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Field evaluation of Indian gooseberry (*Emblica officinalis*) accessions for yield, fruit quality and antioxidant potential

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ABSTRACT

Ten diverse promising genotypes of Indian gooseberry (*Emblica officinalis* Gaertn.) along with two commercial varieties, viz, NA-6 and NA-7 were evaluated during the year 2013 and 2014 for commercial potential based on tree growth and physico-chemical characteristics**.** Maximum plant height was recorded in genotype CISH A-19 (7.11m) and minimum in NA-6 (4.13m). Plant spread in East-West and North-South directions varied from 3.01-5.13m and 2.91-4.89m respectively, while plant girth was recorded maximum in CISH A-19 (63.88 cm). Pulp weight varied from (22.91-33.92g), recorded highest in genotype CISH A-31 (33.92g) while lowest weight was found in CISH A-17 (22.91g). Large variations in fruit shape, viz. oval round, flattened round, round, conical, flattened oblong and flattened oval was noticed amongst the genotypes. Similarly, fruit colour at maturity among different genotypes recorded as green, light green and pinkish. Fruit weight varied from 24.37 to 35.41g among the different genotypes being highest in genotype CISH A-19 (35.41g) which is significantly higher than the standard check varieties NA-6 (28.49g) and NA-7 (30.30g). No significant difference was recorded amongst the studied material with respect to standard check for fruit length and fruit diameter. Significantly higher percentage of pulp was recorded in CISH A-31 (95.60%) compared to check NA-6 (94.77%) and NA-7 (95.01%). Stone size with respect to length ranged from 1.02-1.15cm being highest in CISH-A-15 (1.15 cm) while stone width was recorded maximum in CISH A-1 and CISH A-2 (1.06cm). Stone weight varied from 1.46-1.57g being maximum recorded in CISH A-19 (1.57g) and minimum in CISH A-17 (1.46g). Considerable variation in fruit yield (26.14 to 52.50 kg/tree) from 6 years old trees were observed. Highest fruit yield was recorded in genotype CISH A-31 (52.50 kg/tree) followed by CISH A-3 (48.11 kg/tree) which is highly significant compared to standard check NA-6 (32.90 kg/tree) and NA-7 (35.76kg/tree). The chemical parameters, viz. vitamin-C content ranged from 309.66-473.13 mg/100g, TSS (9.3-10.6 ^{0}B), acidity (1.49-2.88%), total sugar content (5.66-6.89%), polyphenol content (0.633-1.427 mg/100g) and FRAP activity (102.01-235.76 mg/100g $FeSO_4$) among different accessions evaluated. Conclusively, based on yield, associated physico-chemical traits and antioxidant value, genotype CISH A-31 found most promising and can be recommended for future commercialization.

Key words: Field evaluation, Genotypes, Indian gooseberry, Pysico-chemical, Quality, Yield

Commonly, Indian gooseberry (*Emblica officinalis* Gaertn.) is being grown as house hold tree as well as an important component in forest programmes. However, with the advancement of knowledge about its importance, the commercial plantation of Indian gooseberry reached to farmers and attains fully utilized state. There has been large expansion in the area under cultivation across the country utilizing the wastelands, resulted in efficient utilization of resources leading to better income and nutritional security coupled with enhanced employment of rural youth and rehabilitation of wastelands (Pathak 2003). In India, Madhya Pradesh has rich natural diversity because of Indian gooseberry based cropping systems are very common (Pathak 2003). Indian gooseberry trees are one of the most important components in the majority of forest programmes of Madhya Pradesh, as they require less care and best suited to wasteland (Bajpai and Shukla 1985). Generally, the aonla genotypes growing in this region have relatively higher content of vitamin C and total phenols (Pandey *et al.* 2008). Keeping in view, the Indian gooseberry genotypes was identified and collected from Madhya Pradesh and its adjoining places followed by multiplication through asexual method. Finally, these genotypes were planted in the field gene bank for field evaluation to find out the promising genotypes for commercialization.

