

Short Communication

Standardization of Maturity Indices in Aonla (*Emblica officinalis* Gaertn.) under Semi-arid Environment of Western India

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The Indian gooseberry or aonla (*Emblica officinalis* Gaertn.) of family Euphorbiaceae is an important fruit of arid and semi-arid regions. It is being grown on 50,000 ha area, producing 2.25 lakh tonnes fruits annually with average productivity of 4.05 t ha⁻¹ (Singh *et al.*, 2005). Physiological maturity in aonla is mainly determined on the basis of specific gravity, ground color, fiber content, seed color and TSS/acid ratio (Singh *et al.*, 2006). Gupta *et al.* (2003) reported a gradual increase in average fruit weight, stone weight, pulp weight, pulp to stone ratio, total soluble solids and ascorbic acid with the maturity in aonla under North Indian conditions. Harvesting of fruits at proper stage of maturity is desirable for maintaining the quality and consumer acceptability (Singh *et al.*, 2006). Therefore, the present investigation was undertaken to ascertain the maturity indices of four cultivars under semi-arid ecosystem of Gujarat.

The present investigation was carried out in the experimental orchard of Central Horticultural Experiment Station, Vejalpur (Godhra) on aonla cultivars NA-7, Krishna, Kanchan and Chakaiya during the years 2001 and 2002. Twelve-year-old plants of uniform vigor and productivity were

selected and the experiment was conducted in randomized block design with four replications. Every tree received 30 kg FYM, 1 kg nitrogen, 500 g phosphorus and 750 g potash every year. Half dose of nitrogen and full dose of phosphorus, potash and FYM were given in the month of June (after onset of rain) and remaining half amount of nitrogen was applied in the month of September. For control of pests during the month of July, dimethoate (0.05%) was sprayed twice at 15 day interval. Uniform cultural practices were adopted in sole crop of aonla during the course of investigation. The branches having uniform fruit set on all four sides of the plants were tagged after fruit set (NA-7, Krishna, Kanchan and Chakaiya on 7 April, 12 April, 17 April and 9 April, respectively). The data on physico-chemical changes in fruits were recorded 165 days after fruit set and continued until last harvest. The fruits were sampled at 10 day interval. On each sampling date, 20 fruits from each plant were harvested at random from all sides and analyzed for different parameters. Fruit volume was measured by the water displacement method and specific gravity (weight/volume) was calculated. The fiber content of the fruits was estimated following

Table 1. Changes in physico-chemical attributes during maturation of aonla

Sampling dates (Days after fruit set)	Fruit weight (g)	Skin color	Specific gravity	Fiber content (g/100 g)	TSS (%)	Acidity (%)	TSS/acid ratio
NA-7							
Aug. 20 (135)	5.10	G	1.00	0.00	2.11	2.56	0.82
Aug. 30 (145)	12.00	G	1.00	0.00	3.12	2.61	1.19
Sept. 09 (155)	14.20	G	1.00	0.00	4.92	3.09	1.59
Sept. 19 (165)	18.00	G	1.00	0.00	6.13	2.87	2.14
Sept. 29 (175)	28.00	G	1.00	1.14	8.13	2.71	3.00
Oct. 09 (185)	31.00	G	1.00	1.35	9.14	2.51	3.64
Oct. 19 (195)	37.00	YG	1.02	1.14	10.01	2.31	4.33
Oct. 29 (205)	38.11	YG	1.03	1.39	10.29	2.24	4.59
Nov. 08 (215)	38.14	YG	1.03	1.41	11.0	2.21	4.97
CD (P=0.05)	1.10	—	0.01	0.03	1.03	0.13	0.67
Krishna							
Sept. 24 (165)	28.49	G	1.00	0.00	6.12	2.81	2.18
Oct. 04 (175)	34.13	G	1.00	0.00	8.19	2.72	3.01
Oct. 14 (185)	35.69	G	1.00	0.00	9.10	2.61	3.49
Oct. 24 (195)	37.34	G	1.02	0.86	10.00	2.50	4.00
Nov. 03 (205)	40.50	AY	1.02	0.84	10.03	2.39	4.20
Nov. 13 (215)	42.00	AY	1.03	0.88	10.11	2.37	4.26
Nov. 23 (225)	42.13	AY	1.03	0.87	10.14	2.32	4.37
CD (P=0.05)	1.01	—	0.01	0.04	1.09	0.12	0.60
Kanchan							
Sept. 29 (165)	23.11	G	1.00	0.00	6.19	2.89	2.14
Oct. 09 (175)	25.87	G	1.00	0.00	7.93	2.71	2.93
Oct. 19 (185)	26.10	G	1.00	0.00	8.69	2.61	3.33
Oct. 29 (195)	29.13	LG	1.02	1.23	9.49	2.49	3.81
Nov. 08 (205)	30.43	LG	1.03	1.44	10.42	2.12	4.92
Nov. 18 (225)	31.69	LG	1.03	1.95	10.46	2.11	4.96
Nov. 28 (225)	31.74	LG	1.03	2.64	10.50	2.10	5.00
CD (P=0.05)	1.14	—	0.01	0.06	1.03	0.12	0.60
Chakaiya							
Sept. 21 (165)	24.13	G	1.00	0.00	6.11	2.71	2.25
Oct. 01 (175)	26.13	G	1.00	0.00	7.99	2.69	2.97
Oct. 11 (185)	27.14	G	1.00	0.77	8.13	2.63	3.09
Oct. 21 (195)	30.16	G	1.01	1.29	8.69	2.51	3.46
Oct. 31 (195)	31.14	LG	1.02	1.57	8.86	2.43	3.65
Nov. 10 (215)	32.57	LG	1.02	2.21	9.30	2.30	4.04
Nov. 20 (225)	33.60	LG	1.02	2.32	9.31	2.21	4.21
Dec. 10 (245)	33.72	LG	1.02	2.40	9.34	1.91	4.89
CD (P=0.05)	1.00	—	0.01	0.06	1.00	0.11	0.71

