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Characterization of aonla (*Phyllanthus emblica* Linn.) germplasm under semi-arid condition of Haryana

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Abstract

The present study was conducted to characterization of aonla (*Phyllanthus emblica* Linn.) germplasm for tree, foliage, fruit and stone attributes under semi-arid ecosystem of Haryana (India) during the years 2017-18. Among the genotypes, growth habit was observed spreading, upright and drooping. Leaf retention was observed as deciduous and semi-deciduous. Plant height, plant spread (N-S) and (E-W) among the genotypes varied from 4.83 m (Chakaiya) to 6.62 m (G1), 4.39 (CHES 1) to 7.47 m (G 1) and 4.43 (NA 7) to 7.10 m (G 1), respectively. The foliage was visualized as dense and sparse among all the germplasm. Oblong, elliptical and oval shaped leaves were present in different germplasm. Young shoots have green to light green colour and they have varied strength at maturity (weak, intermediate and strong). There was substantial variation with respect to different fruit attributes viz., fruit shape (oval, round, flattened round); fruit apex (flat, papillate, depressed), fruit base cavity (Shallow, flat, absent), segment ridges (absent, prominent, less prominent), fruit colour (yellow green, light green, light green with red tinge), stone wing (slight/prominent) and number of seeds per stone (4-6) under semi-arid conditions of Haryana.

Keywords: Aonla genotypes, foliage characters, fruit characters, stone characters, tree characters

Introduction

The aonla (*Phyllanthus emblica* Linn.) also known as 'Indian gooseberry' is an important indigenous minor fruit crop. It belongs to the family Phyllanthaceae and subfamily Phyllanthoidae [1]. It is indigenous to tropical South-East Asia, particularly the region of central and southern India considered as centre of origin of aonla. India ranks first in the area (99000 ha) and production (1216000 MT) of aonla [2]. Besides systematic plantation, the natural distribution of wild aonla is found on the Himalayas, Chota Nagpur, Bihar, Orissa, West Bengal and the Western Ghats. A rich genetic diversity also exists in North-Eastern region of India, where it grows abundantly in the forest of Khasi and Garo hills of Meghalaya and locally known as Sohmylleng [3]. Aonla fruit is highly valued among indigenous medicinal plants and regarded as the sacred tree in India. Trifla and chavanprash are well-known indigenous products of aonla. The fruit is highly nutritive and second richest source of ascorbic acid (400-565 mg/100 g pulp) after barbados cherry. It helps in prevention of scurvy disease [4, 5]. The fruits are processed into preserves (murabba), sauce, candy, jellies, pickles, powder etc.

Aonla is a subtropical plant and prefers dry subtropical climate. Deep root system, reduced foliage and fruitlet dormancy during dry weather (April-June), makes it an ideal tree for growing in arid and semi-arid ecosystem. Being a hardy plant, it can be grown successfully in marginal soils, moderately alkaline soils and slightly acidic to saline/sodic (pH 6.5-9.5) conditions. Thus due to its nutritional security, high medicinal value and high productivity (15-20 t/ha) has the immense possibility for commercial growing in the arid zone and marginal soils, where only a few fruits can be grown [6, 7].

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 seed propagation. However, there is paucity of scientific information regarding distinct traits of aonla germplasm and also for visualizing the prospects of this fruit under rainfed semi-arid conditions. In order to identify distinct characters of various aonla germplasm, the morphological characters are also equally important to the fruit characters. Keeping in view, a study was undertaken to characterize aonla germplasm on the basis of different morphological attributes of tree, foliage, fruit and stone of selected aonla germplasm under semi-arid conditions of Haryana.

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Material and methods

The present study was carried out at experimental orchard (28°10'N & 76°50'E; 266 m above msl) at Regional Research Station, Bawal (Rewari) of CCS Haryana Agricultural University during the year 2017-18. The climate of experimental site characterized as typical semi-arid climatic zone with hot and dry summer and extremely cold winter. The field experiment was conducted on 10 year old aonla germplasm planted at 6 × 6 m spacing. A total 11 number of germplasm viz., CHES 1, Chakaiya, Krishna, NA 6, NA 7, NA 10, NA 20, G 1, BSR 1 along with two seedling (S1 and S2) were taken for study. The plants were earmarked in February, 2017, and were observed for their tree, foliage, fruit and stone attributes. These observations were taken uniformly in all the germplasm at the stage(s) recommended in the descriptor of NBPGR^[8] and guidelines for DUS testing of PPV and FRA. Foliage retention was observed in the month of February and was designated as deciduous (tree completely shed their leaves and became leafless), semi-deciduous (some leaves were retained on tree) and evergreen (higher leaf retention). Attributes of tree and foliage viz., plant height, plant spread (N-S and E-W), tree habit, foliage density, leaf shape, young shoot colour were observed in the month of August-September when fruit attain pea size stage. Fruit and stone attributes viz., fruit shape, fruit base cavity, fruit apex, segment ridges, fruit colour, numbers of segments, stone wing nature and number of seeds/stone were observed from mature fruits. Statistical analysis for tree attributes (plant height and tree spread) were performed using the SAS package (9.3 SAS Institute, Inc., USA) and P-value ≤ 0.05 were considered as significant.

