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Research Article

GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR YIELD AND YIELD TRAITS IN YARD LONG BEAN (*Vigna unguiculata* ssp. sesquipedalis (L.) Verdcourt)

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Abstract: An experiment was conducted to study the genetic variability, heritability and genetic advance for yield and yield traits in yard long bean. Four parents and three hybrids of yard long bean were evaluated in a field experiment in randomized block design with three replications during Kharif 2020. Analysis of variance revealed significant differences among the parents and hybrids for most of the characters studied. PCV expressed higher value than corresponding GCV for all the traits. High phenotypic and genotypic coefficient of variation (PCV and GCV) was observed for pod length (52.86 and 52.79) and pod weight (32.07 and 31.82). High heritability (broad sense) was observed for pod length (99.76) and hundred seed weight (99.73) with high genetic advance as per cent of mean which suggests that simple selection breeding method would be effective in improving the traits.

Keywords: *Genetic advance, GCV, Heritability, PCV, Yard long bean*

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Introduction

Yard long bean (*Vigna unguiculata* subsp. sesquipedalis (L.) Verdcourt; 2n=24), a distinct form of cowpea, is one of the most important leguminous vegetable crops originated from Central Africa and widely distributed in India, Indonesia, Philippines and Sri Lanka. It is an annual food legume belonging to the family Fabaceae and the genus Vigna, which comprises of about 80 species. It is called as 'vegetable meat', being a rich and inexpensive source of vegetable protein (3.5 g), calcium (72 mg), iron (2.5 mg), riboflavin (0.09 mg), phosphorus (59 mg) and vitamin A (564 mg 100 g-1 of edible pod) [1]. Cowpea is widely grown in China, South and South East Asia. Because of its quick growth habit and enrichment of soil fertility by fixing atmospheric nitrogen (70 – 240 kg ha^{-1} of nitrogen year-1), it has become an essential component of sustainable agriculture.

Trailing type of vegetable cowpea or yard long bean, vernacularly known as *'Achingapayar', 'Kurutholapayar', 'Vallipayar', 'Pathinettumaniyan'* etc., is one of the most popular and remunerative vegetable crops traditionally grown in Kerala, evenly distributed and preferred in all the 14 districts. It is cultivated mainly for crisp and tender pods, which are consumed in cooked form. It is one of the most favourite vegetable crops in Kerala as it ensures a stable market throughout the year.

Variability, heritability and genetic advance are the deciding factors for the development of plant idiotypic phenotypes. Variation in the estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) measures the presence of genetic as well as phenotypic diversity for diverse growth and yield traits. High heritability and high genetic advance indicate the presence of additive gene action. Under selection, genetic advance refers to an increase in the mean genotypic value over the base population, thus a simple selection breeding method would be effective in improving the traits.

PCV indicates the total variability whereas GCV provides a platform for the assessment and comparison of genetic variability of the characters studied. Hence the present experiment is conducted to study the genetic variability, heritability and genetic advance for yield and yield traits in yard long bean.

Materials and Method

The experiment was laid out in randomized block design with 7 treatments (P1, P2, P3, P4, three hybrids) using the parents, P1 (KAU Deepika), P2 (Vellayani Jyothika), P3 (Githika) and P4 (Kanakamony) in three replications from January-April 2020. One replication consisted of 10 plants planted at a spacing of 1.5 m x 0.45 m with a plot size of 6.75 m^2. The crop was raised according to the Package of Practices Recommendations [2].

Mean performance was studied for the vegetative and flowering characters viz., vine length at final harvest (cm), primary branches plant-1, length and breadth of leaflets (cm) and days to first flowering, yield characters like pod length (cm), pod girth (cm), pod weight (g), pods plant-1, seeds pod-1, hundred seed weight (g), yield (g plant-1), yield plot-1 (kg), days to harvest, crop duration and quality characters like pod protein (%) and keeping quality (% weight loss). The average of five plants were worked out in each replication for statistical analysis. Vine length has been measured from the ground level to the tip of the plants in centimetres at the time of crop senescence. Pod Protein was estimated by Lowry method [3]. The phenotypic and genotypic variances were calculated by utilizing the respective mean square values [3,4].

