

Original Research Article

Studies on Physical Changes during Growth and Development of Aonla (*Emblica officinalis* Gaertn.) Fruit cv. Narendra Aonla-10

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ABSTRACT

Physiological maturity in aonla is mainly determined on the basis of specific gravity, ground colour, fiber content and seed colour. Gradual increase was observed in average fruit weight, stone weight, pulp weight and pulp: stone ratio with the advancement of maturity in aonla under northern Indian conditions. Keeping in view above facts the present investigation entitled “Studies on physical changes during growth and development of Aonla (*Emblica officinalis* Gaertn.) fruit cv. Narendra Aonla-10” is carried out with objectives to observe the physical changes during growth & development of fruits and the maturity index for right stage of fruit harvesting during 2019-2020 at Main Experimental Station of Department of Horticulture, A.N.D. University of Agriculture and Technology, Kumarganj - Ayodhya (U.P.). Results showed that all physical parameter of growth and development viz- length, width, weight, pulp / fiber percentage showed significant change from 6th August to 6th December and then showed non-significant change till 6th January.

Keywords

Weight, Fruit, Maturity, Harvesting, Growth and Development

Introduction

Aonla (*Emblica officinalis* Gaertn.) belongs to family Euphorbiaceae. It is indigenous to Tropical South-East Asia, particularly in Central and Southern part of India (Morton, 1960). Naturally growing aonla has been reported from Cylon, Cuba, Puerto Rico, Hawaii, Florida, Iran, Iraq, Java, West-Indies, Trinidad, Pakistan, Malaya and China (Benthal, 1946). It is being cultivated since long back and occupies an important place among indigenous fruits of India. Aonla finds

mention in “Vedas, Ramayana, CharakSamhita, SushrutSamhita” literatures describing its fruit highly valuable as food, medicine and hair dye (Anon, 1964). Aonla is the second richest source of vitamin-C (500 mg/100g pulp) among the fruits, after Barbados cherry.

Aonla is one of most nutritious fruits and it is fair source of minerals particularly iron, phosphorous, calcium, magnesium and rich source in pectin. Beside these, aonla fruit has adequate amount of sugars and acids. Fresh

fruit is rarely consumed. The commercial cultivation of aonla is expanded from the 'Home Land' of Uttar Pradesh to almost all the states of India, including Maharashtra, Gujarat, Rajasthan, Madhya Pradesh, Jharkhand, Chhattisgarh, Andhra Pradesh, Karnataka, Haryana, Punjab and Himanchal Pradesh. In Uttar Pradesh, Pratapgarh has been declared as aonla fruit belt and Agri-export zone. In India, aonla occupies 91000 hectare area with 1075000 metric tons production and 11.56 metric tons per hectare average productivity (Anon, 2017).

Aonla, being a hardy in nature, is successfully cultivated in wide range of variable soil (sodic and saline soil) and climatic condition viz., arid and semi-arid to dry hot and cold arid regions, rain fed to rainfall area. It can be grown under wider edapho-climate situations. It can also do well even in the moderately alkaline soil. Aonla is drought hardy fruit crop which is characterized by deep root system and exhibits deciduous nature due to abscission and shedding of determinate shoot during February and March.

Fruit Pulp of Indian gooseberry is an important ingredient of Chyawanprash and Triphala powder which is used for curing different abnormalities. The fruit contains a chemical substance Gallic acid and leuco-anthocyanin which have anti-oxidant property. Aonla fruit is helpful in the treatment of haemorrhage, dysentery, diarrhoea, gastric disorders, constipation, headache, jaundice and enlargement of liver (Parrotta, 2001; Goyal *et al.*, 2007).

Various research studies show that aonla has prominent antibiotic, antiulcerogenic, diuretic, laxative, adaptogenic, antitumor, antiscorbutic, hepatoprotective, cardio tonic, antiviral, and hypoglycaemic properties (Rege *et al.*, 1999; Jose and Kutton, 2000;

Dahiya and Dhawan, 2001; Pragati *et al.*, 2003; Mishra *et al.*, 2009). Hypolipidaemic effect of fruit juice of aonla was reported in a study by Mathur *et al.*, (1996). Study by Perianayagam *et al.*, (2004) reported anti-pyretic and analgesic activity in ethanolic and aqueous extract of *Embllica officinalis*.

