Mysore J. Agric. Sci., 57 (1) : 388-398 (2023)

Morphometric Evaluation of Selected Jackfruit (*Artocarpus heterophyllus* Lam.) Genotypes / Varieties for the Fruit and Flake Quality Traits

M. D. Valeeta, S. Syamalamma, B. Kalpana and S. N. Nagesha
Department of Plant Biotechnology, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
e-Mail : valeeta.marina22@gmail.com

Authors Contribution

M. D. Valeeta : Conceptualization, investigation and original draft preparation;
S. Syamalamma : Conceptualization, draft correction and supervision;
B. Kalpana &
S. N. Nagesha : Draft correction and supervision

Corresponding Author :
M. D. Valeeta
Department of Plant Biotechnology,
College of Agriculture,
UAS, GKVK, Bengaluru

Received : August 2022
Accepted : November 2022

Abstract

The current study involved morphometric evaluation of flake and fruit quality traits in nineteen Jackfruit genotypes/varieties. Greater variability was observed in fruit traits *viz*., fruit length (31.5-68.5 cm), fruit diameter (45.5-75.9 cm), fruit weight (2.739-11.185cm) fruit shape (oblong, ellipsoid, spheroid, irregular), fruit rind weight per kg fruit (330-524gm), fruit rind-thickness (0.60-2.90 cm), core-thickness (1.40-8.85cm) and latex exudation (low, medium, high).Variability was also observed in flake quality traits *viz*., flake length (4.34-7.3 cm), flake width (2.95-5.88 cm), flake thickness (0.35-1.66 cm), individual flake weight (13.33-70.50), weight of flakes/kg of fruit (450-709 gm), no. of flakes/kg of fruit(13-29.50), and flake colors (cream, yellow, orange and coppery red). Maximum variation was observed for the flake thickness (52.95%) followed by fruit rind thickness (33.51 cm) and minimum variation was observed for core thickness (2.41cm). Among nineteen genotypes a higher fruit length, fruit diameter, and fruit weight was observed in G1 (68.5 cm), G4 (75.9cm) and G10 (11.185 kg), respectively. Similarly, a higher fruit rind weight per kg fruit was recorded in G8 (524 gm), fruit rind thickness in G19 (2.9 cm) and core thickness in G13 (8.85 cm). ANOVA revealed a significant mean sum of squares for all fruit and flake quality traits except for fruit rind weight/kg of fruit and number of flakes/kg of fruit. Genetic variability, heritability and genetic advance for the 12 characters were analysed. A trend of higher magnitude of PCV than GCV was observed. The estimates of PCV ranged from 15.22- 44.46 per cent and a higher per cent of PCV was recorded for fruit rind thickness (44.46%). The estimates of GCV ranged from 9.23-32.95 per cent, heritability ranged from 26.97 to 99.49 per cent and GAM ranged from 9.87-69.40 per cent.

Keywords : Morphometric evaluation, Jackfruit, Fruit traits, Flake traits, ANOVA PCV, GCV

Jackfruit (*Artocarpus heterophyllus* Lam.) is an important tropical fruit crop in the Moraceae family, native to rain forest of Western Ghats of India. It is a major dry land horticulture crop gaining lot of importance, due to its multiple uses and easy cultivation practices. It is widely cultivated in South Asian countries such as India, Malaysia, Thailand, Vietnam, China as well as in Brazil and Queensland. It is widely distributed across several Southern, Eastern as well as North-Eastern states of India (APAARI, 2012). The area and production of Jackfruit in most of these states is very scanty. However, the recent estimates indicate that, the crop is grown in 18.8 M ha with the production of 1893 MT in India. In Karnataka it is grown in 2.40 M ha with a production of 92.2MT (http://nhb.gov.in/).

Jackfruit is an evergreen, latex producing, monoecious tree producing largest tree borne fruit. The tree grows to a height of 8-25 m by the age of 10-25 years and with a canopy diameter of 3.5-7.0 m. Fruits are usually larger in size (0.5 to 80 kg) and botanically it is called as sorosis, which is formed from the modification of the pistillate flowers. It

consists of edible (pulp and seed) and non-edible (rind and rachis) portions (Naik, 1949). Jackfruit is one of the hardy fruit crop and serves as a food for millions of poor people in the countryside during the pre- monsoon and monsoon season, when there is a scarcity of food. Hence it is referred as 'The poor man's food' (Rahman *et al.,* 1995).

Tender green fruit is used as vegetable and the ripe fruit is eaten fresh as dessert. Seeds are also consumed by boiling or by baking. Leaves are used as the source of fodder and wood is extensively used for furniture making. Owing to its multipurpose uses right from fruits to seeds as well as from leaves to wood, every part can be utilized, hence it can be aptly called as second 'Kalpa Vriksha' among trees species (Rahman *et al.,* 1995).