MATERIALS AND METHODS

Ten promising genotypes along with two standard check varieties of Indian gooseberry were planted in randomized block design with 3 replications in field during August 2007. Observations with respect to growth parameters and fruit quality characters (Table 1 and 2) were recorded at the time of harvesting. Height, girth and plant spread were measured with the help of measuring tape.

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Table 1 Vegetative growth behavior of different Indian gooseberry genotypes

Genotype	Plant height (m)	Plant girth (cm)	Plant spread (cm)		Yield (kg/tree)	Fruit shape	Fruit colour
			E-W	N-S			
CISH-A-1	6.11	41.14	3.37	3.75	32.90	Oval round	Green
CISH-A-2	5.55	41.78	3.45	3.58	41.80	Flattened round	Light green
CISH-A-3	6.01	35.69	3.12	3.65	48.11	Round	Light green
CISH-A-4	5.91	41.63	3.01	2.91	42.29	Flattened round	Green
CISH-A-13	6.41	53.76	4.53	4.14	38.01	Oval round	Green
CSH-A-15	5.88	58.46	5.13	4.89	26.14	Oval round	Green
CISH-A-17	6.14	46.89	4.34	4.12	29.04	Conical	Green
CISH-A-19	7.11	63.88	4.19	4.56	31.50	Flattened round	Light green
CISH-A-27	6.73	42.45	4.12	4.13	27.00	Oval round	Light green
CISH-A-31	6.51	36.11	4.33	4.11	52.50	Round	Pinkish
Check-1 (NA-6)	4.13	23.01	3.62	3.19	32.90	Flattened oblong	Light green
Check -2 (NA-7)	5.95	41.12	3.27	3.65	35.76	Flattened oval	Light green
CD (P = 0.05)	1.11	1.39	1.05	1.02	2.21		

The mature fruits were taken randomly from all directions of plants from each accession in November and observations were recorded with respect to fruit characteristics. Size of fruit and stone was recorded with the help of Vernier Caliper. Fruit weight was recorded using a digital balance, and average fruit weight was expressed in gram. Fruit colour at maturity and shape of fruit was taken by visual observations. Total soluble solids were estimated at ambient temperature by Erma hand refractometer (0-32 ^{0}B). Titratable acidity was calculated by titrating the fruit pulp extract with 0.1 N NaOH using phenolphthalein indicators. Ascorbic acid content of juice was estimated by reduction of 2, 6-dichlorophenol indophenol (dye) by ascorbic acid. Total sugar, reducing sugars, polyphenol content and FRAP activity was estimated by the method suggested by Rangana (1986). The data were statistically analyzed as per method given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The results of study on morphological characters and quality attributes of fruit revealed that various genotypes of aonla exhibited wide range of variations for all the studied characters.

Vegetative growth characters

Vegetative characters of different Indian gooseberry genotypes were evaluated for different parameters, viz. plant height, plant girth, plant spread, yield, fruit shape and colour. Significantly higher plant height (7.11 m), plant girth (63.88cm), was recorded in CISH A-19 and while plant spread (E-W-5.13m and N-S-4.89m) in CISH A-15 compared to Check 1 (NA-6) as well as CISH A-4. These variations in growth characters among the Indian gooseberry genotypes may be due to inherent characters of individual varieties and their adaptability to varied agro-climatic conditions. These results in Indian gooseberry genotypes

Table 2 Physico-chemical attributes of Indian gooseberry genotypes during 2013-2014