Result and Discussion

Tree and foliage characteristics

Substantial variations have been observed in the morphological parameters of the studied germplasm (Table 1). On the basis of foliage retention germplasm were categorised into deciduous, semi deciduous and evergreen. The germplasm such as Chakaiya, NA 6, G 1 and NA 20 retained some leaves in the month of February, were grouped into semi-deciduous whereas, rest of the genotypes (CHES 1, Krishna, NA 7, NA 10, BSR 1, Seedling 1 and Seedling 2) complete devoid their leaves in the month of February. Among the studied germplasm, none of the germplasm was observed as evergreen. Previously Chakaiya were observed as semi-deciduous under valley conditions of Garhwal, Himalaya^[9]. The germplasm observed semi-deciduous may

be the genetic makeup of the plant and this might be due to effect of fog and low temperature during winter months under the semi-arid conditions.

Tree habit was observed as, spreading (CHES 1, Chakaiya, Krishna, NA 6, NA 7, NA 10 and BSR 1), drooping (NA 20) and upright (G 1, Seedling 1 and Seedling 2). The plant height among the studied germplasm ranged between 4.83 m and 6.62 m. Chakaiya was reported with the shortest height (4.83 m) and cultivar G 1 was tallest among all the germplasm with the height of 6.62 m; followed by Seedling 1 (6.42 m), NA 6 (6.25 m), NA 20 (6.22 m) and Seedling 2 (6.18 m). Tree spread (NS and EW) in different germplasm ranged from 4.39 (CHES 1) to 7.47 m (G 1) North-South and 4.43 (NA 7) to 7.10 m (G 1) East-West. The foliage density was observed sparse in the genotypes Chakaiya, Krishna, NA 6, G 1, BSR 1, Seedling 1 and Seedling 2 whereas, dense foliage was observed in CHES 1, NA 7, NA 10 and NA 20. These results are similar to the findings of previous studies on aonla varieties under different agro-climatic conditions^[3, 10, 11, 12, 13]. The variation in plant growth and foliage characters in different germplasm may be attributed to genetic background of the individual variety and soil condition^[14]. However, Tripathi *et al.*^[15] observed that the popular cultivars of North India viz., Kanchan, NA 6, NA 10, Krishna and Chakaiya produced lesser vegetative growth as compared to cultivar BSR 1 under the humid conditions of Western Ghats. These results suggest that the adaptability and performance of germplasm vary with climatic conditions. Dwarfness is the desirable characters for the high density planting as it accommodates more number of plants per unit area and better sunlight interception thus helps to enhance the productivity^[5]. Leaf characters are generally used to distinguish and identify the cultivars and species of fruit crops. The shape of the leaf was grouped into oblong, oval and elliptical as per NBPGR descriptor. Among all the germplasm, leaf shape was observed as oval in NA 6, NA 10 and BSR 1; elliptical in Krishna, NA 20, G 1, Seedling 1 and Seedling 2; oblong in CHES 1, Chakaiya and NA 7.

Furthermore, the colour of young shoots was grouped into light green (CHES 1, NA 7, BSR 1 and Seedling 1), green (Chakaiya, NA 6, NA 10, NA 20, G 1 and Seedling 2) and dark green (Krishna). Mature branchlets of cultivars BSR 1 and Seedling 1 were mechanically strong whereas, in other germplasm (CHES 1, Chakaiya, NA 6, NA 10, NA 20, G 1 and Seedling 2) branchlets were of intermediate strength. The strong branchlets in germplasm can sustain heavy more crop load.

Table 1: Tree and foliage characteristics of aonla germplasm under semi-arid conditions\

