Biological Forum – An International Journal 15(9): 383-386(2023)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Genetic Variability, Heritability and Genetic Advance Analysis for Yield and its Attributing Traits in Ridge Gourd Hybrids (*Luffa acutangula* L.)

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(Received: 18 June 2023; Revised: 26 July 2023; Accepted: 26 August 2023; Published: 15 September 2023)
(Published by Research Trend)

ABSTRACT: During the rabi season of 2021-2022, a total of eighteen hybrids of ridge gourd were assessed at the Eastern farm of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U.T. of Puducherry. Observations were meticulously documented for various growth, yield, and quality parameters. For each of the examined traits, it was observed that phenotypic variance exceeded genotypic variation. The slight disparities in genotypic and phenotypic coefficient of variation indicated minimal environmental influence on the considered traits. Notably, traits such as sex ratio, number of male flowers, number of female flowers, number of seeds, number of fruits, weight of individual fruits, vitamin C content, crude protein content, and fruit yield per vine exhibited significantly high estimates of both genotypic and phenotypic coefficient of variation in the current study. Furthermore, the study revealed substantial estimates of heritability and genetic advance for specific traits. These traits included vine length at final harvest, number of primary branches per vine, sex ratio, nodes bearing the first male flower anthesis, nodes bearing the first female flower anthesis, number of male flowers per vine, number of female flowers per vine, fruit length, number of fruits per vine, weight of individual fruit, vitamin C content, crude protein content, total soluble solids content, and fruit yield per vine. This suggests the predominant role of additive gene action in controlling these traits.

Keywords: Ridge gourd, variability, heritability and genetic advance.

INTRODUCTION

Luffa acutangula (L.) Roxb., commonly known as ridge gourd, holds substantial significance in the realm of cucurbitaceous vegetables and exhibits extensive cultivation throughout India. A native of tropical Africa and South-East Asia, including India, this crop is classified as an old-world plant. Its geographical reach encompasses the tropical and subtropical regions of India. With a chromosomal count of 2n=2x=26, it finds its taxonomic home within the Cucurbitaceae family. Ridge gourd stands out as a monoecious plant, primarily relying on a highly cross-pollinating reproductive mechanism. This inherent cross-pollination trait offers considerable potential for its commercial exploitation in hybrid seed production. Notably, the fruit of ridge gourd exhibits significant variability in terms of size, shape, and colour. It is worth noting that a substantial portion of hybrid ridge gourd varieties released in India tends to feature larger fruit sizes, which may not align with the preferences of nuclear families, the predominant consumer demographic. In light of this, there arises an imperative to meticulously undertake selective breeding initiatives within germplasm lines or segregating populations. The primary objective is to develop ridge gourd cultivars characterized by moderately sized fruits while retaining high nutritional content. Crucially, the primary quantitative traits directly associated with ridge gourd's external quality include fruit length and diameter. To navigate the intricacies of ridge gourd genetic variability and harness the potential of progeny improvement, it becomes necessary to evaluate key statistical parameters. Both genotypic and phenotypic coefficient of variation, along with heritability and genetic advance, offer invaluable insights into the genetic diversity and breeding prospects of this crop. Given the inherently quantitative nature of many economically significant traits within ridge gourd, often heavily influenced by environmental factors, the progress of breeding initiatives hinges on a nuanced understanding of the interplay between genetic and non-genetic variations.

In this context, this study represents an investigative effort aimed at estimating the extent of variability, heritability, and genetic advance within ridge gourd. The findings of this study hold substantial promise in directing future selective breeding programs, thus contributing to the enhancement of ridge gourd cultivars in the agricultural landscape

MATERIALS AND METHODS

The study was conducted at the College farm, Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, during the period of 2021–2022. The study material comprised 18 ridge gourd hybrids from diverse sources. Employing a randomized block design (RBD) with two replications and a spacing of 2.0 × 2.0 m, the seeds were directly sown in the experimental field. Recommended doses of farmyard manure (25 tonnes ha^{-1}) and fertilizers were applied. Observations were recorded for five randomly selected plants in each experimental plot.

Variability for various quantitative characters was estimated following the procedure for analysis of variance proposed by Panse and Sukhatme (1978). Genotypic and phenotypic coefficients of variation were computed using Burton's formula (1952). Following the classification by Sivasubramanian and Madhavamenon (1973), the phenotypic and genotypic coefficients of variation were categorized as Low (< 10%), Moderate (10-20%), and High (> 20%). Heritability in broad sense was calculated as per Lush (1940) and expressed as a percentage. Sivasubramanian and Madhavamenon (1973) classified heritability estimates of cultivated plants into three categories: Low (≤ 30%), Moderate (31-60%), and High (> 60%). Genetic advance was calculated based on the formula provided by Johnson *et al.* (1955). According to Robinson *et al.* (1949), genetic advance as a percentage of mean was classified into three categories: Low (< 10%), Moderate (10-20%), and High (> 20%).