i) Genotypic variance (VG) $VG = [MST-MSE] / r$
ii) Environmental variance (VE) $VE = MSE$
iii) Phenotypic variance (VP) $VP = VG + VE$

The genotypic and phenotypic coefficients of variation were calculated as per Burton (1952) [5].

i) Phenotypic coefficient of variation (PCV) $PCV= [\sqrt{VP} \times 100] / \bar{X}$
ii) Genotypic coefficient of variation (GCV)
$GCV = [\sqrt{VG} \times 100] / \bar{X}$
$\bar{X}$ = General mean of characters

Categorization of the range of variation was followed as proposed by Sivasubramanian and Menon (1973) [6].

Low : Less than 10 per cent
Moderate :10 to 20 per cent
High : More than 20 per cent

Table-1 *Analysis of variance*

Source of variation	d.f	Vine length at harvest (cm)	Primary branches plant^{-1}	Days to first flowering	Length of terminal leaf (cm)	Length of lateral leaf (cm)	Breadth of terminal leaf (cm)	Breadth of lateral leaf (cm)	Pod length (cm)	Pod girth (cm)	Pod weight (g)
Replicates	2	72.60	0.133	0.19	0.003	0.02	0.31	0.11	1.91	0.007	0.55
Treatments	6	25903.90**	0.661	122.67**	1.41**	5.93**	0.38	0.26	1221.12**	0.12**	122.19**
Parents	3	46013**	1.206**	131.78**	2.66**	9.65**	0.58	0.31	1264.16**	0.12**	167.80**
Hybrids	2	3083.67**	0.087	156.33**	0.16	2.33**	0.03	0.24	3.86	0.11**	21.31**
Parent *vs*. Hybrids	1	11218.41**	0.175	28.00**	0.16	1.95**	0.47	0.14	3526.90**	0.13**	187.19**
Error	12	71.50	0.089	0.86	0.13	0.08	0.33	0.06	0.99	0.013	0.63

Source of variation	d.f	Pods plant^{-1}	100-seed weight (g)	Seeds pod^{-1}	Yield plant^{-1} (g)	Yield plot^{-1}(kg)	Days to harvest (days)	Crop duration (days)	Pod protein (%)	Keeping quality (PLW)
Replicates	2	3.00	0.09	0.91	2506	0.09	0.07	210.85	0.00	0.76
Treatments	6	802.38**	35.75**	10.63**	286115**	29.99**	117.65**	128.44	0.59**	55.32**
Parents	3	377.48**	69.11**	4.14**	73413**	7.34**	122.74**	197.91	0.73**	98.97**
Hybrids	2	131.13**	1.19**	10.11**	37449**	4.83**	140.81**	20.82	0.38**	17.33**
Parent *vs*.Hybrids	1	3419.61**	4.76**	31.16**	1421552.89**	148.23**	56.07**	124.38	0.63**	0.32**
Error	12	3.46	0.03	0.61	3883	0.3687	2.73	194.21	0.011	1.65

Table-2 *Estimates of genetic parameters for various characters of parents and hybrids of yard long bean*

	Range	Mean	PCV	GCV	Heritability (%)	Genetic advance	GA a per cent of mean
Vine Length at Final Harvest	167.67-474.33	369.87	25.19	25.09	99.18	190.37	51.47
Primary Branches Plant^{-1}	3.66-5.66	4.58	11.54	9.53	68.18	0.74	16.20
Length of Terminal Leaf	16.50-18.90	17.89	4.19	3.65	76.11	1.17	6.56
Length of Lateral Leaf	13.21-17.80	16.35	8.72	8.54	95.99	2.82	17.24
Breadth of Terminal Leaf	9.00-11.00	9.64	6.09	1.37	50.08	0.64	6.40
Breadth of Lateral Leaf	8.00-9.60	9.10	3.92	2.82	51.65	0.38	4.17
Days to First Flowering	53.00-73.00	62.67	10.27	10.17	97.93	12.99	20.73
Pod Length	20.30-69.65	38.20	52.86	52.79	99.76	41.49	108.62
Pod Girth	2.50-3.20	2.83	7.69	6.54	72.27	0.32	11.46
Pod Weight	12.30-29.70	20.00	32.07	31.82	98.46	13.01	65.04
Pods Plant^{-1}	32.28-79.91	59.55	27.57	27.40	98.72	33.40	56.08
Seeds Pod^{-1}	13.00-20.33	17.63	11.27	10.37	84.52	3.46	19.64
Hundred Seed Weight	12.22-22.54	16.40	21.07	21.04	99.73	7.09	43.28
Yield	593.00-1561.00	1018.23	30.73	30.12	96.04	619.19	60.81
Yield Plot^{-1}	5.93-15.61	10.23	31.28	30.71	96.40	6.35	62.12
Days to Harvest	62.90-83.22	72.74	8.80	8.50	93.36	12.32	16.93
Crop Duration	117.67-181.98	126.72	10.57	3.47	10.80	2.98	2.35
Pod Protein	3.90-5.50	4.53	10.01	9.73	94.43	0.88	19.48
Keeping Quality	20.00-36.00	27.19	16.25	15.55	91.55	8.34	30.66