Crop production under arid environment faces several constraints such as scanty water resources, poor soil condition extremes of temperature (high and low), desiccated wind, less precipitation leads to low productivity. Aonla tree bears two types of shoots. These are indeterminate (long) and determinate (short) shoots.

Indeterminate shoots are always sterile and continue to growth in the season. Determinate shoots appear on the nodes of indeterminate shoots and flower comes on determinate shoots. The success of aonla cultivation under arid ecosystem is largely based on efficient management of available natural resources.

Banarasi, Chakaiya, Krishna, Francis (Hathijhool), Kanchan (NA-4), NA-6, NA-7, Anand-1, 2, 3 are some of the commercially cultivated varieties of aonla in India (Goyal, 2008; Singh, 2009). Owing to its excellent nutritional profile and physico-chemical properties, aonla is processed into different types of product. Aonla fruit having sour and astringent taste, generally utilised raw, cooked or in the form of pickle. Murrabas, juice, jam, cheese, candy, powder, beverage, chutney are the different types of aonla products available in the market and preferred by the consumer being the rich source of vitamin C and antioxidants. Aonla is one of the main constituent of many ayurvedic preparations like Triphala and Chyawanprash (Pant *et al.*, 2004; Goyal *et al.*, 2007; Mishra *et al.*, 2009). According to Hindu mythology, one-day meal is arranged beneath aonla tree during October-November

when trees are laden with mature fruits. Hindu literature also prescribes that if ripe fruits of aonla are eaten for forty days in the morning after fast, it restores health and vitality known as Kaya Kalpa (Benthal, 1946). It is a common practice in Indian homes to cook the whole fruit with sugar and saffron and give one or two to a child every morning.

Physiological maturity in aonla is mainly determined on the basis of specific gravity, ground colour, fiber content, seed colour and TSS/ acid ratio (Singh, 1997). Gupta *et al.*, (2003) reported a gradual increase in average fruit weight, stone weight, pulp weight, pulp: stone ratio, total soluble solids and ascorbic acid with the advancement of maturity in aonla under northern Indian conditions.

Harvesting of fruits at proper stage of maturity is desirable for maintaining the quality and consumer acceptability (Mahajan and Dhillon 2002, Rai *et al.*, 2002, Singh and Arora 2000, Dubey *et al.*, 2002 and Chander *et al.*, 2003). Under the present changing scenario of degradation of prime natural resources *viz.* land, water, and vegetations, the promotion of plantation of most hardy fruit species- aonla, is very helpful in rehabilitation and greening of waste land/degraded lands, which resulted to balancing of eco-systems. Among the different tradition grown clonal varieties and land races of aonla have their variation in flowering, fruiting yield and quality of fruits. The bearing behavior is also adversely affected due to variable range of soil moisture, temperature, rainfall and atmospheric humidity.

In addition to these, the yield is highly associated with variable sex ratio, fruit set, fruit drop, fruit retention maturation and physiological disorders. The studies during growth and development of fruits determine

the maturity index and right stage of harvesting. The research findings are changes during growth and development of aonla fruits particularly under current specific agroclimatic conditions are limited.

Materials and Methods

The present investigation entitled “Studies on physical changes during growth and development of Aonla (*Embllica officinalis* Gaertn.) fruit cv. Narendra Aonla-10” was carried out at the main experimental station of Department of Horticulture, A.N.D. University of Agriculture and Technology, Kumarganj- Ayodhya (U.P.) during the year 2019-20. The details about the materials used and experimental procedure followed in the present studies are described here under following heads and subheads.

Source of materials

Aonla fruits for analyzing physical and chemical character were taken at the 30 days intervals from pea stage to maturity from selected aonla tree planted at the Main Experimental Station of Department of Horticulture. The fruits free from any visible sign of microbiological infection, insect infestation and physical injury were selected.

Technical programme

The technical programme comprises following three experiments: -

Experiments no. 1:- Observation on physical changes of fruits during growth and development.

