STUDY ON GENETIC VARIABILITY ESTIMATES OF JACKFRUIT [*Artocarpus heterophyllus* Lam.] GERMPLASM AT NORTHERN REGIONS OF TRIPURA STATE, INDIA

ABSTRACT

The experiment was undertaken, during 2019-21, for the purpose of estimation of the genetic variability existing within different quantitative traits among various locally available jackfruit (*Artocarpus heterophyllus* Lam.) germplasm at northern region of Tripura state. High magnitudes for G.C.V., heritability, genetic advance and genetic advance as percentage of mean were observed for yield, fruit productivity, fruit stalk length and fruit core weight, which might have more role in improvement of these traits through proficient selection process. Comparatively low genetic advance with high heritability estimates for some of the traits like - seed width, seed length and total sugar content of ripe fruit, could be indicating towards the fact that direct selection based on these characters would be less effective. Characters such as, number of fruit per cluster, shelf life of fruit and reducing sugar content exhibited wide range of differences between G.C.V. and P.C.V. Hence improvement of these traits by means of selection may not be effective at all.

KEY WORDS – Genetic advance, G.C.V., Genetic variability, Jackfruit, Heritability, P.C.V., Tripura.

INTRODUCTION

The jackfruit (*Artocarpus heterophyllus* Lam.), also popularly known as the "poor man's fruit", has high nutritive value and a wide range of uses, still yet, it is recognized as minor and underutilized fruit (Popenoe, 1974). Jackfruit tree is drought resistant and it is easy to grow (Suchitra, 2015). It is the largest fruit among the cultivated plants with log tap root and a dense crown (Bose and Mitra, 1990). Every 100 g of ripe flakes of jackfruit contains 287-323 mg potassium, 30.0-73.2 mg calcium and 11-19 g carbohydrates (Samaddar, 1985). The fruits are a good source of vitamin A, B, C, potassium, calcium, iron, proteins, minerals and carbohydrate (Chadha, 2009). The fruits are also rich in pectin, carotene, ascorbic acid and contain substantial amount of fibre (Sharma *et al*., 2006). Many parts of the plant, including the bark, roots, leaves and fruits have medicinal properties (Hakim *et al*., 2005; Arung *et al*., 2006). Tripura being under Eastern Himalayan Agro- Climatic Region produces a major share of jackfruit in India. The largest jackfruit producing districts are West Tripura and South Tripura out of total eight districts. Roy (2008) reported that till date no research study has been conducted on jackfruit, especially of northern Tripura, despite it is being produced in bulk with rich genetic diversity. Therefore, there is a urgent needs for survey, collection, conservation and characterization of the threatened cultivars or clones of jackfruit in Northern Tripura for improvement and to increase the sustainable production and productivity at now or in future for food security in the district. Keeping in view the above perspective, this research survey was conducted to estimate the existence of genetic variability among different quantitative traits of seedling germplasm of jackfruit to use this gene pool for future breeding as well as improvement programme of this crop.

Comment [MK1]: Also mention about the ploidy level and mode of pollination of the plant.

Comment [MK2]: Indicate here about the total no. of germplasm under study

MATERIALS AND METHODS

The region of Northern parts of Tripura State was covered for the study including the hilly zone. Fifty different Jackfruit genotypes were identified from eight blocks namely, Kadamtala, Jubrajnagar, Kalacherra, Laljuri, Panisagar, Damchera, Dasda, Jampui Hills in the state following the Bio-diversity International Jackfruit Descriptor during the years 2019-2021. More than 70% of this area is hilly and forest covered. The terrain is mostly undulating & hilly with small water streams (cherras), rivers and fertile valleys intervening. The climate of this region is tropical in nature and is generally warm and humid. The hilly regions enjoy higher temperature in summer and lower temperature in winter in comparison with the plains. The climatic temperature generally ranges in between 10^0C and 35^0C. Soil is acidic in nature (pH 5.4 – 6.1). The morphological diversity and quantitative characteristics of selected jackfruit genotypes were performed *in situ*. Thirty two ~~numbers various~~ quantitative traits related to tree morphology and yield attributes <u>as mentioned in Table 1</u> were measured as per suitable scale and units. Different bio-chemical parameters including other quality attributes like total soluble solids, acidity, reducing sugar and total sugar content of the ripe fruits of selected jackfruit genotypes had been determined and recorded as per proper methods of estimation.

