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Assessment of aonla varieties (*Emblica officinalis* Gaertn) under rainfed vertisol conditions of Tamil Nadu

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Abstract
An experiment was conducted to evaluate four aonla varieties *viz*; Chakaiya, NA-7, Kanchan and BSR 1 during 2017 – 2020 for their yield and quality characters at Regional Research Station (RRS), Tamil Nadu Agricultural University, Aruppukottai, Virudhunagar Dt., Tamil Nadu state in twelve years old aonla plantation under dry vertisol condition. The plant height varied from 2.77 to 5.37m in all varieties. The number of primary and secondary branches was ranged between 2.33 to 5.53 and 5.33 to 9.62 respectively. The increased stem girth of 79.01cm observed in the variety Kanchan. The variety BSR 1 showed enhanced plant spread in both East – West (4.53 m) and North – South (4.37 m). The aonla variety Chakaiya showed higher individual fruit weight (34.31 g) and pulp weight per fruit (32.03 g). Kanchan recorded the increased fruit diameter (40.79 mm) and reduced seed weight per fruit (1.55 g). The increased number fruits per tree (3744.33) and reduced individual fruit weight (13.68) was recorded in BSR 1. The aonla variety NA 7 showed increased yield per tree of 72.79 kg and yield per ha of 19.62 t. The enhanced TSS content of 15.33^0 Brix was observed in the variety BSR 1.

Keywords: Aonla, varieties, rainfed, *Emblica officinalis* Gaertn

Introduction
The aonla or Indian gooseberry (*Emblica officinalis* Gaertn) belongs to family Euphorbiaceae. It is a subtropical plant and prefers dry subtropical climate and can be grown with an annual rainfall of 350-500 mm. It is indigenous minor fruit crop grown in tropical South-East Asia, particularly central and Suthern India. It also has a tremendous export potential due to its medicinal and therapeutic and high nutritive value, it has been recognized as Amrit Phal (life-giving fruit). The fruit is highly nutritive and second richest source of vitamin C after Barbados cherry. It is a fair source of thiamine (vitamin B1), riboflavin (vitamin B2), and a rich source of pectin and minerals (iron, calcium and phosphorus). The ascorbic acid and other constituents are well retained in dried/processed aonla fruits. It is also used in shampoos, hair dyes and ink industries. Trifla and chavanprash are Wellknown indigenous products of aonla.
Aonla fruit due to its nutritional security, high medicinal value, hardy nature, drought tolerant and high productivity has the immense possibility for commercial growing in the arid zone and marginal soils, where only a few fruits can be grown. It can be grown successfully in marginal soils, moderately alkaline soils and slightly acidic to saline/sodic (pH 6.5-9.5) conditions (Chadha, 2013) [2].
Deep root system, reduced foliage and dormancy of fruitlets during dry weather (April-June) make it an ideal plant for growing in arid and semi-arid conditions. However, heavy frost during winter is not conducive to young plants but a mature plant can tolerate freezing as well as the high temperature of 46 ºC (Bose and Mitra, 2001) [1]. Warm temperature seems to be conducive for the initiation of floral buds and ample humidity is essential for initiation of growth of dormant fruitlets during July-August. Dry spells during this period result in heavy fruit drop and delay in initiation of fruit growth.
Aonla gene pool is spread over different parts of the country and has enormous variability with respect to qualitative as well as quantitative characters due to old age practice of seed propagation. A large number of varieties, mostly from selection have been released for commercial cultivation from different institutes, but their adaptability has not been studied for semiarid region of Tamil Nadu. Farmers are experiencing the challenges of identifying the suitable cultivars, as they are unfamiliar with the characteristics of varieties with respect to adaptability and fruit characters.

Identification of suitable genotype for the region is necessary for promoting its productivity, production and quality of the fruits under semi-arid conditions (Nagar *et al*. 2017) [7].