Genotype	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Stone size (cm)		Pulp (%)	Stone (%)	TSS (°B)	Reducing sugars (%)	Total sugars (%)
				L	D					
CISH-A-1	29.70	3.3	3.3	1.11	1.06	94.84	5.15	10.1	3.14	6.29
CISH-A-2	27.92	3.4	3.3	1.09	1.06	94.62	5.37	10.9	3.44	6.17
CISH-A-3	28.02	3.5	3.2	1.06	1.04	94.61	5.38	10.4	3.09	5.99
CISH-A-4	27.78	3.2	3.2	1.08	1.05	94.52	5.57	10.0	3.76	6.55
CISH-A-13	28.38	3.1	3.1	1.05	1.03	94.71	5.28	9.4	3.49	6.69
CISH-A-15	27.27	3.3	3.3	1.15	1.02	94.46	5.53	10.1	2.99	6.56
CISH-A-17	24.37	3.2	3.2	1.03	1.01	94.00	5.99	9.5	4.0	6.89
CISH-A-19	35.41	3.7	3.7	1.06	1.02	95.56	4.43	10.3	3.19	6.37
CISH-A-27	35.04	3.4	3.4	1.02	1.03	95.54	4.45	10.4	3.69	6.73
CISH-A-31	35.41	3.1	2.9	1.02	1.04	95.60	4.41	9.9	2.98	5.66
Check 1 (NA-6)	28.49	3.2	3.2	1.09	1.04	94.77	5.22	9.4	3.45	6.13
Check 2 (NA-7)	30.30	3.6	3.7	1.08	1.04	95.01	4.98	9.6	3.83	6.65
CD (P=0.05)	2.32	0.34	0.69	0.55	0.41	0.22	0.29	0.29	0.39	0.18

are in close consonance with Shukla *et al*. (2010). Significantly higher fruit yield was recorded in CISH A-31 (52.50 kg/tree) followed by CISH A-3 (48.11 kg/tree), CISH A-4 (42.29 kg/tree), CISH A-2 (41.80 kg/tree) than Check 1 (32.90 kg/tree) and Check 2 (35.76 kg/tree) although no significant differences were recorded between remaining genotypes amongst each other as well as with control. This increase in yield may be due to more number of fruits per determinate shoots. Variations in fruit shape was also noticed amongst the studied genotypes as it varies from oval round, flattened round, round, conical, flattened oblong and flattened oval. Colour of fruits, at maturity varies as green, light green and pinkish among the different genotypes.

Physical parameters

It is evident from the data (Table 2) that fruit weight is the major component of yield contributing factors being the important attribute suitable for processing and value addition especially murabba and candy. Significantly maximum fruit weight was found in CISH A-31 and CISH A-19 (35.41g) which was closely followed by CISH A-27 (35.04 g) as compared to check 1 (NA 6) and Check 2 (NA 7). Apart from this, other accessions were recorded less fruit weight compared to the check varieties. Non-significant differences in fruit length and fruit diameter were recorded amongst the evaluated Indian gooseberry genotypes, compared to check varieties. Although maximum fruit length was recorded in CISH-A-19 (3.7cm) followed by Check 2 (3.6cm).

Non-significant differences in stone size with respect to length and width were recorded amongst the different genotypes along with control. Reasonable variation was recorded in stone percentage which varies from 4.41 (CISH A-31) to 5.99 (CISH A-17). Highest significant stone percentage were recorded in genotypes CISH A-17 (5.99%) followed by CISH A-4 (5.57%) compared to check varieties. Similarly, highest significant pulp percentage were recorded in genotype CISH A-31 (95.60%) followed by CISH A-19 (95.56%) and CISH A-27 (95.54%) compared to check 1 (94.77%) and check 2 (95.01%). Similar types of variation among the different Indian gooseberry accessions are also reported by Mishra *et al*. (2007) and Shukla *et al*. (2010).

