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Evaluation of Aonla Varieties for Yield and Quality under Semi-Arid Conditions

Jegadeeswari. V [a], K.R. Vijayalatha [b*], Padmadevi. K [c] and Kalaivani. J [a]

[a] Department of Fruit Science, Horticultural College and Research Institute for Women, Tiruchirappalli – 620009, India.
[b] Department of Vegetable Science, Horticultural College and Research Institute for Women, Tiruchirappalli – 620009, India.
[c] Agricultural College and Research Institute, Karur – 639007, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study, conducted at the Horticulture College and Research Institute for Women, Trichy, during 2023, aimed to assess the evaluation of Aonla (Indian gooseberry) under arid zone conditions of Trichy, focusing on yield and quality parameters. The experiment was laid out in Randomised Block Design (RRD) with 5 treatments as varieties and three replication. The varities are BSR 1, Krishna (NA 5), Kanchan (NA 4), NA 7, and Chakaiya. NA 7 is recommended for its high yield potential in limited spaces, aligning with the trend of high-density planting. BSR 1 excels in Total Soluble Solids, while Chakaiya stands out in acidity and ascorbic acid content. These insights guide cultivar selection for sustainable Aonla cultivation in semi-arid regions, crucial for meeting population demands.

**Corresponding author: E-mail: vijayalatha.kr@tnau.ac.in;*

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Keywords: Aonla; varieties; yield; quality arid zone.

1. INTRODUCTION

The global population, currently at 7.87 billion, is growing at a rate of 1.03% annually and is projected to reach approximately 9.6 billion by 2050. India, with 1.38 billion people, comprises 17.5% of the world population but occupies only 2.4% of the world's surface area [1]. Addressing the challenge of providing stable, safe, and nutritious food to this growing population is paramount. India ranks 101st out of 116 countries on the Global Hunger Index (GHI), highlighting the urgent need to combat malnutrition, which hampers socio-economic progress. The World Health Organization (WHO) identifies hunger as a serious global issue, particularly affecting African countries and India. To tackle malnutrition comprehensively, 195 nations have committed to adopting sustainable development goals (SDGs) by 2030 [2]. There is growing consumer awareness regarding the health benefits of fruits, driving increased demand for nutrient-dense options as part of a balanced diet, especially in light of the COVID-19 pandemic [3].

In India, major fruit crops such as mango, banana, citrus, guava, and apple dominate more than 72% of total fruit crop area, while indigenous fruit crops cover only 6.56% of the area but exhibit high productivity (11.47 tons/ha) [4]. Climate change exacerbates challenges by raising temperatures, UV radiation levels, and the frequency of extreme events like droughts and floods, posing significant threats to sustainable fruit production. To ensure nutritional food security in such conditions, there's a need to explore underutilized native fruit crops resilient to climatic variations and adaptable to diverse agro-climatic conditions. Despite their nutritional value and environmental resilience, underutilized fruit crops face limitations due to inadequate research, limited variety availability, and insufficient post-harvest management practices.

Underutilized fruit crops offer therapeutic and nutritional benefits and serve as horticultural assets for ensuring food security, along with providing recreational, social, and environmental significance. These resilient species can enhance sustainable farm income in arid and semi-arid regions, including waste lands, marginal or saline soils, and rocky terrains. Their development is advancing rapidly, with increased technological adoption, extension efforts, and policy planning. However, further research and development, especially in packaging practices and superior variety cultivation, are essential. Leveraging the potential of underutilized fruit crops can significantly contribute to global malnutrition eradication efforts, particularly in arid and semi-arid regions [5].

Aonla, also known as Indian gooseberry *(Emblica officinalis),* is a subtropical fruit that thrives in regions with an annual rainfall of 350-500 mm. It is predominantly cultivated in central and southern India. This fruit is renowned for its numerous medicinal properties and health benefits, making it a significant component in traditional Indian medicine, particularly Ayurveda. A rich source of vitamin C, it also contains thiamine, riboflavin, pectin, and minerals like iron, calcium, and phosphorus. Processed aonla finds use in various forms such as chutney, candy, preserves, sauce, dried chips, tablets, jellies, and pickles [6]. Aonla is best suited for arid zones.