Innumerable types or forms with different fruit characters of Jackfruit *viz.,* (i) Soft fleshed (ii) firm fleshed exists due to cross pollination and they are mainly grouped into two textural forms. One with soft flesh, pulpy perianth with high fibre and less shelf life and the other one is firm fleshed with thick and firm carpels which are used for table purpose and value addition (Rahman *et al.,* 1999). Based on flake colour they are grouped mainly into four types owing to its carotenoid compositions such as cream, yellow, orange and coppery red types (Kavya *et al*., 2019).

Similarly, Jagadeesh *et al*. (2007) analyzed the bio-chemical composition of the flakes from the firm type jackfruit clones and reported total carotenoid contents ranging from 0.363mg to 0.879mg/100g of fresh weight. These clones were further classified as yellow, light yellow, cream, lemon yellow, deep yellow, saffron, orange and deep saffron types.

Variations also exist in fruit weight, number of flakes per fruit, flake thickness, sensory quality, flesh type, sweetness, flavor and taste. Such variations will be helpful for development of new varieties or selections in crop improvement (Phaomei *et al.,* 2017). One such variations was reported by Rana *et al.* (2018) with a varying fruit shape having a length of 30 to 100 cm and a diameter of 15 to 50 cm and with individual fruit weight of 10 - 25 kg or more.

Uikey *et al*. (2020), recorded a longer fruit length of about 42.67 cm in GDJF-9 genotype followed by 36.00 cm in GDJF-13 genotype and a lower length of 20.80 cm was recorded in GDJF-7.

Kavya *et al.* (2019), studied twenty jackfruit genotypes across the various districts of Karnataka with the superior traits and reported the highest fruit weight of about 23.20 kg with an average fruit length and diameter of about 38.15 cm and 22.58 cm respectively.

A study was under taken by Shyamalamma *et al*. (2008) in jackfruit and assessed carotenoids content in five different pulp colors of Jackfruit. Results revealed that, the red and orange color pulp contained significantly higher concentrations of β-Cryptoxanthine (45.44mg/100g) followed by β-Carotene (43.14 mg / 100 g), α-Carotene (39.40 mg / 100 g) and Lycopene (30.20mg/100g) respectively.

The ripe Jackfruit flakes have a high nutritional value and are rich source of carbohydrates (16-25. 40 g), protein (1.20-1.90 g), fat (0.10-0.40 g), fiber (1.0-1.5 g) per 100g edible portion. Jackfruit also contains minerals such as calcium (20.0-37.0 mg), potassium (191-407 mg), iron (0.50-1.10 mg), sodium (2.0-41.0 mg), phosphorus (38.0-41.0 mg), magnesium (27.0-54.0 mg) and vitamins such as vitamin A (38.0-41.0IU), thiamine (0.03-0.09 mg) and riboflavin(0.05-0.4 mg) per 100g edible portion (Mukprasirt and Sajjaanantakul, 2004).

Fruit extract exhibited antimicrobial activities (Ragas *et al*., 2004) and it is also rich in anti oxidants, phenols and flavonoids contents (Shanmugapriya *et al.,* 2011). Because of its higher nutritive value, it is gaining popularity in western countries, thus the ethnic and mainstream marketing opportunities are plenty. In this regard fruit quality and flake quality parameters were studied in order to obtain the best suitable genotypes / variety for the table purpose, processing purpose as well as for the crop improvement programme, So that the

The Mysore Journal of Agricultural Sciences

farmers can take up Jackfruit farming as an alternative along with the other commercial fruit crops.

Material and Methods

Experimental Material

The present study consisted of 19 genotypes / varieties of Jackfruit collected from different places of Karnataka. These are selected based on varied flake colours such as cream, yellow, orange and coppery red. The genotypes/ varieties used in the study are listed in Table 1 and depicted in Plate 1.