In order to identify distinct characters of various aonla cultivars, the morphological characters are also equally important to the fruit characters. On the basis of growth, yield and quality performance of different varieties, the emphasis has been made to find out the suitable cultivar(s) for the semi-arid region of Tamil Nadu. This will also help the growers in the selection of suitable cultivar(s) of this underutilized crop for large-scale cultivation to get higher yield and good quality fruits suitable for processing as well as medicinal formulation preparations. Unproductive land of the arid and semi-arid region could be utilized properly by growing such a hardy fruit crop, which holds promise for nutritional security and also helpful in generating income.

Materials and Methods

The experiment was conducted during 2017 to 2020 with the four aonla varieties *viz*., existing genotypes and varieties available at Regional Research Station, Tamil Nadu Agricultural University, Aruppukottai, Virudhunagar District under dry vertisols conditions. This research station is located at Aruppukottai, Virudhunagar District of Tamil Nadu. The experimental site is located at $9^0$33' N; $78^0$05' E and at an altitude of 102 m above mean sea-level. The centre is coming under semi-arid climatic conditions. The annual average rainfall is 770 mm. The soil type is vertisols (Black clay loam soil underlying canker nodules). Soil depth ranged between 0.6 to 1.2 m and received maximum rainfall during North – East Monsoon (Fig. 1).

A study was undertaken during 2017 and 2020 to evaluate the performance of aonla varieties under dry vertisol condition. The twelve years old varieties *viz*. Kanchan, Chakaiya, NA-7 and BSR 1 were taken for this study. The plants has been maintained at the distance of 6 x 6 m and uniform cultural practices were provided for all cultivates. Observations were recorded periodically with respect to growth parameters and fruit characters. Height was measured with the help of ranging rod in meter. To calculate total fruit yield, the harvested fruits were weighed on the digital electric balance for each replication and the value was expressed in kilograms (kg/plant).

The TSS of fresh fruits were determined at room temperature using hand refractometer having a range of 0 to 32 °Brix (ERMA made) by putting a drop of fresh fruit juice on the screen and recorded the readings. The refractrometer was calibrated with distilled water after every use and the values were expressed in degree Brix (°B).The data were analysed in RBD design with four replications using M-stat package. The mature fruits were taken randomly from all direction of plants from each variety and observations were recorded with respect to fruit characteristics. Size of fruit was recorded with the help of vernier calipers. TSS was determined with the help of hand refactometer. The data was statically analyzed by the method described by Gomez and Gomez (1984) [3].

Results and Discussion

I. Growth Parameters

The data on plant height (table 1) revealed that was maximum in BSR 1 (5.37 3.45m) followed by Kanchan (4.00 m) and Chakaiya (3.07 m), whereas minimum was recorded in NA 7 (2.77 m). The increased number of primary branches per plant was observed in BSR 1 (3.53) followed by Kanchan (3.13) and reduced number of branches per plant was noticed in NA 7 (2.33). The variety Kanchan recorded maximum number of secondary branches per plant (9.62), followed by Chakaiya (9.09). Kanchan showed enhanced stem girth (79.01cm) followed by BSR 1 (71.34 cm) and the least stem girth was observed in Chakaiya (46.34 cm). Similar results were reported in aonla by Yadav, 2007 [10] and Patil *et al*., 2010 [8].

Canopy spread in East West direction was vary from 3.17 m to 4.53 m. The maximum spread in East West direction was noted in BSR 1 (4.53 m) followed by Kanchan 4.37 m and minimum was observed in NA 7 (3.17 m). Canopy spread in North South direction was also maximum in BSR 1 (4.37 m) followed by Kanchan (4.13 m), Chakaiya (3.60 m), whereas minimum was found in NA 7 (3.27 m). Variation of plant growth characters in different cultivars is genetic feature of individual variety. The variation in growth parameters such as plant height, plant spread (EW &NS), stem girth, primary and secondary branches might be due to the specific climatic requirement of the variety and the genetic makeup of the cultivar. Similar findings were recorded by Kumar *et al*. (2011) [4].

