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Genetic diversity in litchi (*Litchi chinensis*) for morphological and physico-chemical traits

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ABSTRACT

The genetic diversity in morphological and physico-chemicaltraits of nine genotypes of litchi (*Litchi chinensis* Sonn.) growing under the agroclimatic conditions of Bihar was studied during 2018-19. The genotypes IC-0614730 and IC-0614737 exhibited bright pink colour of young leave and others had yellowish green. Its fruit shape and colour was round and deep pink, respectively. Pink flushes genotypes were late, while yellowish green were early in maturity. These two genotypes showed lowest fruit weight (17.35 g and 16.38 g), TSS (17.86 and 18.35 Brix), seed content (10.66% and 11.97%) but higher pulp content (71.18% and 74.66%). Significant variations were recorded in phenolics and flavonoids contents among the genotypes with highest content in both IC-0614730 and IC-0614737. These two genotypes can be potentially exploited in litchi industry for pulp making and nutraceutical uses. The genotypes differed in most of the morphological characteristics which can be exploited for improvement in litchi.

Key Words: Bioactive compounds, Diversity, TSS, Phenolics, Morphological traits, Quality

Litchi (Litchi chinensis Sonn.) is most important members of family Sapindaceae. Identification of litchi based on morphological traits is highly acceptable and easily distinguishable as morphological diversity occurs. Morphological diversity has been also reported in beal (Singh *et al.* 2018) and ber (Chaudhary *et al.*, 2017) which is used for identification of cultivars. Therefore, study was undertaken to evaluate genetic diversity in morphological and physico-chemical traits of different genotypes of litchi.

MATERIALS AND METHODS

The present investigations were carried out during 2018-19 to describe various morphological characteristics of nine genotypes of litchi available at ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar. Five trees of each genotype (about 8 years old), uniform in size and vigour were selected. The observations were recorded on morphological characteristics of each genotype. Foliage colour, arrangement and shape were recorded by visual observation of trees. Leaf length, width, shape, number of leaflets/leaf, rachis length and petiole length were studied by taking ten leaves and flushes randomly from each genotype. Flower disc colour was visually observed. Panicle length and width were recorded by measuring ten panicles in each genotype.

Fruit colour and size were recorded by taking ten fruits randomly from each genotype. Quality parameter (TSS, total sugar, reducing sugar, ascorbic acid and titratable acidity) and bioactive compound (phenolics, flavonoids and anthocyanin) were estimated from different parts of fruits. Experiment was laid in Randomised Complete Block Design comprising nine treatments (genotypes) with five or ten independent replications. Only quantitative data were analysed statistically using Fisher's analysis of variance techniques. Least significant difference (LSD) test at 5% and probability level was applied to compare the differences among treatments means (Steel and Torrie, 1980).

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RESULTS AND DISCUSSION

The genotypes, IC-0614730 and IC-0614737, had bright pink while others had yellowish green colour of young leaf. Young emerging flushes ranged from yellowish green to deep pink (Lal, 2018) and pale green to pinkish to a copperish red in colour. The litchi cultivars can be distinguished based on colour of flush. Early ripening cultivars flushes pale green while late ripening flushes pink colour leaves. Matured leaf varied from light green to dark green. The foliage colour is a genetic character and also being used for identification of cultivars. The slight variation might be due to prevailing environmental condition of growing area. However, there was no variation in arrangement of leaflet, shape of leaf blade, leaf apex and base and venation. The genotype IC-0614737 had lowest number of leaflet (5.12), followed by IC-0614730 (5.23) and genotype IC-0614731 had highest number of leaflet (7.68)/leaf. Litchi leaves have 4-10 (2-5 pairs) leaflets, 4-8 leaflet depending upon cultivars. The maximum leaf length was recorded in IC-0614729 (15.68 cm), followed by IC-0614733 (15.17 cm), whereas minimum leaf length was in IC-0614737 (8.86 cm). It was at par with IC-0614730 (8.96 cm). The variations in leaf length were earlier reported by Wu *et al.* (2016).