G = Green, LG = Light green.

Sadasivam and Manickam (1990), total soluble solids with the hand refractometer and acidity following the method advocated by AOAC (1980).

The fruit growth was faster initially and slowed down between last week of September and first week of October and completed almost 70% growth during this period and increased slightly thereafter and followed double sigmoid growth pattern in all the cultivars. The average weight of fruits recorded was maximum in Krishna (42.13 g) followed by NA-7 (38.14 g), Chakaiya (33.72 g) and Kanchan (31.74 g) at the time of last sampling date. The maximum fruit growth (on weight basis) was recorded on 215 days after fruit set in NA-7, 225 days after fruit set in Krishna and Kanchan, 245 days after fruit set in Chakaiya. Initial fast growth might be due to increased levels of auxin, gibberellins and cytokinins during the first rapid growth phase of anola fruit (Ram and Rao, 1981; Singh *et al.*, 2006). Gupta *et al.* (2003) also recorded more or less similar pattern of growth in aonla. Fruit skin color at maturity was yellowish green in NA-7 and apricot yellow in Krishna, however, Kanchan and Chakaiya remained light green at this stage. Specific gravity of fruits remained almost constant up to 185 days after fruit set, thereafter it increased in all the cultivars. It was 1.03 in NA-7, Krishna and Kanchan at the last sampling date, while Chakaiya recorded 1.02 specific gravity at maturity. These findings are in conformity with the findings of Singh (1997), Ram *et al.* (2005), Dinesh and Yadav (2002) and Singh *et al.* (2006). The fiber content exhibited significant variation during development of anola cultivars,

and was highest in Kanchan (2.64 g/100 g) followed by Chakaiya and NA-7 at the last date of sampling and it was lowest (0.87 g/100 g) in Krishna. Singh (1997) and Singh *et al.* (2006) reported that appearance of fibers on seed is one of the criteria for assessment of physiological maturity in aonla.

The total soluble solid (TSS) of the fruit increased with the advancement of fruit growth in all the cultivars. The increase was much faster between 30th August to 19th October in NA-7, 4th September to 24th October in Krishna, 9th September to 8th November in Kanchan and 1st September to 11th October in Chakaiya. It was found to be highest in NA-7 (11.00%) at the last date of sampling, closely followed by Kanchan (10.50%) and Krishna (10.14%). The degradation of polymers like starch and metabolism of organic acids to soluble sugars are thought to be the source of increased level of TSS (Dhillon *et al.*, 1999; Singh *et al.*, 2006). Titratable acidity of fruit increased up to 155 days after fruit set, thereafter it declined in all the cultivars. Minimum titratable acidity was recorded in Chakaiya (1.91%) at the last date of sampling followed by Kanchan, and NA-7, however it was maximum in Krishna. An increase in TSS/acid ratio, one of the parameters used for assessing maturity, was noted towards latter stages of development and this could be marked as one of the criteria for fixing maturity standard in all the cultivars. Highest TSS/acid ratio (5.00) was noted in Kanchan closely followed by NA-7 and Chakaiya, while it was least in Krishna (4.37) at maturity. Similar pattern of TSS/acid ratio was recorded in aonla (Singh *et al.*, 2006). Increase in specific

gravity (more than one), appearance of fiber on seed cover and change of seed color from creamy white to brown during maturity was common in all cultivars. It may be concluded that fruits of NA-7 and 'Krishna' matured by last week of October (215 days after fruit set) and second week of November (225 days after fruit set), respectively. Kanchan matured by last week of November (225 days after fruit set) and that of Chakaiya by first week of December (245 days after fruit set), under semi-arid ecosystem of Gujarat.

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