The objective of the study is

1. To assess the growth, yield and quality parameters of aonla under semi-arid zone

2. MATERIALS AND METHODS

The current study on evaluating Aonla under semi- arid conditions aimed to examine both yield and quality parameters, including phytochemical analysis. The research was conducted at the experimental farm of the Horticulture College and Research Institute for Women in Tiruchirapalli during the year 2023 through a field experiment. The experimental design employed was a Randomized Block Design (RBD) with five treatments representing different varieties and three replications. Each replication comprised eight plants. The study investigated the performance of five distinct treatments representing different Aonla varieties: BSR 1, Krishna (NA 5), Kanchan (NA 4), NA 7, and Chakaiya. These treatments were meticulously selected to represent a diverse range of Aonla cultivars, thereby ensuring comprehensive assessment of the crop's characteristics under arid conditions. Such a systematic approach enhances the reliability and applicability of the findings, allowing for informed decisions regarding cultivar selection and cultivation practices.

2.1 Observations and Data Recorded

To assess the vegetative and reproductive performance of various Aonla (Emblica officinalis) varieties, a comprehensive study was conducted recording several growth parameters. The following parameters were meticulously recorded:

2.2 Vegetative Growth Parameters

1. **Tree Height:** The vertical measurement from the base of the trunk to the highest point of the tree.
2. **Canopy Area Spread:** The horizontal spread of the tree's canopy measured at its widest points.
3. **Number of Branches:** The total count of primary branches emanating from the main trunk.

2.3 Reproductive Growth Parameters

1. **Days Taken for First Flowering**: The number of days from planting to the appearance of the first flowers.
2. **Fruit Set**: The proportion of flowers that develop into fruits.
3. **Number of Fruits per Bunch**: The count of individual fruits in each fruit bunch.
4. **Number of Fruits per Tree**: The total number of fruits borne by a single tree.
5. **Mean Fruit Weight**: The average weight of individual fruits, measured in grams.
6. **Mean Bunch Weight**: The average weight of fruit bunches, measured in grams.
7. **Fruit Size**:

- **Fruit Length**: The vertical measurement of the fruit from the base to the tip.
- **Fruit Girth**: The circumference of the fruit at its widest point.

2.4 Additional Parameters

1. **Number of Seeds per Fruit**: The count of seeds contained within an individual fruit.
2. **Pulp:Stone Ratio**: The ratio of the edible pulp to the inedible stone (seed).
3. **Yield per Tree**: The total fruit yield from a single tree, measured in kilograms.

To assess the quality parameters of various Aonla (Emblica officinalis) varieties, the following methods were utilized:

2.5 Total Soluble Solids (TSS)

Total Soluble Solids (TSS) were measured using a Hand Refractometer. Fresh fruit juice was extracted and a few drops were placed on the refractometer's prism. The TSS value, expressed in degrees Brix, was then read directly from the refractometer scale.

2.6 Dry Matter Content

Dry matter content was determined by weighing a fresh fruit sample initially. The fruit was then dried in an oven at 60°C until it reached a stable weight. The dry matter content was calculated by subtracting the weight of the dried fruit from the initial weight of the fresh fruit and expressing the result as a percentage using the following formula:

DMC (%) = (Initial Weight of Fresh Fruit−Weight of Dried Fruit/ Initial Weight of Fresh Fruit) *100

2.7 Ascorbic Acid Content

Ascorbic acid content was determined using the dye method described by Loeffler and Ponting [7]. This method involves titrating a known volume of fruit juice with a dye solution. Ascorbic acid in the juice reduces the dye to a colorless compound. The endpoint of the titration is reached when the pink color of the dye remains for 15 seconds. The amount of dye consumed is directly proportional to the ascorbic acid content in the sample. The ascorbic acid content was calculated and expressed in milligrams per 100 grams of fruit.

2.8 Thiamine Content

Thiamine content was measured using the thiochrome method. This involves oxidizing thiamine to produce a fluorescent compound, thiochrome. The fluorescence intensity was measured using a fluorometer and compared with a standard curve to determine the thiamine content in the fruit. The results were expressed in milligrams per 100 grams of fruit.

The results were subjected to statistical analysis using AGRES SOFTWARE to compare the vegetative, yield and quality attributes among different Aonla varieties.

3. RESULTS AND DISCUSSION

The evaluation of five cultivars of Aonla (Indian gooseberry) under arid conditions revealed significant variations in growth and physicochemical characteristics.

Among the cultivars, NA 7, NA 4, Krishna, BSR 1, and Chakaiya, distinct differences were observed in their growth parameters. Notably,

plant shape varied, with spreading observed in Chakaiya, Krishna, NA 7, and BSR 1, while the maximum plant height was recorded in Krishna (5.72 m), followed by Kanchan and NA 7. Conversely, Chakaiya exhibited the minimum plant height, indicative of the diverse genetic makeup influencing growth habits under arid conditions. Differences in growth characteristics such as plant shape, height, spread, stem girth, volume, and canopy area can be attributed to the specific climatic needs of the variety and the genetic composition of the cultivar. This observation aligns with the results reported by Kumar et al. [8].

