International Journal of Minor Fruits, Medicinal and Aromatic Plants. Vol. 10 (1) : 97-101, June 2024

Effect of organic and inorganic nutrients on growth, yield and quality of aonla (*Emblica officinalis* Gaertn.) cv. NA-7 in the red and laterite zones of West Bengal

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Received : 22.04.2024 ; Revised : 11.05.2024 ; Accepted : 13.05.2024

DOI : 10.53552/ijmfmap.10.1.2024.97-101

ABSTRACT

An investigation was carried out at Bidhan Chandra Krishi Viswavidyalaya's Regional Research Sub-Station, Sekhampur, West Bengal, India during 2019-2020 and 2020-2021 to investigate the impacts of inorganic and organic nutrient management for plant growth, yield of aonla in Red and Lateritic Region of West Bengal. This investigation was arranged by utilizing Randomised Block Design, replicated thrice along with eight treatments (T1- Control (RDF: 600-300-600g NPK/ plant); T2 - 400-200-500g NPK +20 kg FYM/ plant; T3 - 400-150-450g NPK + 10 kg Vermicompost/plant; T4 - 550-300-600g NPK + 40g Azotobacter /plant; T5 - 600-250-600g NPK + 50g PSB/plant; T6 - 550-250-600g NPK + 40g Azotobacter + 50g PSB/plant; T7 - 350-150-500g NPK + 10 kg FYM + 40g Azotobacter + 50g PSB/ plant; T8 - 350-100-450g NPK + 10kg Vermicompost + 40g Azotobacter + 50g PSB/ plant). The findings depicted that the highest percentage increase in plant height (25.61%), canopy spread in North-South (13.61%), as well as East-West (14.50%) direction, maximum volume of fruit (29.28 ml), fruit length (3.64 cm), diameter (3.68 cm), fruit weight (30.20 g), flesh thickness (1.64 cm), TSS (10.81ÚBrix), ascorbic acid (526.36 mg/100 g of flesh pulp), juice content (49.33%), number of fruits/tree (1065.00) as well as maximum yield/tree (32.29 kg), were observed with the implementation of 550:250:600g NPK + 40g Azotobacter + 50g PSB /plant.

Keywords: *Anola, FYM, biofertilizer, growth, yield, quality*

INTRODUCTION

Aonla (*Emblica officinalis* Gaertn.), commonly referred to as Indian gooseberry, holds significant nutritional value, ranking closely with Barbados cherry in terms of its impressive vitamin C content, ranging from 500-625mg/100g of fruit pulp (Singh *et al*., 2018). Aonla, with its immense potential to contribute economically to India, requires the promotion of cultivars with desirable horticultural traits and the expansion of cultivation areas across diverse ecosystems (Singh *et al*., 2019). In the Western region of West Bengal, aonla cultivation flourishes in varied ecological niches, including barren lands, and wastelands, and the suitability of these regions for aonla cultivation is attributed to the prevalence of lateritic soils (Ghosh *et al*., 2009). Soil fertility, type, and nutrient management significantly influence aonla growth and yield. The challenges posed by lateritic soils, such as hardening during dry seasons and deficiencies in major plant nutrients, necessitate effective nutrient management strategies. The escalating costs and adverse environmental impacts associated with continuous and excessive use of chemical fertilizers emphasize the importance of transition towards organic nutrient sources for enhanced production. Against this background, this study explores the synergistic effects of organic and inorganic nutrient management on sustainable aonla production in poor soil conditions.

Integrated Nutrient Management (INM) emerges as a dynamic approach to optimize crop yields while preserving the physical, chemical, and microbiological integrity of the soil. INM involves a balanced combination of organic manure, chemical fertilizer, and biofertilizers tailored to specific land use systems, aimed at enhancing organic matter content and soil quality parameters. Since little information is available regarding the integrated nutrient management of aonla, particularly in red and lateritic tracts of West Bengal, this current experiment was conducted to develop organic and inorganic nutrient management schedule for feasible production of aonla in Red and Lateritic region of West Bengal.