Biochemical characters

It is inferred from Fig 1, that different Indian gooseberry genotypes exhibited significant variations in their qualitative attributes. Maximum total soluble solids (TSS)

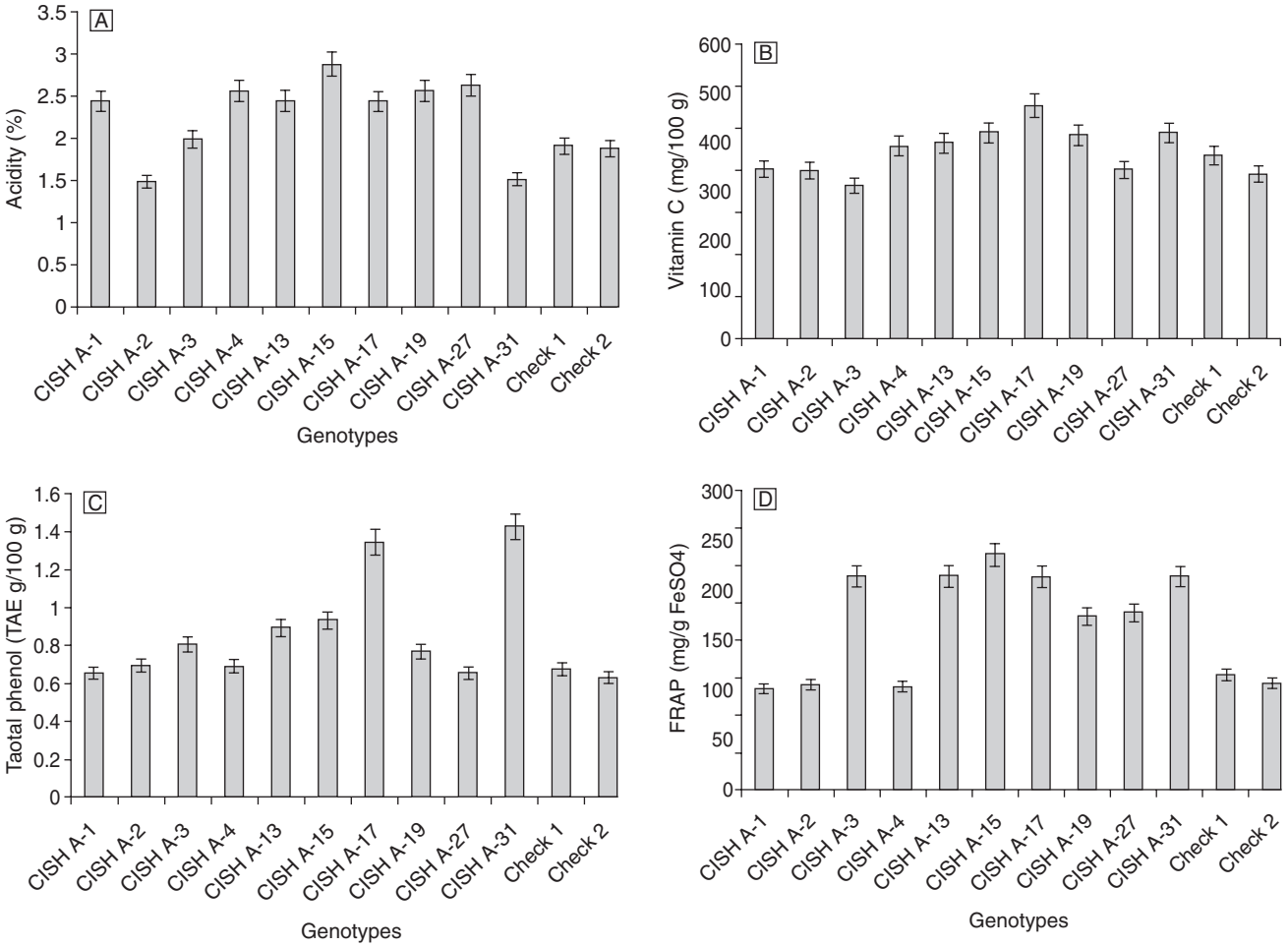

Fig 1 Biochemical attributes showing (a) acidity content (%), antioxidant values *viz;* (b) Vitamin (C mg/100g edible portion), (c) total phenol (TAEg/100g) and (d) FRAP (mg/100g $FeSO_4$) in different Indian gooseberry genotypes during evaluation