In terms of fruit characteristics, a range of shapes, including flattened round, triangular, oval, and round, were observed among the cultivars. Additionally, variations in base and fruit apex were noted, contributing to the overall diversity in fruit morphology. Notably, Chakaiya exhibited the maximum fruit weight, while BSR 1 displayed the minimum, underscoring the importance of genetic factors in determining fruit size and weight. Similarly, NA 7 showcased the maximum fruit length, highlighting the potential for selecting cultivars with desirable fruit attributes for commercial production.

Table 1. Observations on Plant growth parameter in Aonla

S. No	Variety	Tree height (m)	Canopy Area (m 2)	No. Of Branches	No. of Fruits/ Bunch
1.	**BSR 1**	5.30	23.08	24	3
2.	**Krishna (NA 5)**	5.72	25.74	21	5
3.	**Kanchan (NA 4)**	5.69	15.98	19	8
4.	**NA 7**	5.56	15.59	23	3
5.	**Chakaiya**	4.90	25.74	36	4
	SEM	0.05	0.19	0.32	0.02
	CD @ 5%	0.16	0.59	0.97	0.08

Table 2. Observations on Fruit Set and Fruit characteristics in Aonla

S. No	Variety	No. of Fruits/ Tree	Fruit base (Cavity at stem end)	Fruit shape	Fruit weight (g)
1.	BSR 1	48	Flat	Flattened round	5.89
2.	Krishna (NA 5)	70	Flat	Triangular	27.82
3.	Kanchan (NA 4)	67	Shallow	Flattened round	15.36
4.	NA 7	64	Flat	Oval	28.06
5.	Chakaiya	73	Shallow	Flattened round	35.47
	SEM	0.86	-	-	0.10
	CD @ 5%	2.60	-	-	0.32

Table 3. Observations on fruit characteristics in Aonla

S. No	Variety	Fruit Length (cm)	Fruit breadth (cm)	Yield / plant (kg)
1.	BSR 1	1.87	2.28	36.00
2.	Krishna (NA 5)	3.18	3.47	65.33
3.	Kanchan (NA 4)	2.43	2.94	90.00
4.	NA 7	3.31	3.43	48.67
5.	Chakaiya	3.28	3.70	70.00
	SEM	0.02	0.02	0.63
	CD @ 5%	0.07	0.08	1.90

Table 4. Observations on Fruit Quality Parameters in Aonla

S. No	Variety	TSS (Brix)	Dry matter (g)	Ascorbic acid (mg/100g)
1.	BSR 1	7.71	3.64	323
2.	Krishna (NA 5)	4.85	2.66	494
3.	Kanchan (NA 4)	7.34	3.45	443
4.	NA 7	4.09	3.72	514
5.	Chakaiya	4.51	2.34	567
	SEM	0.06	0.02	4.08
	CD @ 5%	0.19	0.06	12.32