Table 1

List of genotypes used in the present study

Treatment no.	Genotypes used	Location
G1	Siddu	Seegenahalli, Tumkur
G2	Janagere	Janagere, Magadi
G3	Kemparaju	Kodiyala, Tumkur
G4	Lakshminarayanrao	Hosakere, Tumkur
G5	Umashankar	Biligerepalya,Tiptur
G6	Subanna	Bomanahalli, Doddballapura
G7	Nelagudige	Nelagudige, Doddballapura
G8	Singapur Jack	GKVK ,Bengaluru
G9	Ramachandra	GKVK,Bengaluru
G10	Byrachandra	GKVK,Bengaluru
G11	Malaysia jack	GKVK,Bengaluru
G12	HV-1	GKVK,Bengaluru
G13	Gumless	GKVK,Bengaluru
G14	Swarna	GKVK,Bengaluru
G15	Thailand pink	GKVK,Bengaluru
G16	Malleshwaram red	GKVK,Bengaluru
G17	Lalbaug madhura	GKVK,Bengaluru
G18	Tubagere red	GKVK,Bengaluru
G19	KT-17	Kachahalli, Doddballapura

Methods

Three average sized fruits were collected from the above said genotypes / varieties during two seasons of the year 2020-21 and 2021-22, from various places in Karnataka as well as the Jackfruit Garden, Department of Plant Biotechnology, University of Agricultural Sciences (UAS), GKVK, Bengaluru. The observations were recorded as per the DUS Jackfruit descriptors on fruit quality and flake quality traits (PPV and FRA, 2020).

Statistical Analysis

The data recorded on the above mentioned fruit and flake quality traits were statistically analysed using Microsoft Excel and RStudio software.

ANOVA

Analysis of variance (ANOVA) was performed to detect significant differences among the jackfruit genotypes using Microsoft Excel and RStudio software.

Variability Parameters

To estimate the contribution made by each factor to variation, GCV (Genotypic coefficient of variation), PCV (Phenotypic coefficient of variation), broad sense heritability, GA (Genetic advance) and GAM (Genetic advance as *per cent* of mean) were estimated.

Results and Discussion

ANOVA

ANOVA is the diagnostic step to detect different sources of variation relevant to the results of field experiments such as those being reported in the present study. ANOVA revealed significant mean squares attributed to test genotypes for all the fruit quality traits except for fruit rind weight per kg of fruit (Table 2) and for all the flake quality except for weight of flakes / kg of fruit (Table 3). These results indicated substantial differences among the genotypes for fruit quality and flake quality traits such as fruit length, fruit diameter, fruit weight, rind thickness, core thickness, flake length, flake width, flake thickness, individual flake weight and number of flakes / kg of fruit and thus provide justification for their use in the present study. Further, there is no significant differences among the genotypes for fruit rind weight per kg of fruit and the weight of flakes per kg of fruit. This suggests that the above said traits are almost similar in all genotypes.

Plate 1 : Jackfruit genotypes /varieties used in the study

TABLE 2

ANOVA of Jackfruit genotypes for fruit quality

Source of variation	DF	MSS					
		Fruit length	Fruit diameter	Fruit weight	Rind weight /kg of fruit	Rind thickness	Core diameter
Replication	1	0.24	97.37	0.005	9904.79	0.014	0.37
Genotypes	18	174.9**	199.8*	13.82**	7013.83	0.65*	179.4**
Error	18	22.9	85.92	2.71	4034	0.25	0.018

*Significance at P=0.05, **Significance at P=0.01

TABLE 3

ANOVA of Jackfruit genotypes for flake quality

Source of variation	DF	MSS					
		Flake length	Flake width	Flake thickness	No of flakes/ kg of fruit	Wt of flakes/ kg of fruit	Individual flake wt
Replication	1	0.41	0.17	0.16	1.68	0.014	16.64
Genotypes	18	1.12*	0.95*	0.26**	78.19*	0.65	174.93**
Error	18	0.46	0.38	0.18	3.68	0.25	20.61

*Significance at P=0.05, **Significance at P=0.01

Morphological Evaluation of Selected Jackfruit Genotypes for Fruit Quality

A total of seven quantitative characters of the fruit were recorded and evaluated to know the genetic variability among the studied nineteen jackfruit genotypes / varieties. Wide range of variation was observed among the genotypes in terms of fruit length, fruit diameter, fruit weight, fruit shape, fruit rind weight per kg fruit, fruit rind thickness, core thickness and latex exudation (Table 4).

Fruit length (*cm*) : Fruit length plays a major role in determining the size, shape as well as edible portion of the fruit. Longer sized fruits are preferred for the export purposes whereas smaller sized fruits are preferred for house hold consumption. In the present findings, fruit length varied from 28 to 69 cm with a mean value of 48.33cm. Longer fruit length was recorded in G17 (68.5 cm) followed by G18 (63.5 cm) and smaller fruit length was (31.5 cm) in genotype G5. Similarly, a firm flesh type with the higher fruit length of about 68.5 cm was reported by Karunarathne *et al*. (2018) in Sri Lankan region.