Heritability in the broad sense refers to the proportion of genotypic variance to the total observed variance in the total population. Heritability in broad sense was estimated for various characters and expressed in percentage [7].

Heritability (h^2) = *[VG x 100] / VP*

Heritability in broad sense estimates were categorized as suggested by [4]

Low : Less than 30 per cent

Moderate : 30 to 60 per cent

High : More than 60 per cent

Genetic advance refers to the expected genetic gain or improvement in the next generation by selecting superior individuals under certain amount of selection pressure. It depends upon standardized selection differential, heritability and phenotypic standard deviation [7]. Genetic advance was calculated as per cent by the formulae suggested by [4].

Genetic advance (GA) = $k \times h^2 \sqrt{Vp}$

GA as percentage of mean = [GA x 100] / $\overline{X}$

where,

k = standardized selection differential (2.06 at 5% selection intensity)

h2 = heritability

Range of genetic advance as per cent of mean was classified as suggested [4].

Low : Less than 10 per cent

Moderate : 10 to 20 per cent

High : More than 20 per cent

Results and Discussion

Significant variation was noticed on mean performance of yard long bean parents and hybrids for vegetative, flowering, yield and quality characters [Table-1]. Estimates of population mean, range, PCV, GCV, heritability, genetic advance and genetic advance as per cent of mean are presented in [Table-2].

Vegetative and Flowering Characters

High PCV and GCV values (25.19 and 25.09 respectively) coupled with high heritability (99.18 %) and high genetic advance (51.47) was evident for vine length at final harvest. Primary branches per plant exhibited moderate PCV (11.54) and low GCV (9.53) with high heritability (68.18 %) and moderate genetic advance (16.20). Low PCV (4.19) and GCV (3.65) values coupled with high heritability (76.11%) and low genetic advance (6.56) was recorded for length of terminal leaf. Length of lateral leaf exhibited low PCV and GCV (8.72 and 8.54 respectively) with high heritability (95.99%) and moderate genetic advance (17.24). Low PCV and GCV (6.09 and 1.37 respectively) with moderate heritability (50.80%) and low genetic advance (6.40) for breadth of terminal leaf. Low PCV (3.92) and GCV (2.82) were recorded with moderate heritability (51.65) and low genetic advance (4.17) for breadth of lateral leaf. Days to first flowering exhibited moderate PCV and GCV values (10.27 and 10.17 respectively) with high heritability (97.93%) as well as genetic advance (20.73).

Pod Characters

Pod length recorded high PCV (52.86 and GCV (52.79) values with high heritability (99.76%) as well as genetic advance (108.62). Low PCV and GCV were recorded (7.69 and 6.54 respectively) along with high heritability estimate (72.27%) and moderate genetic advance (11.46) for pod girth. Pod weight exhibited high PCV (32.07) and GCV (31.82) values with high estimates of both heritability (98.46%) and genetic advance (65.04). High PCV (27.58) and GCV (27.40) values coupled with high estimates of heritability (98.72 %) and high genetic advance (56.08) observed for pods plant-1.