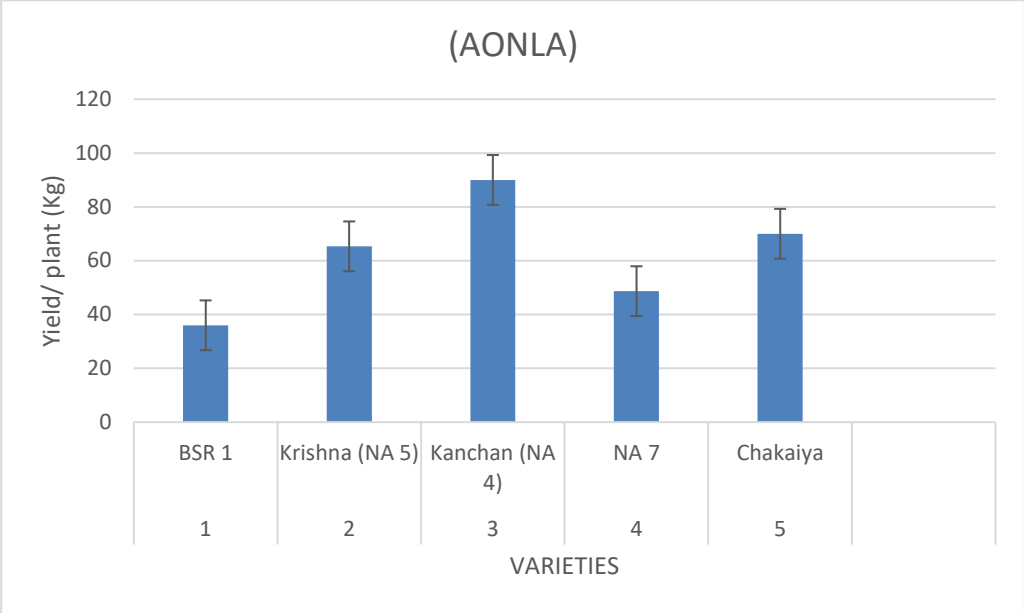

Fig. 1. Experimental result of Yield (kg) in Aonla

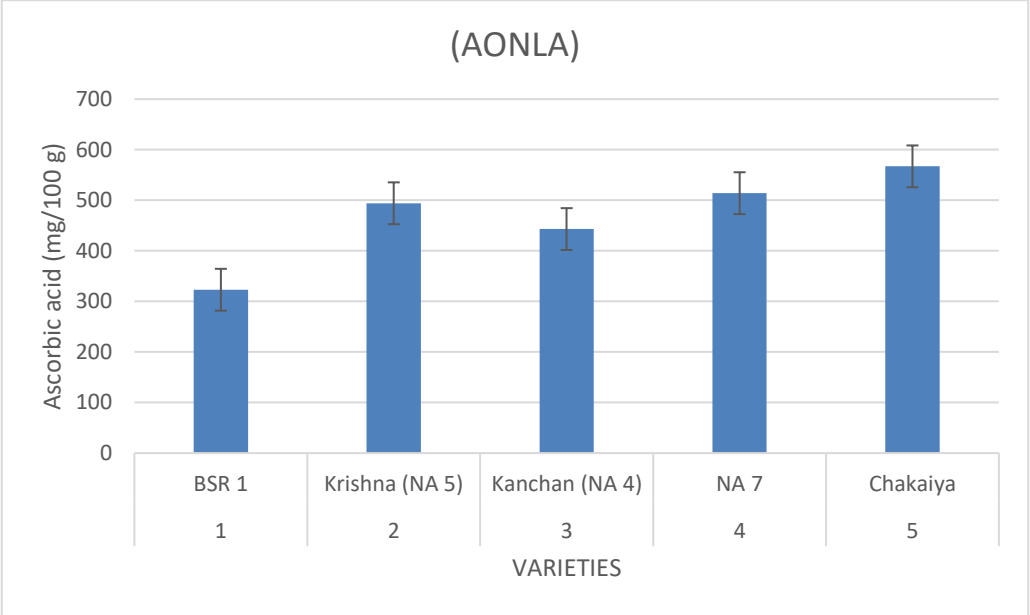

Fig. 2. Experimental result of ascorbic acid (mg/100g) in Aonla

Physicochemical analyses revealed significant differences among the cultivars in terms of Total Soluble Solids (TSS) and ascorbic acid content. BSR 1 exhibited the highest TSS, while Chakaiya displayed the maximum ascorbic acid content. These variations were attributed to both varietal characteristics and local soil and climatic conditions, emphasizing the need for tailored agronomic practices to optimize fruit quality and nutritional value under arid environments. Variations in qualitative characteristics may be due to genetic differences among cultivars, a notion supported by observations made by Nagar et al. in [9] regarding bael. The diversity seen in growth parameters could be attributed to specific genetic traits of the germplasm or cultivar. Increased fruit weight may be linked to genotype characteristics. Additionally, fruit weight and size could be influenced by the bearing habit and yield potential of the variety, as noted by Malshe et al. in [10]. Similar findings regarding aonla in laterite soil of West Bengal were reported by

Ghosh et al. in [11]. Differences in chemical composition may be linked to varietal traits and the specific soil and climate conditions of the area, as suggested by Malshe et al. in [10].

Furthermore, yield assessments demonstrated varying productivity among the cultivars, with NA 7 exhibiting the highest yield per plant, followed by Chakaiya and BSR 1. Yield per unit volume and per unit canopy area were also calculated to assess fruiting intensity and suitability for increased yields under population pressure. These findings underscore the importance of varietal selection based on growth, fruit characteristics, and yield potential, while also emphasizing the need for further research to elucidate the genetic basis of observed traits and optimize agronomic practices for enhanced Aonla cultivation in arid regions.

4. CONCLUSION

NA 7 demonstrated exceptional yield potential, particularly suitable for high-density planting, while BSR 1 excelled in Total Soluble Solids, and Chakaiya showed superior acidity and ascorbic acid content. These findings are instrumental in guiding the selection of Aonla cultivars for sustainable cultivation in semi-arid regions, ensuring that agricultural practices can meet the increasing demands of the population.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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