RESULTS AND DISCUSSION

A. Genetic Variability Analysis

The current investigation reveals a proximity between the General Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV) across most traits, suggesting minimal environmental influence on trait expression. Notably, the coefficient of variation for yield per plant among the 18 hybrid varieties exhibited substantial magnitude at both phenotypic and genotypic levels (Table 1). This observation aligns with the findings of Ramkumar and Anuja (2021) as well as Haque *et al.* (2021).

Following the classification by Sivasubramanian and Menon (1973), GCV and PCV values were categorized into low (<10 percent), medium (11-20 percent), and high (>20.0 percent) ranges. Within the present study, notably elevated estimates of genotypic and phenotypic coefficient of variation were discerned for traits encompassing sex ratio, number of male and female flowers per vine, seeds per fruit, fruits per vine, individual fruit weight, vitamin C content, crude protein content, and fruit yield per vine. This trend corroborates the findings of Kamaladevi (2012); Karthik *et al.* (2017); Manoj *et al.* (2018); Vijayakumar *et al.* (2020) in ridge gourd. Moreover, it aligns with the observations of Abhijeet *et al.* (2018); Kumar *et al.* (2019) in sponge gourd, and Khan *et al.* (2016) in snake gourd. The considerable values for both phenotypic and genotypic coefficient of variation signify substantial variation within the hybrid population for these traits.

Meanwhile, attributes such as vine length at final harvest, number of primary branches per vine, node bearing first male flower anthesis, fruit length, fruit girth, 100-seed weight, total number of harvests, crude fibre content, and total soluble solids exhibited a moderate degree of both genotypic and phenotypic coefficient of variation. This suggests the presence of intermediate variance within the examined hybrids. This observation aligns with the outcomes reported by Samadia (2011); Kamaladevi (2012); Varalakshmi *et al.* (2015) in ridge gourd, as well as Pushpalatha *et al.* (2016) in cucumber, and Torkadi *et al.* (2007) in muskmelon.

B. Heritability and genetic advance Analysis

Estimations of heritability and genetic advance, expressed as a percentage of the mean, bear crucial significance in the selection of desirable genotypes. Heritability estimates elucidate the inheritable component within the total variation, while genetic advance delineates the potential for genetic progress (Johnson *et al.*, 1955). Notably, it is observed that a trait subjected to continual and intensive selection within a population tends to exhibit low heritability (Sivasubramanian and Menon 1973). Traits exhibiting high heritability signify a prevalence of additive gene action, wherein the phenotype closely mirrors the genotype. Consequently, individuals demonstrating superiority in a specific trait also possess favorable genes for the trait, which are then transmitted to their progeny.

In alignment with the classification proposed by Johnson *et al.* (1955), the heritability values were categorized into low (0-30 percent), moderate (31-60 percent), and high (>61 percent) brackets. Within the present study, elevated estimates of both heritability and genetic advance were evident for traits including vine length at final harvest, number of primary branches per vine, sex ratio, node bearing first male flower anthesis, node bearing first female flower anthesis, number of male flowers per vine, number of female flowers per vine, fruit length, number of fruits per vine, individual fruit weight, vitamin C content, crude protein content, total soluble solids, and fruit yield per vine. This observation is consistent with findings reported by Varalakshmi *et al.* (2015); Gautham and Balamohan (2018); Manoj *et al.* (2018); Kannan *et al.* (2019); Kannan and Rajamanickam (2019); Vijayakumar *et al.* (2020) in ridge gourd. Additionally, it aligns with observations made by Hanchinamani *et al.* (2011); Pushpalatha *et al.* (2016) in cucumber, as well as Khan *et al.* (2016) in snake gourd. The concurrent presence of high heritability and substantial genetic advance, expressed as a percentage of the mean, for the aforementioned traits, indicates the efficacy of selection in the context of ridge gourd crop improvement.

Traits such as days to first male flower anthesis, days to first female flower anthesis, calcium content, phosphorus content, and crude fibre content displayed high heritability coupled with moderate genetic advance, signifying a predominant influence of both additive and non-additive gene actions. These findings are in accordance with those reported by Krishnamoorthy (2020); Vijayakumar *et al.* (2020) in ridge gourd, as well as Muralidharan (2012) in bottle gourd. The co-occurrence of high heritability and moderate genetic advance, as a percentage of the mean, for these traits suggests the potential for marginal enhancement through selection.

In summation, it is deduced that traits characterized by both high heritability and substantial genetic advance predominantly exhibit additive gene action, rendering selection more potent. For the enhancement of these traits, the implementation of the simple pedigree method of breeding, followed by meticulous selection, holds substantial promise. Traits encompassing days to first male flower anthesis, days to first female flower anthesis, calcium content, phosphorus content, and crude fibre content are under the influence of both additive and non-additive gene actions, as inferred from their high heritability and moderate genetic advance.