II. Yield and quality parameter

Individual fruit weight is an important component of yield. The maximum fruit weight was reported in Chakaiya (34.31 g) followed by NA 7 (30.57 g), whereas minimum was found in BSR 1 (13.68 g). The maximum fruit diameter was observed in Kanchan (40.79 mm) which was closely followed by Chakaiya (38.20 mm), whereas minimum fruit diameter was reported in BSR 1 (29.39 mm). The stone weight was found maximum in BSR 1 (2.59 g), followed by Chakaiya (1.85 g), and minimum was recorded in Kanchan (1.55 g). Pulp weight was found maximum in variety Chakaiya (32.03 g) followed by NA 7 (27.90 g), and minimum was observed in BSR 1 (11.10 g). Number of fruits per tree was recorded maximum in BSR 1 (3744.33), followed by NA 7 (2186.33) and minimum in Chakaiya (1597.00).

Fruit yield per tree (kg)

Significant variation was observed in pooled mean. It is a most important parameter for evaluating any kinds of varieties. Highly significant differences were observed for fruit yield per tree. In the year 2017, recorded fruit yield per tree range between 56.42 to 76.15 kg. During 2018, recorded the fruit yield per tree range between 41.64 to 54.60 kg, During 2019, showed the fruit yield per tree ranged between 44.35 to 57.05 kg. In the year 2020, fruit yield per tree range between 42.47 to 72.79 kg. The pooled data (2017-2020) indicated that, the variety NA 7 continuously recorded increased fruit yield per tree of 65.14 kg followed by Chakaiya (55.25 kg) and Kanchan (50.61 kg) and the decreased fruit yield was observed in BSR 1 (46.22 kg)

Fruit yield per hectare (t)

Highly significant differences were observed for fruit yield per ha. It is an essential parameter for valuing any kinds of varieties. In the year 2017, recorded fruit yield per ha range between 15.23 to 20.56 t. During 2018, recorded the fruit yield per ha range between 11.24 to 14.74 t, During 2019, showed the fruit yield per ha ranged between 11.76 to 20.16 t. In the year 2020, fruit yield per ha range between 11.44 to 19.62 t. The pooled data (2017-2020) indicated that, the

variety NA 7 continuously recorded increased fruit yield per ha of 18.77 followed by Chakaya (15.85 t) and Kanchan (13.97 t). The decreased fruit yield was observed in BSR 1 (12.41 t). Variation in mass fruit and yield characters might be due to the varietal character and also the prevailing weather conditions at the time of fruit development stage of respective variety. Similar results were reported in aonla by Yadav and Yadav, 2010 [11], Jaiswal *et al*., 2007.

TSS was found maximum in BSR 1 (15.33^0 Brix) NA-6 (19.30%) and minimum in Chakaiya (10.27^0 Brix). The variation in the chemical constituent might be associated with the varietal characters and prevailing soil and climatic conditions in that locality (Malshe *et al*. 2016) [5]. Similar results were also observed by Singh *et al*. (2017) [9] in aonla and Nagar *et al*. (2017) [7] in bael. Aonla growing in arid region with limited water tended to more accumulation of dry matter and lower moisture may result in higher TSS in fruits Meghwal and Azam (2004) [6].

Table 1: Evaluation of aonla varieties for growth parameters (2017 – 2020)

Variety	Plant ht. (m)	No. of Primary branches	No. of Secondary branches	Stem girth (cm)	Plant spread (m)		Individual fruit Wt. (gm)	Fruit Dia. (mm)	Seed wt. / Fruit (g)	Pulp wt. / Fruit (g)	No. of fruits / tree	TSS (º Brix)
					E-W	N-S						
Chakaiya	3.07	2.67	9.09	46.34	3.30	3.60	34.31	38.20	1.85	32.03	1597.00	10.27
NA 7	2.77	2.33	8.66	50.34	3.17	3.27	30.57	37.66	1.66	27.90	2186.33	11.33
Kanchan	4.00	3.13	9.62	79.01	4.37	4.13	25.94	40.79	1.55	24.36	2142.33	11.63
BSR1	5.37	3.53	5.33	71.34	4.53	4.37	13.68	29.39	2.59	11.10	3744.33	15.33
S.Ed	0.017	0.008	0.027	0.225	0.011	0.007	1.500	2.150	0.200	1.274	0.182	0.580
CD (P=0.05)	0.035	0.016	0.057	0.455	0.023	0.014	3.00	4.301	0.399	2.551	0.368	1.161