Seed Characters

Moderate PCV (11.27) and GCV (10.37) were observed with high heritability

(84.52) and moderate genetic advance as per cent of mean (19.64) for seeds per pod. The estimates of PCV (21.07) and GCV (21.04) were high for hundred seed weight along with high estimates of heritability (99.73%) and genetic advance (43.28).

Yield Characters

High PCV of (30.74) and GCV of (30.12) were recorded for yield per plant with high estimates of both heritability (96.04%) and genetic advance (60.81). The estimates of PCV (31.28) and GCV (30.71) were high for yield per plot along with high estimates of heritability (96.40%) and genetic advance (62.12).

Duration

Days to harvest exhibited low PCV and GCV values (8.80 and 8.50) with high estimates of heritability (93.36%) and moderate genetic advance (16.93). Moderate PCV of 10.57 and GCV of 3.47 were recorded for crop duration with low estimates of both heritability (10.80%) and genetic advance (2.35).

Quality Characters

Moderate PCV value (10.02) and low GCV value (9.73) coupled with high heritability (94.43%) and moderate genetic advance (19.48) was evident for pod protein. Keeping quality exhibited moderate PCV (16.25) and GCV (15.55) with high heritability (91.55%) and high genetic advance (30.66).

High estimates of PCV and GCV was recorded by vine length at final harvest among the vegetative and flowering characters. Among the pod characters, pod length pod weight and pods plant-1 had high values of PCV and GCV. Among the seed characters, hundred seed weight possess highest PCV and GCV whereas high estimates of PCV and GCV were recoded for yield plant-1 and yield plot-1 among yield characters. Moderate PCV and GCV were reported for primary branches plant-1, days to first flowering, seeds pod-1 and keeping quality. Moderate PCV with low GCV was observed for crop duration. Low PCV and GCV were recorded by length of terminal leaf, length of lateral leaf, breadth of terminal leaf, breadth of lateral leaf, days to harvest and pod protein. These results are in compliance with Ullah, *et al.,* (2011) [8] and Praveena, (2019) [9]. Vidya, *et al*., (2002) [10] reported high estimates of GCV and PCV for number of pods plant-1, pod weight and pod yield plant-1 in yard long bean. Shanko, *et al.,* (2014) [11] also reported similar results for number of pods plant-1, hundred seed weight and yield plant-1 in cowpea (*Vigna unguiculata* L. Walp).

In the present experiment, PCV expressed higher value than corresponding GCV for all the traits, indicating that environment has minimum effect on trait expression and the small existing variability was due to their genetic makeup. Hence, selection based on phenotypic character is more reliable. These findings are in line with the reports of Rambabu, *et al*., (2016) [12]; Rupesh, *et al.,* (2016) [13]; Asoontha, (2017) [14] and Sultana, *et al.,* (2020) [15] in yard long bean.

Estimating heritability and genetic advance as per cent of mean act as key tool to identify the heritable portion of total variation and to predict the level of genetic advance in selection. High heritability and genetic advance for vine length at final harvest, days to first flowering, pod length, pod weight, pods plant-1, yield plant-1, yield plot-1, hundred seed weight and keeping quality suggested that the expression of these traits are less influenced by environment. High heritability and moderate genetic advance were observed for primary branches plant-1, length of lateral leaf, pod girth, pod protein and days to harvest. Length of terminal exhibited high heritability and low genetic advance. Moderate heritability and low genetic advance were observed for breadth of terminal leaf and breadth of lateral leaf. Low heritability and genetic advance were observed for crop duration. Since most the traits observed are highly heritable with high genetic advance, additive gene action predominates which indicates that yard long bean genotypes can be successfully improved by selection. However, non-additive gene action is expected in the characters with low genetic advance. These results are in agreement with Manju (2006) [16], Kumar, *et al.,* (2013) [17], Rambabu, *et al*., (2016) [12] and Asoontha, (2017) [14]. Multilocation trial should be conducted to confirm the results.

Application of research: Moderate heritability and low genetic advance were observed for breadth of terminal leaf and breadth of lateral leaf.
Research Category: Genetic variability

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Study area / Sample Collection: College of Agriculture, Trivandrum, 695522

Cultivar / Variety / Breed name: Long bean (*Vigna unguiculata* subsp. sesquipedalis (L.))

Conflict of Interest: None declared

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