in pulp was recorded in accession CISH A-2 (10.9 ^{0}Brix) followed by CISH A-27 (10.4 ^{0}Brix) and CISH A-3 (10.4 ^{0}Brix) while minimum in CISH A-13 (9.4 ^{0}B) followed by check 1 (9.4 ^{0}B). Significantly, higher acidity was recorded in all the Indian gooseberry genotypes studied except CISH A-2 (1.49%) and CISH A-31 (1.51%) compared to checks. Maximum acidity was recorded in genotypes CISH A-15 (2.88%) followed by CISH A-27 (2.63%) and CISH A-19 (2.57). This large variation in acidity content may be due to inherent genetic makeup of genotypes collected from different geographic locations. Reducing sugar was recorded maximum in CISH-A-17 (4.0%) followed by NA 7 (3.83%), CISH A-4 (3.76%) and CISH A-27 (3.69%) while, minimum in CISH-A-31 (2.98%). However, CISH A-17 (6.89%) observed maximum total sugar followed by CISH A-27 (6.73%), CISH A-13(6.69%) and CISH A-31(5.66%) recorded the minimum one.

Antioxidant potential

Ascorbic acid is an important antioxidant ingredient in Indian gooseberry genotypes. The ascorbic acid content varied from 309.66 to 473.13 mg/100g being maximum recorded in CISH A-17 (473.13 mg/100g) followed by CISH A-15, CISH A-31 (418.12 mg/100g), CISH A-19 (413.23 mg/100g) and CISH A-13 (397.20). The majority of the genotypes recorded significantly higher amount of ascorbic acid compared to check 1 (334.05 mg/100g) and check 2 (371.55 mg/100g). Non-significant differences were recorded in genotype CISH A-3 compared to control. Significantly higher content total polyphenol was reported in accession CISH A-31(1.427 TAE g/100g) followed by CISH A-17, CISH A-15 (0.940 TAE g/100g) and CISH A-13 (0.901 TAE g/100g) while minimum total polyphenol content was observed in NA-7 (0.633 TAE g/100g). The FRAP activity amongst the different Indian gooseberry accessions varied from 102.01mg/100g $FeSO_4$ (CISH A-1) to 235.76 mg/100g $FeSO_4$ (CISH A-15). Significantly, higher and almost double FRAP activity were recorded in genotypes CISH A-15 (235.76 mg/100g$FeSO_4$) followed by CISH A-13 and CISH A-31 (214.04 mg/100g $FeSO_4$) compared to check 1 (115.11 mg/100g $FeSO_4$) and check 2 (106.5801 mg/100g $FeSO_4$). The minimum FRAP activity lower than the standard check varieties was recorded in accession CISH-A-1 (102.01 mg/100g $FeSO_4$) followed by CISH A-4 (103.02 mg/100g $FeSO_4$) and CISH A-2 (105.07 mg/100g $FeSO_4$). Non-significant differences were recorded between the accessions CISH A-17 and CISH A-13 and CISH A-17 and CISH A-13. Similar results are also reported by Kumar and Rao (2010) in aonla cultivars. The changes in biochemical parameters in aonla cultivars/accessions are also reported by Kumar and Singh (2013), Hazarika *et al*. (2009) and Jaiswal *et al*. (2007).

From the above findings, it can be concluded that accession CISH A-31 identified best in terms of yield, fruit quality and antioxidant value compared to remaining germplasm accessions as well as check (standard control NA 7 and NA 10) cultivars during field and laboratory evaluation. Hence, the particular accession (CISH A-31) may be recommended for commercial multiplication followed by multilocation evaluation in the different agro-ecological regions so that its full potential can be ascertained for further dissemination to grower's field for commercialization.

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