The leaf width also showed significant differences among genotypes. The maximum leaf width was in IC-0614733 (4.35 cm). The minimum leaf width was in IC-0614737 (3.38 cm). Leaf size was also positively correlated with fruit size. Dwarf genotypes have small leaf, whereas vigorous genotypes have larger sized leaf. The genotypes showed wide variations in rachis with maximum in IC-0614732 (11.12 cm) and minimum in IC-0614737 (6.27 cm). Petiole length varied from 3.08 to 4.12 cm with maximum in IC-0614728 and minimum in IC-0614730. Lal (2018) also reported variations in rachis and petiole length in different genotypes. The maximum length of rachis and petiole were positively correlated with vigorous of plants, whereas least length of rachis and petiole were positively related with dwarf stature of plants as IC-0614730 and IC-0614737 exhibited low vigour and dwarf structure. Similarly, both genotypes exhibited bright pink colour of young leaf, least number of leaflet/leaf, minimum length and width of leaf. These traits can be used for identification of dwarf cultivars in litchi.

Maximum length of panicle (48.92 cm) was in IC-0614732, while minimum (24.56 cm) was recorded in IC-0614730. The maximum width of panicle (27.95 cm) was found in IC-0614728, while minimum (15.68 cm) was in IC-0614730. The difference is due to genetic make-up of genotypes. Chandola and Mishra (2015) reported maximum panicle length in Rose Scented (34.80). The intensity of flowering and panicle strength depend on previous years fruiting, temperature during floral bud differentiation, phenol content (Lal *et al.*, 2019b) and age of plants (Lal and Nath, 2020). Female flower varied from 11.23 to 22.58% with maximum in IC-0614735 and minimum in IC-0614730. The variation in female flowers varied from 155 in Early Seedless to 580 in Calcuttia (Chandola and Mishra, 2015). Yield varied from 3.86 to 8.75 kg/plant with maximum in IC-0614733 and lowest in IC-0614737. The difference in yield is due to genetic make-up of genotypes and depended on age of plants. Chandola and Mishra (2015) found variation in yield with maximum in Rose Scented (26.85 kg/plant) and minimum in Longia (12.57 kg/plant).

Number of fruits/panicle varied from 5 to 8.6 with maximum in IC-0614732 and minimum in IC-0614728. However, fruit retention depends on pollen-grains used in pollination and fertilization (Lal *et al.* 2019c and d) as well as age of plants. The maximum fruit weight was recorded in IC-0614728 (24.68 g) and minimum in IC-0614737 (16.38 g). Haq and Rab (2012) found maximum fruit weight in Gola (23.08 g) and lowest in Bedana (15.20 g). Fruit weight varied from 12 to 21.80 g with maximum in Rose Scented (Chandola and Mishra, 2015). The fruit weight inIC-0614728 was superior to IC-0614737 by 33.63%. The fruit weight in Gola was superior to Bedana by 34.14%. The maximum fruit length was recorded in IC-0614728 (36.86 cm) and minimum in IC-0614737 (27.74 cm). The maximum fruit diameter was recorded in IC-0614728 (32.56 cm) and minimum in IC-0614731 (29.76 cm). Calcuttia cultivar had large-sized fruits, while rest of the cultivars had medium-sized fruits. The maximum pulp weight was in IC-0614728 (14.56 g) and lowest in IC-0614737 (12.23 g), followed by IC-0614730 (12.35g) but pulp content was highest in IC-0614737 (74.66%), followed by IC-0614730 (71.18%). Pulp weight varied from 11.19 g (Bedana) to 16.58 g (Gola) in litchi and 7-14 g in other cultivars (Chandola and Mishra, 2015). The maximum pulp thickness was recorded in IC-0614730 (8.26 mm) and minimum in IC-0614729 (7.16 mm). The genotype IC-0614730 and IC-0614737 had round fruit shape and round tip shape, medium clustering habit, partial distribution of colour on fruit and smooth tubercles and others genotypes had elliptic shape, obtuse tip, heavy clustering, uniform distribution of colour and pointed tubercles, respectively. Fruit colour varied from red to deep pink. The colour of fruit varies depending upon the cultivars and is also influenced by growing conditions.