MATERIALS AND METHODS

The current investigation was conducted at the Regional Research Sub-Station, Sekhampur of Bidhan Chandra KrishiViswavidyalaya, West Bengal during the period from 2019 to 2021. The experimental site is located at an altitude of 30m above MSL, at latitude 23^{0}68'N and longitude 87^{0}69'E. The experimental site has red and lateritic soil with low water holding capacity, pH 5.63, 0.17% organic carbon content, available nitrogen 160.16 Kg/ha, available phosphorus 19.04 Kg/ha, and available potassium 138.28 Kg/ha.The trees were uniform in height and 12 years old. A Randomised Block Design (RBD) was used to set up the experiment and it was replicated thrice with eight treatments, with each replication containing one plant (T_1 - Control (RDF: 600-300-600g NPK per plant); T_2 - 400-200-500g NPK +20 kg FYM per plant; T_3 - 400-150-450g NPK + 10 kg Vermicompost per plant; T_4 - 550-300-600g NPK + 40g *Azotobacter* per plant; T_5 - 600-250-600g NPK + 50g PSB per plant; T_6 - 550-250-600g NPK + 40g *Azotobacter*+ 50g PSB per plant; T_7 - 350-150-500g NPK + 10 kg FYM + 40g *Azotobacter* + 50g PSB per plant; T_8 - 350-100-450g NPK + 10kg Vermicompost + 40g *Azotobacter* + 50g PSB per plant). Fertilizers were applied in two equal splits, during January-February and September-October. Biofertilizers were applied to the rhizosphere soil, and mixed with organic manures (FYM/ Vermicompost), two weeks after the application of inorganic fertilizers in each split. The growth, yield and physico-chemical composition of fruits were observed two years consecutively and average was presented in the paper. The A.O.A.C. (1980) recommended methods were followed for the estimation of the acidity, total sugar, and ascorbic acid content. The pooled mean data analysis in this study followed the statistical method described by *Panse and Sukhatme* (1985).

RESULTS AND DISCUSSION

Growth parameters

The analysis of data from Table 1 revealed significant variations in the percentage increase of both plant height and canopy spread in the N-S and E-W directions due to different nutrient treatments. In the aggregated analysis, treatment T_6 (550:250:600g NPK + 40g Azotobacter + 50g PSB per plant) showed the highest enhancement in plant height (25.61%), while the control (RDF: 600:300:600g NPK) exhibited the minimum increase (20.85%). Similarly, the maximum percentage increase in canopy spread in both the East-West (14.50%) and North-South (13.61%) directions was observed in treatment T_6, whereas the minimum increase was noted in the control group for both directions (East-West: 11.93%, North-South: 10.77%).

This considerable growth improvement can be attributed to the synergistic effects of the nutrient components present in T_6. The balanced supply of essential nutrients, complemented by the synergistic effects of Azotobacter and PSB, likely promoted lateral growth and canopy expansion in both directions. This relationship likely contributed to enhanced root development, improved nutrient transportation, and increased growth parameters. Conversely, in the control treatment, nutrient deficiencies hampered optimal vegetative growth characteristics. Identical findings have been reported in aonla by researchers (Kour *et al.* 2019, Mandal *et al.,* 2013, Mustafa *et al*., 2013 and Yadav *et al.,* 2007).

Physical parameters of fruits

The application of various nutrient combinations significantly impacted the physical characteristics of aonla fruits as presented in Table 2. Treatment T_6 exhibited the maximum fruit volume (29.28 ml) and average fruit weight (30.20 g), statistically comparable to T_4 (550:300:600g NPK + 40g Azotobacter per plant), while the control treatment (RDF: 600:300:600g NPK) displayed the minimum fruit volume (24.89 ml) and weight (26.31 g).