Table 2: Evaluation of aonla varieties for yield / tree (kg) and yield / ha (t) (2017 – 2020)

Variety	Yield / tree (kg)				Pooled	Yield / ha. (t)				Pooled
	2017	2018	2019	2020		2017	2018	2019	2020	
Chakaiya	71.95	40.72	47.93	60.41	55.25	19.42	10.99	16.73	16.29	15.85
NA 7	76.15	54.60	57.05	72.79	65.14	20.56	14.74	20.16	19.62	18.77
Kanchan	61.01	42.60	47.71	51.15	50.61	16.47	11.50	14.16	13.77	13.97
BSR1	56.42	41.64	44.35	42.47	46.22	15.23	11.24	11.76	11.44	12.41
S.Ed	3.208	2.081	1.928	4.367	3.315	0.825	0.646	1.323	1.422	1.563
CD (P=0.05)	6.412	4.123	4.031	8.715	6.154	1.731	1.277	2.734	2.910	3.012

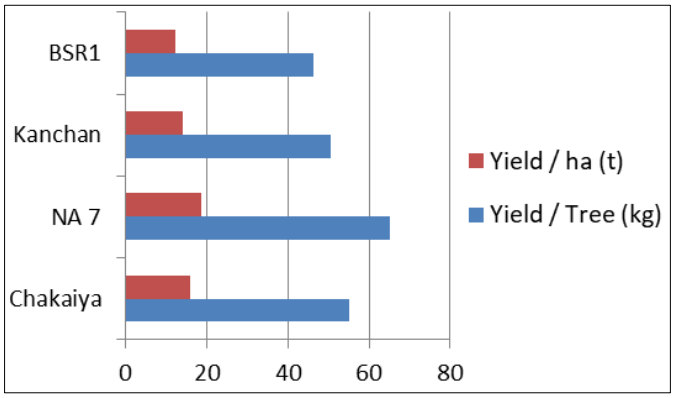

Fig 1: Evaluation of aonla varieties for yield per tree (kg) and yield per hectare recorded during 2017-2020 at Regional Research Station, Aruppukottai, Tamil Nadu, India

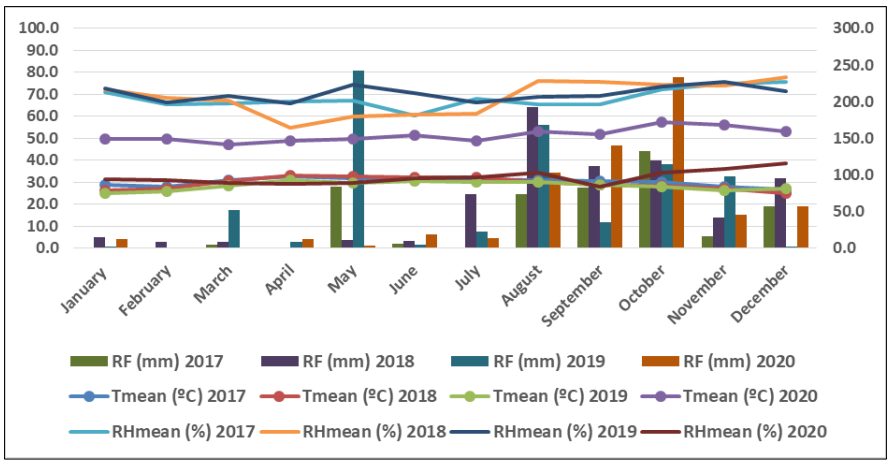

Fig 2: Weather data recorded during 2017-2020 at Regional Research Station, Aruppukottai, Tamil Nadu, India

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