The maximum TSS was found in IC-0614731 (21.47) and minimum in IC-0614730 (17.86). Lal *et al.* (2018a) reported highest TSS in IC-0615610 (19.98 °Brix) and lowest in IC-0615589 (17.04°Brix) (Table 1). The

variation in TSS was also reported by Haq and Rab (2012). The maximum ascorbic acid was recorded in IC-0614737 (35.68 mg/100g) and minimum in IC-0614728 (24.56 mg/100g). The differences in ascorbic acid might be due to genetic effect of the genotypes.

Highest total sugar was recorded in IC-0614732 (13.68%) and minimum in IC-0614730 (10.25%). Differences in sugar content might be due to maximum conversation of starch into sugar which might be related to inherent varietal character and heavy fruit load also affected fruit weight and quality in litchi (Nagraj *et al.*, 2019). The reducing sugar contents in litchi fruits varied significantly among different genotypes with highest (10.73%) in IC-0614738 and lowest in IC-0614737 (8.68%). Titratable acidity varied from 0.51 to 0.58% maximum being in IC- 0614730 and minimum in IC-0614732 (0.51%). The maximum seed length was recorded in IC-0614731 (24.58 mm) and minimum in IC-0614737 (16.58 mm). Seed weight varied from 1.85 to 4.56 g with maximum in IC-0614731 and minimum in IC-0614730. Mandal and Mitra (2016) reported maximum seed weight in cv. McLean (4.56 g). Lal *et al.* (2018b) found variation in seed content varied from 6.96 to 22.58% highest being in Coll. 38 and lowest in IC-0615613.

Total chlorophyll content in mature leaf varied from 7.12 to 9.56 mg/100g with maximum in IC-0614737 and lowest in IC-0614731 (Table 2). Total phenolics varied from 0.49 to 0.76 mg GAE/g, 15.24 to 54.56 and 26.78 to 44.32 mg GAE/g in pulp, pericarp and seed, respectively. The IC-0614731 had lowest phenolics content in pulp. Total phenolics in litchi varied from 7.5-62.2 mg GAE/g in pericarp with maximum in genotype IC-0615613 and 23.01 mg -85.57 mg GAE/g in seed with maximum in IC-0615597 (Lal *et al.*, 2018b). Phenolic content in plant depends on genetic, agronomic and environmental factors.

A great variation was seen in phenolics content in genotypes in different parts and pulp contains lower phenolics than pericarp and seed. The genotypes which

Table 1. Quality and seed characteristics in litchi

Genotype	TSS (Brix)	Ascorbic acid (mg/100g)	Total sugar (%)	Reducing sugar (%)	Titratable acidity (%)	Seed length (mm)	Seed width (mm)	Seed weight (g)	Seed (%)
IC-0614728	20.15	24.56	13.56	10.56	0.56	23.45	13.97	4.10	16.61
IC-0614729	20.75	26.57	10.86	10.36	0.54	24.38	14.26	4.17	18.39
IC-0614730	17.86	32.68	10.25	8.96	0.58	17.23	9.02	1.85	10.66
IC-0614731	21.47	26.57	12.86	9.86	0.55	24.58	14.12	4.56	21.43
IC-0614732	20.35	24.58	13.68	9.57	0.51	22.98	12.86	4.25	20.67
IC-0614733	20.86	26.57	14.25	10.25	0.55	23.56	13.34	4.22	20.34
IC-0614735	21.45	25.46	13.28	10.38	0.52	24.57	13.86	4.26	18.17
IC-0614737	18.35	35.68	11.45	8.68	0.54	16.58	10.35	1.96	11.97
IC-0614738	19.67	29.37	10.12	10.73	0.56	23.15	13.56	4.22	19.67
SE (d)	0.595	0.615	0.621	0.275	0.01	0.81	0.662	0.914	0.78
CD (0.05)	1.273	1.316	1.327	0.588	0.02	1.733	1.416	1.954	1.66