Table 1: Effect of inorganic and organic nutrients composition on per cent increase in plant height and canopy spread of aonla cv. NA-7 (Pooled mean data from two years)

Treatment	% increase in plant height	% increase in Canopy spread	
		East- West	North- South
T_1	20.85 (27.16)	11.93 (20.20)	10.77 (19.15)
T_2	21.25 (27.44)	12.22 (20.46)	11.24 (19.58)
T_3	22.07 (28.01)	13.58 (21.61)	12.37 (20.58)
T_4	23.79 (29.18)	14.03 (21.99)	13.13 (21.23)
T_5	23.50 (28.99)	13.05 (21.17)	12.01 (20.27)
T_6	25.61 (30.39)	14.50 (22.37)	13.61 (21.64)
T_7	22.77 (28.49)	12.81 (20.97)	11.66 (19.96)
T_8	22.97 (28.62)	13.81 (21.81)	12.78 (20.94)
S.E.m(±)	**0.038**	**0.036**	**0.032**
C.D. at 5%	**0.116**	**0.111**	**0.099**

***Data in the parenthesis are angular transformed value**

T_1 - Control (RDF: 600-300-600g NPK per plant); T_2 - 400-200-500g NPK +20 kg FYM per plant; T_3 - 400-150-450g NPK + 10 kg Vermicompost per plant; T_4 - 550-300-600g NPK + 40g *Azotobacter* per plant; T_5 - 600-250-600g NPK + 50g PSB per plant; T_6 - 550-250-600g NPK + 40g *Azotobacter*+ 50g PSB per plant; T_7 - 350-150-500g NPK + 10 kg FYM + 40g *Azotobacter* + 50g PSB per plant; T_8 - 350-100-450g NPK + 10kg Vermicompost + 40g *Azotobacter* + 50g PSB per plant

Table 2: Effect of inorganic and organic nutrients composition on fruit physical characteristics and yield of aonla cv. Na-7 (Pooled mean data from two years)

Treatment	Fruit volume (ml)	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	Stone weight (g)	Fruit weight (g)	Yield (kg/tree)
T_1	24.89	2.70	2.96	1.19	1.79	26.31	22.70
T_2	26.44	2.79	3.02	1.29	1.86	26.73	23.59
T_3	27.93	2.94	3.27	1.36	1.91	27.61	25.20
T_4	28.52	3.46	3.55	1.58	1.76	29.61	30.14
T_5	28.00	3.37	3.44	1.53	1.66	28.82	27.60
T_6	29.28	3.64	3.68	1.64	1.62	30.20	32.29
T_7	25.85	3.10	3.19	1.43	1.90	27.33	25.51
T_8	27.39	3.24	3.38	1.47	1.96	28.43	27.94
S.E.m(±)	**0.381**	**0.044**	**0.042**	**0.022**	**0.032**	**0.362**	**0.479**
C.D. at 5%	**1.166**	**0.135**	**0.128**	**0.069**	**0.098**	**1.108**	**1.465**

T_1 - Control (RDF: 600-300-600g NPK per plant); T_2 - 400-200-500g NPK +20 kg FYM per plant; T_3 - 400-150-450g NPK + 10 kg Vermicompost per plant; T_4 - 550-300-600g NPK + 40g *Azotobacter* per plant; T_5 - 600-250-600g NPK + 50g PSB per plant; T_6 - 550-250-600g NPK + 40g *Azotobacter*+ 50g PSB per plant; T_7 - 350-150-500g NPK + 10 kg FYM + 40g *Azotobacter* + 50g PSB per plant; T_8 - 350-100-450g NPK + 10kg Vermicompost + 40g *Azotobacter* + 50g PSB per plant

Table 3: Effect of inorganic and organic nutrients composition on fruit chemical characters of aonla cv. Na-7 (Pooled mean data from two years)