Fruit diameter (*cm*) : Diameter of the fruits is directly proportional to flake size and to some extent to the number of flakes. The results on fruit diameter revealed significant variation in fruit diameter (Table 4). The higher (75.9 cm) fruit diameter was recorded in G4 genotype and the lower was in G18 (45.5 cm) genotype, with a mean of 62.51 cm. The coefficient of variation for fruit diameter was 14.82. Similar findings were reported by Dey and Baruah (2019) with fruit diameter varying from 74 cm to 49.67 cm.

Fruit weight (*kg*) : In a study carried out by Gayatri *et al*. (2020) reported a small Jackfruit genotype with a oblong fruits known as Rudrakshi, weighing an average of two to five kg. Similarly the higher and the lower fruit weight of about 17.50 kg and 1.69 kg respectively was reported by Krishnan *et al.* (2015) from the jackfruit collection of Kuttanad region. These results revealed a significant variation in fruit weight among the jackfruit genotypes with a fruit weight ranging from 2.73 kg to11.18 kg. Among the present genotypes, the higher fruit weight was recorded in G10 (11.18 kg) followed by G12 (11.02 kg) with a mean fruit weight of 7.33kg.

Fruit rind weight per kg fruit (*gm*) : Higher fruit rind weight is not a desirable quality for its use in

TABLE 4

Morphometric evaluation of selected jackfruit genotypes for fruit quality

Genotypes	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	Fruit rind weight per kg fruit (gm)	Fruit rind thickness (cm)	Core thickness (cm)	Latex exudation	Fruit shape
G1	53	67	9.922	330	1.45	5.05	M	E
G2	54.5	67.5	8.1245	392.5	0.80	6.10	L	E
G3	44.25	47.5	4.656	436	1.10	5.25	H	E
G4	49.65	75.9	9.391	522	2.40	6.03	L	E
G5	31.5	50.75	2.739	440.5	1.00	3.95	H	O
G6	42.5	66.25	6.04	441.5	1.35	5.00	H	E
G7	54	69.75	10.9625	430	2.05	6.45	H	E
G8	50	69.5	8.43	524	1.75	7.75	L	O
G9	48.5	66	8.322	413.5	1.25	5.10	H	O
G10	45.5	64.5	11.185	368.5	0.60	6.75	M	O
G11	37.5	55	3.33	413	1.40	5.40	M	E
G12	55.17	75.45	11.025	491.25	1.72	8.85	M	E
G13	53.5	61	6.1	430	0.95	8.65	L	O
G14	44	75.5	6.0835	389.5	1.70	6.70	H	S
G15	35.75	46.75	3.53	415	1.10	7.80	M	E
G16	37	65.25	6.33	335	1.60	1.40	H	I
G17	68.5	51.615	8.935	486.5	1.65	3.90	M	O
G18	63.5	45.5	6.12	342	2.10	3.05	M	O
G19	50	67	8.016	347.5	2.90	4.20	M	O
Mean	48.33	62.51	7.33	.418.33	1.52	5.65		
CV	9.90	14.829	22.48	15.18	33.51	2.413011		
SE	3.38	6.55	1.16	44.91	0.36	0.09643		
CD (5%)	10.054	19.47	3.46	133.43	1.069	0.28651		
Significance	S	S	S	NS	S	S		

*L-Low, **M-Medium, *** H-High; * E-Ellipsoid, **O-Oblong, ***S-Shperoid ****I-Irregular

value addition or for table purposes. Weight of rind is indirectly proportional to edible portion of fruit, and it ranged from 250 to 550 gm with a mean value of 418.33 gm. The higher fruit rind weight per kg of fruit was recorded in G8 (524 gm) and the lower fruit rind weight was recorded in G1 (330 gm). At the same time, thicker rind will help to protect fruits from post-harvest damages. Non-significant differences were observed in the fruit rind weight per kg of fruit among the genotypes studied.

Fruit rind thickness (*cm*) : Higher fruit rind thickness renders lower edible portion of the jackfruit. It varied significantly with a range of 0.6 to 2.9 cm among nineteen jackfruit genotypes. The higher fruit rind thickness of 2.9 cm was recorded in G19 and a lower thickness was recorded in G10 (0.6 cm). These results are in accordance with Akter and Rahman (2017), who reported a maximum rind thickness of about 2.5 cm.

Fruit shape : Fruit shapes such as ellipsoid, clavate, oblong, spheroid, irregular were recorded among the nineteen genotypes. Spheroid and oblong shaped fruits are more preferable for the market purposes as they are in perfect shapes and one can expect higher flake number. In present study, nine genotypes (G1, G2, G3, G4 G6, G7, G11, G12, G15) were ellipsoid in shape, eight genotypes (G5, G8, G9, G10,

G13, G17, G18, 19) were oblong in shape and few genotypes such as G14 and G16 were spheroid and irregular in shape. Wann (2012) reported wide variations in fruit shape of jackfruit ranging from ellipsoid, oblong, spheroid and irregular shape. Variation in fruit shape may be due to the combined effect of genetic traits and the nature of pollination. Uniform pollination results in complete fruit set and provide a definite fruit shape whereas inadequate pollination gives irregular shaped fruits (Dey and Baruah, 2019).