Germplasm	Foliage retention	Tree habit	Plant height (m)	Plant spread N- S (m)	Plant spread E-W (m)	Foliage density	Leaf shape	Young shoot colour	Nature of branchlets
CHES 1	Deciduous	Spreading	5.58 ^{cd}	4.39 ^d	4.50 ^d	Dense	Oblong	Light green	Intermediate
Chakaiya	Semi-deciduous	Spreading	4.83 ^f	5.82 ^{bc}	5.50 ^{bcd}	Sparse	Oblong	Green	Intermediate
Krishna	Deciduous	Spreading	5.67 ^{cde}	6.40 ^{abc}	6.52 ^{ab}	Sparse	Elliptical	Dark green	Weak
NA 6	Semi-deciduous	Spreading	6.25 ^{ab}	5.80 ^{bc}	5.50 ^{bcd}	Sparse	Oval	Green	Intermediate
NA 7	Deciduous	Spreading	5.47 ^{ed}	4.40 ^d	4.43 ^d	Dense	Oblong	Light green	Weak
NA 10	Deciduous	Spreading	5.88 ^{bcd}	5.47 ^{cd}	5.33 ^{cd}	Dense	Oval	Green	Intermediate
NA 20	Semi-deciduous	Drooping	6.22 ^{abc}	6.00 ^{bc}	5.77 ^{bc}	Dense	Elliptical	Green	Intermediate
G 1	Semi-deciduous	Upright	6.62 ^a	7.47 ^a	7.10 ^a	Sparse	Elliptical	Green	Intermediate
BSR 1	Deciduous	Spreading	5.22 ^{ef}	5.50 ^{cd}	5.22 ^{cd}	Sparse	Oval	Light green	Strong
Seedling 1	Deciduous	Upright	6.42 ^{ab}	6.91 ^{ab}	6.50 ^{ab}	Sparse	Elliptical	Light green	Strong
Seedling 2	Deciduous	Upright	6.18 ^{abc}	6.10 ^{bc}	6.20 ^{abc}	Sparse	Elliptical	Green	Intermediate

Fruit and stone characteristics

In the present study, germplasm differed in the fruit shape; as round (NA 20), flattened round (CHES 1, Chakaiya, NA 6, NA 10, G 1 and BSR 1), oval (NA 7, Seedling 1 and Seedling 2) and triangular (Krishna). The fruits with flattened round shape and medium large size have the more processing preference [16]. The fruit base cavity (cavity at stem end) of cultivar Krishna was observed deep; flat in NA 7, NA 10 and BSR 1; it was absent in CHES 1 and Seedling 2, while in rest of the germplasm (Chakaiya, NA 6, NA 20, G 1 and Seedling 1) it was observed as shallow. The fruit apex observed as depressed (G 1), papillate (NA 6 and BSR 1) and flat fruit apex (CHES 1, Chakaiya, Krishna, NA 7, NA 10, NA 20, Seedling 1 and Seedling 2). Segment ridges at stem end were absent on the fruits of genotypes CHES 1, Chakaiya, BSR 1 and Seedling 2; prominent in Krishna and G 1 whereas, it was less prominent in NA 6, NA 7, NA 10, NA 20 and Seedling 1. Selection of cultivar for processing into different kind of products also depends on their appearance and other physical

properties as they affect the final appearance and quality of the end product. Light green fruit colour was observed in Chakaiya, Krishna, NA 6, NA 10, G 1 and Seedling 1; yellow green in CHES 1, NA 7, NA 20 and Seedling 2, while the fruit of cultivar BSR 1 had red tinge on light green colour background. Number of segments in all the germplasm was found six. Stone wings were observed slight (CHES 1, Chakaiya, Krishna, NA 7, NA 10, BSR 1, G 1, Seedling 1 and Seedling 2) and prominent (NA 6 and NA 20). In most of the germplasm, number of seeds per stone were recorded 6 whereas, in BSR 1, Chakaiya and NA 7 genotypes some stones were having 4-6, 5-6 and 5-6 seeds, respectively. Insufficient pollination and failure of fertilization in some of the ovules might be the reason of the observed deviations. Previous findings also suggested similar attributes in these genotypes under different agro-climatic conditions [12, 16, 17, 18]. These attributes are stable characteristics and could be useful for identification of specific genotype.

Table 2: Fruit and stone characteristics of aonla germplasm under semi-arid conditions

Germplasm	Fruit shape	Fruit base (Cavity at stem end)	Fruit apex	Segment ridges at stem end	Fruit colour	Number of segments per fruit	Stone wing nature	Number of seeds per stone
CHES 1	Flattened round	Absent	Flat	Absent	Yellow green	6	Slight	6
Chakaiya	Flattened round	Shallow	Flat	Absent	Light green	6	Slight	5-6
Krishna	Triangular	Deep	Flat	Prominent	Light green	6	Slight	6
NA 6	Flattened round	Shallow	Papillate	Less prominent	Light green	6	Prominent	6
NA 7	Oval	Flat	Flat	Less prominent	Yellow green	6	Slight	5-6
NA 10	Flattened round	Flat	Flat	Less prominent	Light green	6	Slight	6
NA 20	Round	Shallow	Flat	Less prominent	Yellow green	6	Prominent	6
G 1	Flattened round	Shallow	Depressed	Prominent	Light green	6	Slight	6
BSR 1	Flattened round	Flat	Papillate	Absent	Light green with red tinge	6	Slight	4-6
Seedling 1	Oval	Shallow	Flat	Less prominent	Light green	6	Slight	6
Seedling 2	Oval	Absent	Flat	Absent	Yellow green	6	Slight	6

Conclusion

In the present investigation a substantial variations have been observed in the morphological parameters of the studied aonla germplasm under semi-arid conditions of Haryana. From the above results, it may be inferred that the aonla genotypes varied in their morphological characters of tree, foliage, fruit and stone which can be used to characterize the varieties and for further crop improvement.

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