Table 1: Estimation of variability parameters for ridge gourd hybrids.

Sr. No.	Characters	Genotypic variance (GV)	Phenotypic variance (PV)	Coefficient of variance		Heritability (%)	Genetic advance	GA as per cent of mean
				GCV per cent	PCV per cent			
1.	Vine length at final harvest	5557.39	6821.97	17.17	19.02	81.46	138.61	31.92
2.	Number of primary branchesvine^{-1}	0.66	0.77	14.52	15.79	84.57	1.53	27.51
3.	Days to first male flower anthesis	9.17	10.70	7.17	7.75	85.66	5.77	13.67
4.	Days to first female flower anthesis	5.65	6.44	5.54	5.91	87.67	4.58	10.68
5.	Days to 50 percent flowering	2.68	3.81	3.83	4.57	70.30	2.83	6.61
6.	Sex ratio	60.51	64.29	48.88	50.38	94.13	15.55	97.69
7.	Node bearing first male flower anthesis	2.07	2.48	16.12	17.63	83.56	2.71	30.36
8.	Node bearing first female flower anthesis	2.62	3.46	11.98	13.78	75.59	2.90	21.45
9.	Number of male flowers vine^{-1}	13304.16	13625.51	43.74	44.27	97.64	234.79	89.04
10.	Number of female flowers vine^{-1}	42.20	44.61	35.04	36.03	94.58	13.01	70.19
11.	Days to first harvest	1.17	3.63	2.10	3.70	32.22	1.26	2.45
12.	Days to final harvest	17.47	18.91	4.18	4.35	92.41	8.28	8.28
13.	Fruit length	64.52	67.58	17.94	18.36	95.47	16.17	36.11
14.	Fruit girth	5.87	7.93	13.77	16.01	74.00	4.29	24.41
15.	Number of seeds fruit^{-1}	933.38	1045.35	29.35	31.06	89.29	59.47	57.13
16.	100 seed weight	4.56	4.84	14.74	15.18	94.32	4.27	29.50
17.	Total number of harvest	0.89	1.37	18.40	22.89	64.65	1.56	30.48
18.	Number of fruits vine^{-1}	20.32	21.51	38.30	39.40	94.46	9.03	76.67
19.	Weight of individual fruit	13498.21	13527.79	32.65	32.69	99.78	239.07	67.18
20.	Vitamin C	10.07	10.49	31.69	32.33	96.06	6.41	63.97
21.	Calcium	3.90	4.73	9.50	10.46	82.45	3.69	17.77
22.	Phosphorus	4.51	6.79	6.74	8.28	66.36	3.56	11.32
23.	Crude fibre	0.00	0.00	16.21	17.73	83.62	0.11	30.54
24.	Crude protein	0.11	0.12	38.26	40.35	89.93	0.65	74.75
25.	Total soluble solids	0.10	0.13	18.64	21.97	71.99	0.54	32.59
26.	Fruit yield vine^{-1}	7.13	7.39	57.65	58.68	96.53	5.40	116.67

CONCLUSIONS

This study revealed high variability in traits like sex ratio, number of male flowers per vine, number of female flowers per vine, number of seeds per fruit, number of fruits per vine, individual fruit weight, vitamin C content, calcium content, crude protein content, and fruit yield per vine. Moderate variability was observed for vine length at final harvest, number of primary branches per vine, node bearing the first male flower anthesis, node bearing the first female flower anthesis, fruit length, fruit girth, 100-seed weight, total number of harvests, crude fibre content, and total soluble solids content.

Traits with high heritability and genetic advance, such as vine length at final harvest, number of primary branches per vine, sex ratio, node bearing the first male flower anthesis, node bearing the first female flower anthesis, number of male flowers per vine, number of female flowers per vine, fruit length, number of fruits per vine, individual fruit weight, vitamin C content, crude protein content, total soluble solids content, and fruit yield per vine, are predominantly governed by additive gene action. This indicates the potential for effective selection in crop improvement for these traits.

FUTURE SCOPE

The findings of this study lay the foundation for further research in the genetic improvement of ridge gourd. Future studies could focus on molecular approaches to enhance specific traits and explore novel breeding techniques.

Acknowledgements. The authors extend their gratitude to PAJANCOA & RI, Affiliated to Pondicherry Central University) for providing the necessary resources and support for conducting this research.

Conflict of Interest. None.

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How to cite this article: Suvedha M., Marichamy M.S., Kanthaswamy V., Vengadessan V. and Venkadeswaran E. (2023). Genetic Variability, Heritability and Genetic Advance Analysis for Yield and its Attributing Traits in Ridge Gourd Hybrids (*Luffa acutangula* L.). *Biological Forum – An International Journal*, *15*(9): 383-386.