ($T_0$). Treatments $T_{10}$ and $T_{11}$ ($GA_3$ 600 ppm and 800 ppm) were, however, found statistically at par.

The data contained in the table reveals that seed treatment with $GA_3$ 400 and 600 ppm was significantly superior to all other treatments with regard to dry weight of shoot due to amylase and protease enzymes induced by gibberellc acid. Dhankar and Singh (1996) [1] also reported similar results.

**Table 1:** Effect of Potassium Nitrate (KNO3) and Gibberellic Acid (GA3) on Root and Shoot Growth of Aonla

| Treatment | | Concentration | Length of root (cm) | Diameter of shoot (cm) | Diameter of root (cm) | Diameter of root (cm) | fresh weight of root (g) | Dry weight of shoot (g) | Dry weight of root (g) | Root - shoot ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_0$ | Control | - | 15.00 | 0.60 | 0.25 | 10.00 | 8.00 | 10.00 | 6.00 | 1 : 1.67 |
| $T_1$ | $KN0_3$ | 0.50% | 22.00 | 0.71 | 0.40 | 12.50 | 9.50 | 10.30 | 7.60 | 1 : 1.36 |
| $T_2$ | KNO3 | 1,00% | 27.00 | 0.73 | 0.44 | 13.00 | 10.10 | 10.80 | 8.00 | 1 : 1.35 |
| $T_3$ | KNO3 | 2.00% | 18.50 | 0.69 | 0.42 | 13.70 | 10.50 | 11.20 | 8.40 | 1 : 1.33 |
| $T_4$ | KNO3 | 3.00% | 20.00 | 0.70 | 0.41 | 15.00 | 11.10 | 11.60 | 9.50 | 1 : 1.22 |
| $T_5$ | KNO3 | 4.00% | 22.00 | 0.75 | 0.41 | 16.50 | 12.00 | 12.00 | 10.00 | 1 : 1.20 |
| $T_6$ | KNO3 | 5.00% | 23.00 | 0.78 | 0.40 | 20.00 | 14.50 | 12.50 | 10.50 | 1 : 1.19 |
| $T_7$ | $GA_3$ | 100 ppm | 25.00 | 0.82 | 0.36 | 22.00 | 13.10 | 13.40 | 11.00 | 1 : 1.22 |
| $T_8$ | $GA_3$ | 200 ppm | 26.50 | 0.85 | 0.35 | 23.50 | 15.30 | 13.70 | 11.50 | 1 : 1.19 |
| $T_9$ | $GA_3$ | 400 ppm | 28.00 | 0.89 | 0.32 | 24.00 | 17.34 | 14.40 | 12.50 | 1 : 1.15 |
| $T_{10}$ | $GA_3$ | 600 ppm | 26.00 | 0.87 | 0.30 | 18.00 | 16.00 | 14.00 | 12.00 | 1 : 1.17 |
| $T_{11}$ | $GA_3$ | 800 ppm | 24.50 | 0.86 | 0.29 | 18.00 | 15.86 | 13.50 | 11.80 | 1 : 1.14 |
| $T_{12}$ | $GA_3$ | 1000 ppm | 21.50 | 0.83 | 0.27 | 17.50 | 14.50 | 13.00 | 11.00 | 1 : 1.18 |
| | | F- test | S | S | S | S | S | S | S | S |
| | | S. Ed. (±) | 0.42 | 0.01 | 0.01 | 0.22 | 0.19 | 0.16 | 0.19 | 0.11 |
| | | C. D. at 5% | 0.86 | 0.02 | 0.01 | 0.45 | 0.40 | 0.33 | 0.38 | 0.02 |

**Root: Shoot ratio**

Maximum root: shoot ratio (1: 1.67) was observed with control ($T_0$) followed by 1: 1.36 with treatment $T_1$ i.e. $KN0_3$ 0.05%, whereas, the minemum root: shoot ratio (1:1.14) was found with $T_{11}$ i.e. GA3 800 ppm. Treatments $T_1$ and $T_2$ ($KN0_3$ 0.50% and 1.00%); $T_5$ and $T_6$ (KNO3 4.00% and 5.00%); $T_8$ and $T_{11}$ ($GA_3$ 200 and 1000 ppm); $T_9$ and $T_{11}$ ($GA_3$ 400 and 800 ppm); $T_{10}$ and $T_{12}$ ($GA_3$ 600 and 1000 ppm) were, however, found statistically at par.

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