Core thickness (*cm*) : Similar to the rind thickness, higher core thickness is also not preferred, as it reduces the edible portion of the fruit. Among the genotypes the core thickness was higher in G12 (8.85 cm) followed by in G13 (8.65 cm). Lower core thickness was recorded in G16 (1.4 cm). Wangchu *et al.* (2013), reported core diameter ranging from 0.29 cm to 2.16 cm with a general mean of 0.54 cm.

Latex exudation : The consumer preferences for Jackfruit in the market also depends on the latex exudation. Higher latex content also hampers with the Jackfruit cutting. Latex exudation was found to be high in 7 genotypes, medium in 9 genotypes and low in 3 genotypes. Nowadays there is a lot of scope for identification and improvement of gumless genotypes. The gumless type of Jackfruit with medium to low latex with a medium fruit size (6.4-9kg) was developed at Indian Institute of Horticultural Research, Bengaluru (APAARI, 2012).

Morphological Evaluation of Selected Jackfruit Genotypes for Flake Quality Traits

Flake Length

The mean flake length among the genotypes was 5.69 cm. Higher flake length was observed in G17 (7.3cm) followed by G9 (7cm) and a lower flake length of about 4.34cm was observed in G5 genotype. Similar results were found by Dey and Baruah (2019) with a higher flake length of 7.37 cm. The variation in flake length might be attributed to genetic character of the individual genotype.

Flake Width

The observations on flake width (Table 5) revealed that, there is significant variations in flake width among the genotypes. The broader flake width of 5.88 cm was recorded in G6 genotype and it was lower in G10 (2.95 cm) and the mean flake width recorded at 4.45 cm. A comparable results were obtained by the Paulpi and Daryono (2021), with a flake width ranging from 2.3-5.7 cm.

Flake Thickness

Flakes with higher thickness is favoured for canning purposes on the other hand flakes with lower thickness is preferred for chips making. The thickness of the flakes in the present study ranged from 0.35 cm to 0.95 cm with the mean flake thickness of 0.8cm. Higher thickness of flake was observed in G3 (1.66cm) followed by G17 (1.6cm) and a lower flake thickness was observed in G13 (0.35cm). Similar results were reported by Krishnan *et al.* (2015), with a higher flake thickness of about 0.63 cm in APJ-2 genotype, which was collected from Kuttanad regions of Kerala.

Individual Flake Weight (gm)

It plays a major role in determining the economic value of the fruit. Lower the flake weight higher the number of flakes per fruit and also to some extent proportionate to the fruit weight. Fruits with higher flake weight are considered more attractive than the smaller ones. Individual flake weight differed significantly with a maximum flake weight (70.50 gm) recorded in G17 followed by G06 (55.75 gm) and minimum was in G9 (13.33gm) genotypes. A higher individual flake weight of 42.5cm and a lower individual flake weight of about 15gm was reported by Rai *et al.* (2003).

Weight of Flakes / kg of Fruit

This parameter is economically important in terms of yield. The weight of the flakes per kg of fruit was higher in G4 (858 gm) followed by G 10 (709 gm). The lower weight was recorded in G8 (450gm). Dey and Baruah (2019) reported a higher weight of

TABLE 5

Morphometric evaluation of selected jackfruit genotypes for flake quality

Genotypes	Flake length	Flake width	Flake thickness	Individual flake wt	Wt of flakes/ kg of fruit	No of flakes/ kg of fruit	Flake color
G1	6.095	4.71	0.75	46.70	645	20.50	Coppery Red
G2	5.24	4.31	0.78	41.75	617.5	15.50	Yellow
G3	5.57	4.33	1.66	38.18	607	13.00	Coppery Red
G4	6.1775	5.17	1.24	37.20	858	13.00	Coppery Red
G5	4.34	4.06	0.66	29.60	485.5	19.50	Yellow
G6	6.33	5.88	1.17	55.75	576.5	11.00	Orange
G7	5.71	4.47	0.76	50.50	558	11.50	Orange
G8	5.175	4.43	0.645	16.33	450	15.50	Orange
G9	7	4.50	0.65	13.33	581	28.50	Orange
G10	5.35	2.95	0.625	13.50	709	31.00	Orange
G11	5.5	5.65	0.6	19.00	528	24.00	Yellow
G12	5.16	3.93	0.37	31.67	567.5	15.50	Cream
G13	4.65	3.95	0.35	55.63	540	29.50	Cream
G14	5.81	3.93	0.7	37.33	555	17.00	Yellow
G15	5.225	4.30	0.55	22.00	527.5	18.50	Yellow
G16	5.1375	4.02	0.61	35.50	667	25.00	Coppery Red
G17	7.3	5.25	1.6	70.50	603.5	13.50	Yellow
G18	6.19	3.90	0.865	41.00	505	13.50	Coppery Red
G19	6.3	4.87	0.78	34.33	541.5	16.50	Coppery Red
Mean	5.69	4.45	0.809	36.3	525.79	18.56	
CV	11.9	13.9	52.95	12.5	10.218	10.36	
SE	0.48	0.43	0.30	3.21	42.29	1.36	
CD(5%)	1.43	1.301	0.89	9.54	125.67	4.032	
Significance	S	S	S	S	NS	S	