Table 2. Bioactive compound in litchi

IC Number	Total chlorophyll (mg/100g)	Phenolics in pulp (mg/g)	Phenolics in pericarp (mg/g)	Phenolics in seed (mg/g)	Flavonoids in pulp (mg/g)	Flavonoids in pericarp (mg/g)	Flavonoids in seed (mg/g)	Anthocyanin in pericarp (mg/100g)
IC-0614728	7.58	0.52	16.54	28.26	3.56	0.86	4.12	102.56
IC-0614729	8.14	0.57	15.29	29.37	4.12	0.75	3.86	98.56
IC-0614730	8.93	0.76	53.25	44.32	4.10	6.85	13.26	26.45
IC-0614731	7.12	0.49	15.48	29.37	3.85	0.92	3.75	98.25
IC-0614732	7.68	0.51	17.26	26.78	3.28	0.73	4.57	100.12
IC-0614733	8.75	0.57	15.24	29.38	4.27	0.79	4.25	99.45
IC-0614735	8.97	0.50	17.25	29.38	3.27	0.83	4.67	103.58
IC-0614737	9.56	0.73	54.56	43.57	4.56	5.86	13.28	28.26
IC-0614738	7.55	0.55	17.26	29.38	3.86	0.76	4.85	97.25
SE (d)	0.108	0.02	1.4	0.904	0.055	0.344	0.907	3.351
CD (0.05)	0.23	0.043	2.993	1.933	0.117	0.736	1.939	7.166

contain low phenolics in pulp might have diverted to pericarp and seed. Total flavonoids varied from 3.27 to 4.56 mg CE / g, 0.75 to 6.85 mg CE / g and 3.75 to 13.28 mg CE / g in pulp, pericarp and seed, respectively. Lal *et al*. (2018b) showed variation in flavonoids content from 0.73-96.62 mg CE / g in pericarp and 2.41-27.50 mg CE / g in seed. Pericarp and seed were major sources of flavonoids than pulp. Total anthocyanin content varied from 26.45 to 103.58 mg / 100 g with maximum in IC-0614735 and minimum in IC-0614730. Mandal and Mitra (2016) reported maximum anthocyanin (41.75 mg 100 g) in Deshi, followed by Kasba (34.62 mg 100 g), whereas it was recorded minimum (15.78 mg 100 g) in Elaichi. The IC-0614730 and IC-0614737 was free from sun burn but suffered lower with fruit cracking (<3%). The maximum sun burn was recorded in IC-0614729 (26.35%). Sun burn is predisposed to fruit cracking in litchi in early cultivars. Sun burn parts of fruit turned into cracking as fruit growth was extended. The IC-0614729 had maximum fruit cracking (28.62%), whereas IC-0614737 showed least fruit cracking (2.14%). Sun burn and fruit cracking are genetic characters of genotypes and intensity of sun burn and fruit cracking are highly influenced by the age of plants. Young plants are severely affected with sun burn and fruit cracking than old ones.

It can be concluded that genotypes IC-0614730 and IC-0614737 exhibited bright pink colour of young leave and others had yellowish green. Pink flushes genotypes matured late while yellowish green matured early. These two genotypes showed lowest seed content (10.66% and 11.97%) but higher pulp content (71.18% and 74.66%) as well as higher phenolics and flavonoids contents with least affected by sun burn and fruit cracking. These genotypes exhibited low vigour, least number of leaflet / leaf, minimum length and width of leaf and dwarf structure. These traits can be used for identification of dwarf cultivars in litchi.

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