Replications:- 3

Interval:-30 days

Design: CRD

Observations recorded

Weight (g), volume (cm³), width (cm), length (cm), specific gravity, seed (%), pulp (%), fibre content (%), pulp and seed ratio.

Methodology adopted in observations

Physical character

Physical analysis of fruit was done for the following parameters.

Length (cm)

The length of each of 15 fruits from each replication was measured in centimeters with the help of Vernier calipers and the average length of fruit was calculated.

Width (cm)

The width of each of 15 fruits from each replication was measured in centimeters with the help of Vernier calipers and the average width of fruit was calculated.

Volume (cm³)

The volume of fruits was determined by water displacement method and expressed in ml. The fruit was taken and immersed in measuring cylinder containing water. The displacement of water caused by the immersed fruit was noted to determine volume of the fruit.

Weight (g)

The weight of 15 fruits of each replication was taken by analytical balance and the average weight per fruit was calculated.

Specific gravity

The specific gravity of the fruit was calculated based on the average weight and

volume of fruit. The weight was divided by the volume and represented as specific gravity of fruit. The formula of specific gravity is given below:-

$$\text{Specific gravity} = \frac{[\text{weight of fruit(g)}]/[\text{volume of fruit(ml}^3\text{)}]}{1\text{g ml}^{-3}\text{(water)}}$$

Seed (%)

For estimation of seed percentage, seed weight and fresh fruit weight were taken by analytical balance and seed percentage was calculated by following given formula:-

$$\text{Seed(\%)} = \frac{\text{Seed weight(g)}}{\text{Fruit weight(g)}} \times 100$$

Pulp (%)

For estimation of pulp percentage, weight of pulp was calculated by deducting the seed weight from fresh fruit weight. The fresh fruit were measured by analytical balance and pulp percentage was calculated by following given formula:-

$$\text{Pulp(\%)} = \frac{\text{Pulp weight(g)}}{\text{Fruit weight(g)}} \times 100$$

Fibre content (%)

For estimation of percentage of fibre content, firstly fruits were boiled and then, fibre content was separated with help of knife from boiled fruit and thereafter weight of fibre content was taken by analytical balance and fibre content percentage was calculated by following given formula:-

$$\text{Fibre content(\%)} = \frac{\text{Fibre content weight(g)}}{\text{Fruit weight(g)}} \times 100$$

Table.1 Changes in physical attributes during growth and development of aonla fruit cv. NA-10

Date of Sampling	Length (cm)	Width (cm)	Weight (cm)	Volume (cm ³)	Specific Gravity	Pulp (%)	Fibre (%)	Seed (%)	Pulp to Seed Ratio
06/08/2019	1.72	2.04	4.31	3.50	1.23	90.94	0.0	9.06	10.44
06/09/2019	3.19	3.59	24.30	20.81	1.17	91.98	0.11	7.91	11.75
06/10/2019	3.58	3.92	34.00	29.97	1.13	92.70	0.58	6.72	13.82
06/11/2019	3.76	4.36	38.00	35.85	1.06	93.50	1.27	5.23	17.88
06/12/2019	3.79	4.38	40.16	39.23	1.02	93.96	1.34	4.71	19.95
06/01/2020	3.80	4.40	40.19	39.79	1.01	94.00	1.40	4.60	20.44
SEm±	0.11								
CD at 5%									

Pulp and Seed ratio

Pulp to Stone Ratio was determined by dividing the weight of pulp of the fruit by the weight of the stone of the fruit. The formula of seed and pulp ratio is given below:-

$$\text{Pulp and Seed ratio} = \frac{\text{Pulp weight(g)}}{\text{Seed weight(g)}}$$

Statistical analysis

The analysis of variance (ANOVA) of the data was carried out by the techniques as by Raghuramula *et al.*, 1983.

$$\text{Sem}\pm = \sqrt{\frac{\text{MSE}}{r}}$$

CD at 5% = S.E. x t value

Results and Discussion

Fruit length

The data pertaining to fruit length at various stages of fruit growth are presented in Table 1. Among different stages, maximum fruit length of 3.80 cm recorded on 6th January followed by 3.79 cm on 6th December and

minimum 1.72 cm on 6th August. But the differences between two consecutive observations were non-significant. Table 1 shows that increase rate in length was fast up from 6th August to 6th September and significant change was found from 6th August to 6th October.