flakes/ kg fruits in SON1 genotype (540gm) followed by KA3 (480gm) genotype, among 22 accessions collected from the Assam region.

Number of Flakes / kg of Fruit Weight

It is directly proportional to weight of the individual flakes and a lower flake number is preferred for the commercial purposes. The number of flakes varied significantly among the genotypes and it ranged from 11 to 29 with a mean value of 18.56. The higher number of flakes were found in G13 (29.5) followed by G9 (28.50) genotype and the lower number of flakes/ kg of fruit was found in G6 (11). Chandrashekar *et al.* (2018) reported varying no of flakes / kg fruit weight in HRS TKD AH-5 (24.19) and HRS TKD AH-14 (22.85) genotypes respectively, which were grown under coffee ecosystem of lower Pulney hills in Tamil Nadu.

Flakes Colour

Colour of the flakes often results from the carotenoid content. It differs from genotype to genotype based on the different agro climatic zones. Flake colour is also of economic importance since the consumer preference for coppery red colour is more followed by orange coloured flakes. In the present study, the genotypes with four flake colours were identified. Among them coppery red (31.57%),

yellow (37.57%), orange (26.31%) and cream (10.52%) were observed. Akter and Rahman (2017), reported distinctly varied flake colours among the twenty-three jackfruit germplasms in Bangladesh region. The colours varied from yellow (73.91%), whitish yellow (17.39%) and cream colour (8.70%).

Genetic Variability, Heritability and Genetic Advance

The GCV and PCV values for the 12 characters studied are presented in Table 6. A trend of higher magnitude of PCV than that of GCV, indicates the influence of environmental factors on the expression of the traits evaluated in the present study (Table 6).

Phenotypic Co-efficient of Variation (PCV) and Genotypic Co-efficient of Variation (GCV)

As expected, the magnitude of PCV was higher than the corresponding GCV for all the traits. The estimates of PCV ranged from 15.22 to 44.46 per cent. Higher percentage of PCV (> 30%) was recorded for rind thickness (44.46%), fruit weight (39.24%), no of flakes per kg of fruit (34.54%) and core diameter (33.86%).

Moderate estimates (10 to 30%) were recorded for individual flake weight (27.24%), flake thickness (22.82%), fruit length (20.58%), fruit diameter (19.12%), flake width (18.40), rind weight per kg of fruit (17.77%), flake length (15.62%) and weight of flakes per kg of fruit (15.22%). GCV ranged from 9.23 to 32.95 per cent and the higher estimates of GCV (>30%) was recorded in core diameter (33.78%), number of flakes per kg of fruit (32.95%) and fruit weight (32.16%). Lower estimates (10 to 30%) were recorded for rind thickness (29.20%), flake thickness (27.03%) individual flake weight (24.19%), fruit length (18.04), fruit diameter (12.07%), flake width (12.03%), weight of flakes per kg of fruit (11.28%) and flake length (10.08). However rind weight per kg of fruit (9.23%) showed lesser estimate (<10%).