Variability of different characters was estimated as suggested by Burton (1952). Genotypic coefficient of variability (GCV) and phenotypic coefficient of variability (PCV) were computed as follows:

Comment [MK3]: Include the germplasm name, collection area in tabular form

Comment [MK4]: Mention whether the observation were made for all traits during three years i.e. 2019-21. If yes, whether the presented data are pool of 3 years data? Also mention about the year wise variation among the traits, i=f observed in the study

$$\text{Genotypic coefficient of variability (GCV)} = \left(\frac{Genotypic\ Standard\ Deviation}{Mean}\right) X100$$

$$\text{Phenotypic coefficient of variability (PCV)} = \left(\frac{Phenotypic\ Standard\ Deviation}{Mean}\right) X100$$

Heritability (h^2(b)) in broad sense was calculated by using the following formula suggested by Allard (1960).

$$\text{Heritability (h2)} = \left(\frac{Genotypic\ Variance}{Phenotypic\ Variance}\right) X\ 100$$

Expected genetic advance was estimated by the proposed method of Johnson *et al.* (1955).

$$GA = h^2(b)\ X\ K\ X\ \sigma p$$

Where,

h^2(b) = Heritability in broad sense

σp = Phenotypic standard deviation of given character

K = Selection differential at 5% selection intensity (2.06)

Genetic advance as per cent of mean (G.A.M.) was calculated as suggested by Johnson *et al.* (1955).

$$\text{G.A.M} = \left(\frac{Gentic\ Advance}{Mean}\right) X100$$

The estimate of genetic variability of quantitative data were analysed by using software RSTUDIO Pro version 4.1.3.

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RESULTS AND DISCUSSION

The assessment of variability parameters revealed a good amount of variation among genotypes studied for different quantitative physical, yield attributing and physicochemical quality oriented traits of jackfruit. A comparative study of thirty two quantitative traits for the genotypic coefficient of variation (G.C.V.), the phenotypic coefficient of variation (P.C.V.), the environmental coefficient of variation (E.C.V.), heritability (in broad sense) and genetic advance (as % of mean) have been presented in Table-1.

Genotypic and Phenotypic co-efficient of variation (G.C.V. and P.C.V.)

The genotypic coefficient of variation was observed maximum for yield (83.94%), followed by fruit productivity (75.58%), fruit stalk length (62.65%), number of fruit per cluster (62.08%), flake (bulb)/seed ratio (52.56%), fruit core weight (51.20%) and fruit weight (47.62%), whereas minimum was observed in case of acidity percentage of ripe fruit (12.00%), preceded by reducing sugar content of ripe fruit (12.92%) and leaf blade length (13.79%). The highest phenotypic coefficient of variation was observed also for yield (84.47%), followed by fruit productivity (75.88%), number of fruits per cluster (69.37%), fruit stalk length (63.67%), flake (bulb)/seed ratio (52.76%), fruit core weight (51.58%) and fruit weight (48.08%). The environmental coefficient of variation was observed as the maximum for number of fruit per cluster (30.96%), followed by weight of fresh flakes without seed (22.21%), reducing sugar content of ripe fruit (18.15%), shelf life of fruit (17.53%), number of seed per kg fruit (12.10%) etc. and the least was found for leaf blade width (1.76%). The estimates of the phenotypic