Fruit width

Fruit width increased considerably from 6th August to 6th November. The average width of fruit was 3.78 cm after 6th September and reached the maximum of 4.4 cm on 6th January and minimum 2.04 on 6th August as per data presented in Table 1 and width is increased continuously during growth and development.

Fruit weight

Data recorded on changes during growth and development in weight of aonla fruit cv. NA-10 is presented in Table 1. Average weight continuously increased with periods and the change was significant during early stage of fruit growth and development.

The increased rate in weight was found to be more from 6th August to 6th October. Increase in weight of fruit was recorded till day of maturity. There was minimum 4.31g

on 6th August that increased to maximum 40.19g on 6th January.

Fruit volume

Data observed on changes in fruit volume during growth and development presented in Table-1. Data showed that the volume of fruits increased continuously from 3.5 cm³ to 39.79 cm³ from 6th August to 6th January. The increase in volume was statistically significant up till 6th January.

Specific gravity

It is clear from data of Table-1 that the specific gravity of fruits was continuously decreased during growth and development from 6th August to 6th January. The maximum specific gravity of fruit was 1.23 on 6th August that was gradually decreased to 1.01 on 6th January.

Pulp (%)

The data presented in Table 1 pertaining to pulp percentage recorded at various stages of fruit growth was found to be non-significant at initial stage, but it was observed to be significant at end stage of growth and development of fruit. The minimum pulp percentage were found 90.94% on 6th August and maximum weight of pulp were found 94% on 6th January.

Fibre (%)

The data presented in Table-1 pertaining to fibre percentage showed significant difference in all observations. It is clear from data that the fibre percentage was found maximum 1.4% on 6th January.

Seed (%)

The data pertaining to seed content are presented in the Table-1 reveals that seed percentage of aonla fruit cv. NA-10

decreased continuously from 6th August to 6th January. The maximum seed percentage was 9.06% on 6th August and minimum percentage of seed was found 4.6% on 6th January.

Pulp and Seed ratio

The data pertaining to Pulp and Seed ratio are presented in the Table-1 reveals that pulp to stone weight ratio increased continuously during growth and development from 6th August to 6th January in aonla fruit cv. NA-10 which indicates more increase rate in pulp content than seed content during growth of the fruit. Pulp to seed ratio was minimum 10.44 on 6th August and maximum pulp to seed ratio 20.44 was found on 6th January.

The results from present investigation entitled “Studies on physical changes during growth and development of Aonla (*Emblica officinalis* Gaertn.) fruit cv. Narendra Aonla-10” was carried out at Main Experimental Station of the College of Horticulture & Forestry, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya 224229 (U.P.) India during the years 2019-2020.

The result of the present investigation can be summarized and concluded as follows:

The length of the fruit showed increasing trend from 6th August to 6th January and found to be maximum at maturity during 6th December to 6th January.

Width of the fruit increased during the observation period and at the maturity, it was found to be maximum indicating right time for harvesting. Weight of the fruit during observation period increased and attained maximum weight at the time of maturity. Volume of the fruit increased rapidly during initial stage of growth and development

between observation period and at the maturity it increased by slow rate.

Changes in specific gravity showed decreasing trend from 6th August to 6th January and specific gravity for maturity was found suitable during 6th December to 6th January.

Pulp percentage during observation period showed increasing trend from 6th August to 6th January and found to be maximum at 6th January.

Fibre percentage increased from 6th August to 6th January and found to be maximum at 6th January.

Seed percentage showed decreasing trend during observation period. Seed percentage decreased due to increasing pulp percentage.

Pulp to seed ratio observed during 6th August to 6th January during growth and development increased and found to be maximum at the maturity. This stage takes place from 6th December to 6th January.

Moisture percentage increased from 6th August to 6th October then decreased till 6th January and at this stage it was found to be 81.50%.

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