Similar observations were made by Chandrashekar *et al*. (2018), with a maximum GCV in yield (83.94%), followed by fruit productivity (75.58%), fruit stalk length (62.65%), number of fruit per cluster (62.08%), flake (flakes) / seed ratio (52.56%), fruit core weight (51.20%) and fruit weight (47.62%),

TABLE 6

Estimation of components of variance, coefficient of variance, heritability, genetic advance over mean in Jackfruit varieties/genotypes for fruit and flake traits

Traits	Mean	Range		Co-efficient of variability (%)		H^2	GAM
		Min	Max	GCV	PCV		
Fruit length	48.33	28.00	69.00	18.04	20.58	76.84	32.57
Fruit diameter	62.51	32.00	83.00	12.07	19.12	39.85	15.70
Fruit weight	7.32	2.00	11.85	32.16	39.24	67.17	54.29
Rind weight /kg of fruit	418.32	250.00	550.00	9.23	17.77	26.97	9.87
Rind thickness	1.52	0.50	4.30	29.20	44.46	43.15	39.52
Core diameter (cm)	5.65	1.40	8.85	33.78	33.86	99.49	69.40
Flake length	5.69	3.24	8.00	10.08	15.62	41.67	13.41
Flake width	4.45	2.90	6.30	12.03	18.40	42.78	16.22
Flake thickness	0.67	0.35	0.95	27.03	22.82	71.26	39.67
Individual flake weight	36.30	12.00	71.00	24.19	27.24	78.91	44.28
No of flakes/kg of fruit	18.52	10.00	32.00	32.95	34.54	91.00	64.74
Wt of flakes/kg of fruit	585.4	378.00	896.00	11.28	15.22	54.94	17.23

whereas minimum was observed in case of leaf blade length (13.79%).

Heritability (Broad sense) : Heritability provides information regarding the amount of transmissible genetic variation. It also determines response to selection. High heritability estimates are helpful in making selection of superior genotypes apparently from phenotypic performance. In the present study, heritability values ranged from 26.97 to 99.49 *per cent*. The estimates of heritability were high for core diameter (99.49%), number of flakes/ kg of fruit (91.00%) followed by individual flake weight (78.91%) and fruit length (76.84%). Chandrashekar *et al*. (2018), reported broad sense heritability of 83 per cent in fruit length , 92.16 per cent in fruit weight, 80.18 per cent in fruit diameter, 93.16 per cent in no of flakes per fruit, 76.02 per cent in flake length and 88 per cent in flake width.

Genetic Advance as per cent of Means (GAM)

The estimates of expected GAM ranged from 9.87 to 69.40 per cent. The expected GAM was least for fruit rind weight / kg of fruit (9.87%) followed by flake length (13.41%) and the estimates of expected GAM were high for core diameter (69.40%) followed by no of flakes per kg of fruit (64.74%) (Table 6).

Debnath and Deb (2022), reported very high genetic advance for fruit core weight (498.40%), 100 seed weight (301.20%), fruit stalk length (201.45%). The moderate genetic advance was observed for fruit productivity (133.70%) and weight of flakes per kg fruit (129.74%). Extremely low genetic advance was recorded for acidity percentage of ripe fruit (0.05%), flake / fruit ratio (0.12%), seed width (0.93%), seed length (1.21%), shelf life of fruit (1.30%) and flake width (1.79%). High heritability coupled with high expected GAM indicates effectiveness of selection for the fruit and flake quality traits among the Jackfruit genotypes. Thus, in the present study the following genotypes can be selected based on two years data recorded.

Trait	Table purpose	Value addition
Fruit weight	G5	G10
Indiviual flake weight	G17	G9
Weight of flakes/kg of fruit	G10	G8
No.of flakes/kg of fruit	G6	G9
Flake length	G17	G5
Flake thickness	G3	G13

References

Akter, A. and Rahman, H. 2017, Evaluation of jackfruit (*Artocarpus heterophyllus* Lam.) germplasm. *Research & Reviews: J. Bot*., **7 (1)** : 38 - 53.

Apaari, 2012, Jackfruit Improvement in the Asia-Pacific Region - A status report. Asia pacific association of Agricultural Research Institutions, Bangkok, Thailand. pp. : 182.

Chandrashekar, K. G., Vijayakumar, R. M., Subramanian, S., Kavino, M. and John, J.A., 2018, Morphological characterization of jackfruit (*Artocarpus heterophyllus* Lam.) Local genotypes under coffee ecosystem of lower pulney hills. *Int. J. Curr. Microbiol. App. Sci.,* **7 (3)** : 2210 - 2224.

Debnath, A. and Deb, P., 2022, Study on genetic variability estimates of jackfruit (*Artocarpus heterophyllus* Lam.) Germplasm at northern regions of tripura state, India. *Curr. J. Appl. Sci.*, **41 (17)** : 1 - 8.

Dey, B. and Baruah, K. 2019, Morphological characterization of jackfruit (*Artocarpus heterophyllus* Lam.) of Assam. *Int. J. Curr. Microbiol. App. Sci*., **8** (11) : 1005 - 1016

Gayatri, Kavya, K. and Shyamalamma, S., 2020, Characterization of selected jackfruit germplasm accessions for fruit shape through morphological and marker based assay. *Indian J. Agric Res*., **54** (5) : 599 - 604.