coefficient of variation were higher than the genotypic coefficient of variation in the present study. It means that the apparent variation was not only due to genotypes, but it was also due to environmental influence. Out of 32 quantitative traits under study, majority of the characters (26 traits) exhibited almost equal magnitude of phenotypic as well as genotypic coefficient of variation i.e. indicated less environmental influence in their expression. Hence, most of the quantitative traits of jackfruit accessions in the present study were considered comparatively stable compared to the remaining six characters (namely, leaf blade length, number of fruit per cluster, weight of fresh flakes without seed, flake/fruit ratio, shelf life of fruit and reducing sugar content of ripe fruit) that revealed high magnitude of differences between G.C.V. and P.C.V. Similar kind of observation also had been documented by Wangchu (2005). The high estimate of P.C.V. and G.C.V. for yield, fruit productivity, fruit stalk length, number of fruit per cluster, flake (bulb)/seed ratio, fruit core weight and fruit weight indicated greater variability, which can be effectively utilized through selection. These finding corroborate with the finding of Maiti *et al*. (2003). Sharma *et al*. (2005) also observed high genotypic and phenotypic coefficient of variation for weight of bulbs without seed, weight of bulbs with seed and fruit weight.

The phenotypic and genotypic coefficient of variation does not fully estimate the total heritable variations and therefore, computation of heritability becomes necessary. Burton and De-Vane (1953) has suggested that genetic coefficient of variability and heritability estimates would provide a reliable proof of expected amount of improvement through selection.

Heritability (h^2 bs)

Heritability is the transmissibility of traits from parents to offspring. The ratio of genetic variance to the total variance called heritability. Knowledge of heritability of a trait thus guides a plant breeder to predict the behaviour of succeeding generations and helps him to predict the response to selection. The broad sense heritability was observed extremely high (99.00%) for leaf blade width, fruit core weight, fruit productivity, 100 seed weight, flake (bulb)/seed ratio and yield per tree per year. However, characters namely, fruit weight, number of flakes (bulb) per kg fruit, weight of fresh flakes with seed, fruit stalk length, rachis length and total sugar content of

ripe fruit also exhibited very high heritability (having heritability percentage between 97.00-98.00%). Moderate heritability was observed for fruit length (84.00%), weight of flakes per kg fruit (83.00%), number of fruit per cluster (80.00), Flake/fruit ratio (77.00%), weight of fresh flakes without seed (74.00%) and leaf blade length (64.00%).The characters acidity parentage of ripe fruits (31.00%) and shelf life of fruits (48.00%) expressed comparatively much lower heritability values. Majority of the traits included in the present investigation revealed heritability ranging from extremely high to moderate. Hence, these traits indicated less environmental influences and selection for such traits on the basis of phenotype will be effective. This might be indicative towards the fact that selection will be the best step for identification of genotypes having traits with high heritability. However, relatively much lower heritability had been registered for acidity content for ripe fruits and shelf life of fruit, where environmental influences played a major role. Similar result was obtained by Wangchu *et al*. (2013) and Maiti *et al*. (2003), while evaluating forty-four superior genotypes of Jackfruit in West Bengal.

Genetic advance and Genetic advance as percentage of mean

The genetic advance was observed ~~extremely high~~highest for yield (949.91%). Very high genetic advance was registered 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%) etc. Genetic advance as % of mean was also recorded as the highest for yield (171.82%), followed by fruit productivity (155.06%), fruit stalk length (127.01%), number of fruit per cluster (114.44%), flake (bulb)/seed ratio (107.87%) and fruit rind weight (104.68%).

Genetic advance is the improvement over the base population that can potentially be incorporated from the selection for a character, while the estimate of heritability is important to find out the heritable part of variability and genetic gain that can be likely achieved in the

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next generation. However, co-efficient of variation and heritability estimates coupled with genetic advance should be considered more reliable for maximum genotypic information (Nayak, 2010). Therefore, heritability, as well as genetic advance, was determined in the present study to get a clear idea for the scope of improvement in important quantitative traits of jackfruit accessions. According to Johnson *et al.* (1995 a), heritability and genetic advance determines the heritable portion of variation. They also stated that high heritability along with high genetic advance are more reliable index.