Treatment	TSS (^{0}Brix)	Titratable acidity (%)	Ascorbic acid (mg/100 g flesh pulp)	Total sugar (%)	Juice (%)
T_1	9.27	2.05	487.14	5.44	44.96
T_2	9.43	1.95	493.78	5.52	45.46
T_3	9.66	1.89	500.47	5.61	46.43
T_4	10.63	1.63	522.20	6.20	48.38
T_5	10.12	1.75	513.63	5.83	46.55
T_6	10.81	1.51	526.36	6.26	49.33
T_7	9.92	1.83	511.26	5.91	47.72
T_8	10.36	1.67	517.71	5.97	47.09
S.E.m(±)	**0.080**	**0.037**	**1.396**	**0.037**	**0.132**
C.D. at 5%	**0.244**	**0.113**	**4.274**	**0.113**	**0.405**

T_1 - Control (RDF: 600-300-600g NPK per plant); T_2 - 400-200-500g NPK +20 kg FYM per plant; T_3 - 400-150-450g NPK + 10 kg Vermicompost per plant; T_4 - 550-300-600g NPK + 40g *Azotobacter* per plant; T_5 - 600-250-600g NPK + 50g PSB per plant; T_6 - 550-250-600g NPK + 40g *Azotobacter*+ 50g PSB per plant; T_7 - 350-150-500g NPK + 10 kg FYM + 40g *Azotobacter* + 50g PSB per plant; T_8 - 350-100-450g NPK + 10kg Vermicompost + 40g *Azotobacter* + 50g PSB per plant

Moreover, plants treated with T_6 yielded the longest fruit length (3.64 cm) and widest diameter (3.68 cm), contrasting with the control treatment. Treatment T_6, comprising 550:250:600g NPK fertilizer, 40g Azotobacter, and 50g PSB, demonstrated the highest fruit yield per tree (32.29 kg), in contrast to the control (22.70 kg). The incorporation of Azotobacter and PSB likely played a pivotal role in augmenting the yield, as supported by the findings of Mandal *et al.* (2013) and Mustafa *et al*. (2013).

Quality parameters of fruit

A perusal of the data represented in Table 3 clearly showed significant variation in TSS, titratable acidity, ascorbic acid, total sugar and juice content of the pulp due to the application of different nutrient combinations. The maximum TSS content (10.8^0 Brix), ascorbic acid (526.36 mg/100g of pulp) and total sugar (6.26%) content were observed in the treatment T_6 (550:250:600g NPK + 40g *Azotobacter* + 50g PSB) which was statistically at par with treatment T_4 (550:300:600g NPK + 40g *Azotobacter* per plant) compared with minimum TSS content of 9.27^0 Brix and ascorbic acid content of 487.14 mg/100 g of pulp in plants under control (RDF: 600:300:600g NPK). Plants treated with T_6 showed a notable decrease in acidity content, recording 1.51%, whereas T_1 exhibited the highest acidity at 2.05%. The highest juice percentage (49.33%) was recorded from fruits of those plants received 550:250:600g NPK + 40g *Azotobacter* + 50g PSB compared with 44.96% in control. The application of Azotobacter and PSB enhanced fruit quality by supplying essential nutrients to the soil and promoting nutrient transformation. Similar outcomes have been also observed by Kour *et al*. (2019).

CONCLUSION

In the present investigation, various nutrient sources including 600:300:600g NPK (100% recommended dose of NPK), Vermicompost, Farm Yard Manure (FYM), and inoculations of Azotobacter and PSB (40g and 50g each) were administered to plants.From the results of two years investigation, it was observed that the application of both inorganic and organic nutrient treatments significantly impacted plant growth parameters, physico-chemical characteristics of fruits and yield parameters. Ultimately, it was concluded that the application of NPK at a ratio of 550:250:600g along with 40g of Azotobacter and 50g of PSB per plant proved beneficial for enhancing yield and improving fruit quality in aonla (cv. NA-7) under the agro-climatic conditions of Sekhampur, Birbhum, West Bengal, India.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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