Jagadeesh, S. L., Reddy, B. S., Basavaraj, N., Swamy, G. S. K., Gorbal, K., Hegde, L. and Kajjidoni S, T., 2007, Inter tree variability for fruit quality in jack fruit selections of western ghats of India. *Sci. Hort.,* **112** (4) : 382 - 387.

KARUNARATHNE, S. I., RANAWEERA, L. T., DAUNDASEKERA, D., ANANDA, G. K., KANNANGARA, S. K., RANATHUNGA, A. P., MADHUKALPANI, O., WEEBADDE, C. AND SOORIYAPATHIRANA, S. S., 2018, Assessment of the applicability of morphometric, organoleptic and phylogenetic analyses to differentiate soft and firm flesh bearing trees of jackfruit (*Artocarpus heterophyllus* Lam.) *in Sri Lanka. J. Agric. Sci.,* Sri Lanka., **13** (3) : 200 - 218.

KAVYA, K, SHYAMALAMMA, S. AND GAYATRI, 2019, Morphological and molecular genetic diversity analysis using SSR markers in jackfruit (*Artocarpus heterophyllus* Lam.) genotypes for pulp colour. *Indian J. Agric. Res.,* **53** (1) : 8 - 16.

KRISHNAN, G. G., JAYALEKSHMI, ELIZABETH, J. AND THUSHARA, S. S., 2015, Assessment of physic-chemical properties of jackfruit collections from kuttanand region of Kerala. *Asian J. Hort*., **10** (2) : 262 - 266.

MUKPRASIRT, A. AND SAJJAANANTAKUL, K., 2004, Physico-chemical properties of flour and starch from jack fruit seed, *Int. J. Food Sci. Technol,* **39** (3) : 271 - 276.

NAIK, K. C., 1949, South Indian Fruits and Their Culture. P. Varadachery & Co, Madras, 300 - 302.

PHAOMEI, G., PEREIRA L.S. AND MATHEW, B., 2017, Diversity of jackfruit (*Artocarpus heterophyllus* Lam.) in rongram block of west garo hills, meghalaya. *Int. J. Sci. Environ. Technol.,* **6** (3) : 1940 - 1947.

RAGASA C. Y., JORVINA K. AND RIDEOUT J. A., 2004, Antimicrobial Compounds from *Artocarpus heterophyllus*. *Philipp J. Sci.,* **133** (2) : 97 - 101.

RAHMAN, A. K., HUQ, M. M., MIAN, E. AND CHESSON, A., 1995, Microscopic and chemical changes occurring during the ripening of two forms jackfruit (*Artocarpus heterophyllus* L). *Food Chem*., **52** : 405 - 410.

RAHMAN, M. A., NAHAR, N., MIAN, A. J. AND MOSIHUZZAMAN, M., 1999, Variation of carbohydrate composition of two forms of fruit from jack tree (*Artocarpus heterophyllus* L.) with maturity and climatic conditions, *Food Chem*., **65** : 91 - 97.

RAI, M., NATH, V., DAS, B., RAVI, A. AND KUMAR, M., 2003, Evaluation of Jackfruit genotypes for yield and quality attributes under Eastern Indian condition. *Orissa J. Hort*. **31** (1) : 1 - 6.

RANA, R. C., PRADHAN AND MISHRA, S., 2018, Variation in properties of tender jackfruit during different stages of maturity. *JFST*., **55** (6) : 2122 - 2129.

SHANMUGAPRIYA K., SARAVANA P. S., PAYAL, H., MOHAMMED S. P. AND BINNIE, W., 2011, Antioxidant activity, Total phenolic and flavonoid contents of *Artocarpus heterophyllus* and *Manilkara zapota* seeds and its reduction potential. *Int. J. Pharm. Sci.,* **3** (5) : 256 - 260.

SHYAMALAMMA, S., CHANDRA, S. B. C., HEGDE, M. AND NARYANSWAMY, P., 2008, Evaluation of genetic diversity in jackfruit (*Artocarpus heterophyllus* Lam.) based on amplified fragment length polymorphism markers. *Genet. Mol. Res.,***7** (3) : 645 - 656.

UIKEY, A., EKTA, P. N. AND POONAM, M., 2020, Evaluation of different jack fruit cultivars for their physical parameters fruit. *Int. J. Curr. Microbiol. App. Sci.,* **11** : 3022 - 3026.

WANGCHU, L., SINGH, D. AND MITRA, S. K., 2013, Studies on the diversity and selection of superior types in jackfruit (*Artocarpus heterophyllus* Lam). *Genet. Resour. Crop Evol.*, **60** : 1749 - 1762.