CONCLUSION

In the present experiment, high magnitudes for G.C.V., heritability, genetic advance and genetic advance as percentage of mean were observed for yield (kg/tree/year), fruit productivity (kg/m^2), fruit stalk length, flake (bulb)/seed ratio, fruit core weight and 100 seed weight, which revealed that these characters of the jackfruit germplasm, belonging to the northern part of Tripura state, might had an additive gene effect and therefore, have more role in proficient selection. Comparatively low genetic advance with high heritability estimates for some of the traits like seed width, seed length, flake width, weight of fresh flakes without seed, leaf blade width, rachis diameter, flake length and total sugar content of ripe fruit, could be due to non-additive gene action which associated with epistasis and dominance. Therefore, direct selection based on these characters would be less effective. Characters such as, number of fruit per cluster, flake/fruit ratio, shelf life of fruit and reducing sugar content of ripe fruit that exhibited wide range of differences between G.C.V. and P.C.V. Thus, might have proven maximum influences of environmental factors for effective expression of these traits, hence improvement of these traits by means of selection may not be effective at all among the seedling genotypes of jackfruit locally available at the northern parts of Tripura State.

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Table-1: Estimation of phenotypic, genotypic, environmental coefficient of variation, heritability (broad sense) and genetic advance of different morphological and physicochemical quantitative traits of the Jackfruit (*Artocarpus heterophyllus* Lam.) **germplasm**

Sl. No.	Parameters	GCV (%)	PCV (%)	ECV (%)	h^2 bs (%)	GA (%)	GA (as % of mean)
1	Leaf blade length (cm)	13.79	17.30	10.44	64.00	2.97	22.65
2	Leaf blade width (cm)	17.47	17.56	1.76	99.00	2.98	35.81
3	Petiole length (mm)	24.79	25.77	7.02	93.00	11.88	49.15
4	Fruit stalk length (mm)	62.65	63.67	11.32	97.00	201.45	127.01
5	Fruit stalk diameter (mm)	25.47	26.81	8.37	90.00	12.91	49.83
6	Fruit length (cm)	23.27	25.42	10.25	84.00	13.07	43.86
7	Fruit diameter (cm)	27.19	28.28	7.77	92.00	13.25	53.86
8	Rachis length (cm)	30.07	30.52	5.20	97.00	13.29	61.05
9	Rachis diameter (cm)	26.15	26.82	5.94	95.00	2.71	52.54
10	Number of fruit per cluster	62.08	69.37	30.96	80.00	3.07	114.44
11	Fruit weight (kg)	47.62	48.08	6.62	98.00	5.43	97.16
12	Fruit core weight (g)	51.20	51.58	6.27	99.00	498.40	104.68
13	Fruit rind weight (kg)	39.34	40.58	9.96	94.00	2.16	78.56
14	Fruit productivity (kg/m^2)	75.58	75.88	6.74	99.00	133.70	155.06
15	Number of flakes (bulb) per kg fruit	35.61	36.00	5.29	98.00	13.53	72.55
16	Weight of flakes per kg fruit (g)	16.92	18.59	7.70	83.00	129.74	31.73
17	Weight of fresh flakes with seed (g)	39.26	39.75	6.20	98.00	24.54	79.90
18	Weight of fresh flakes without seed (g)	37.34	43.45	22.21	74.00	19.62	66.10
19	Flake/Fruit ratio	16.74	19.07	9.07	77.00	0.12	30.27
20	Flake length (cm)	21.25	21.96	5.54	94.00	2.53	42.37
21	Flake width (cm)	20.39	20.84	4.34	96.00	1.79	41.08
22	Shelf life of fruit (days)	16.69	24.21	17.53	48.00	1.30	23.71
23	Seed length (cm)	19.95	20.75	5.67	93.00	1.21	39.54

24	Seed width (cm)	24.80	26.02	7.85	91.00	0.93	48.71
25	Number of seeds per kg fruit	35.74	37.73	12.10	90.00	12.68	69.73
26	100 seeds weight (g)	34.46	34.71	4.23	99.00	301.20	70.45
27	Flake (bulb)/seed ratio	52.56	52.76	4.58	99.00	8.41	107.87
28	TSS (^{0}Brix)	17.92	18.42	4.24	95.00	8.30	35.93
29	Acidity (%)	12.00	21.69	18.15	31.00	0.05	13.69
30	Reducing sugar (%)	12.92	13.39	3.51	93.00	2.78	25.69
31	Total sugar (%)	15.45	15.66	2.52	97.00	6.59	31.42
32	Yield (kg/tree/year)	83.94	84.47	9.47	99.00	949.91	171.82