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Studies on genetic variability, heritability and genetic advance in yardlong bean (*Vigna ungiculata* (L.) walp. ssp. *sesquipedalis* verdc.)

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Abstract
The present investigation was carried to study genetic variability, heritability and genetic advance among 24 genotypes of yardlong bean collected from various locations. The results revealed that PCV was greater than GCV for all the characters indicating the influence of environment in the expression of traits. High PCV and GCV were observed for the traits like number of primary branches per plant, pod length, number of pods per plant, ascorbic acid content, 100 seed weight, pod yield per plant, pod yield per plot and pod yield per hectare. High heritability coupled with high genetic advance were reported with the traits like vine length, number of primary branches per plant, number of nodes per plant, pod length, number of clusters per plant, number of pods per plant, pod ascorbic acid content, 100 seed weight, pod yield per plant, pod yield per plot and pod yield per hectare. This indicates that these traits are under the control of additive gene action and directional phenotypic selection for these traits in segregating populations could be effective for desired genetic improvement.

Keywords: Yardlong bean, PCV, GCV, heritability, genetic advance

1. Introduction
Yardlong bean (*Vigna ungiculata* (L.) walp. ssp. *sesquipedalis* verdc. 2n=22) belonging to family leguminaceae is cultivated mainly for its crisp and tender green pods which are consumed both fresh as well as in cooked form. It is also called as asparagus bean, Chinese long bean, pea bean, string bean, snake bean, snake pea, snap pea, bodi and borboti. Yardlong beans, as the name suggests, differ from cowpeas in their very slender long green beans, which have a beautiful delicate flavour. This legume is also known as poor man's meat as it is a rich and inexpensive source of vegetable protein along with vitamin A, thiamin, riboflavin, calcium, phosphorus, sodium, potassium, magnesium, vitamin C and micronutrients like iron, zinc, manganese and cobalt (Ano and Ubochi, 2008) [1].

Collection, maintenance and evaluation of germplasm for studying genetic variability of economically important traits is one of the basic steps for initiating breeding programme for genetic improvement of any crop as it provides scope for selection. The variability is a combined estimate of genetic and environmental causes. Heritability is the portion of phenotypic variation which is transmitted from parent to progeny. According to Lush (1948) heritability in broad sense refers to the genetic variation in the population in relation to the total observed variance and in the narrow sense it is the ratio of additive variance to the total variance. Higher the heritable variation, greater will be the possibility of fixing the characters by selection methods.

Only a limited breeding work has been done and very little attention has been given for the genetic improvement of this crop to enhance the productivity level. Hence, considering the importance of yardlong bean as a vegetable, the present study was undertaken to access the genetic variability among yardlong bean genotypes.

Material and methods
The present investigation entitled "Studies on genetic variability in yardlong bean (*Vigna ungiculata* (L.) walp. ssp. *sesquipedalis* verdc.) was conducted during *kharif*, 2017-18 at College of Horticulture, Venkataramannagudem. Twenty four genotypes of yardlong bean collected from various places were sown in Randomized Block Design with 3 replications.

Each genotype of a replication consists of eight plants, sown in two rows with a spacing of 2m between the rows and 1m between the plants. All the package of practices were followed as per the recommendation. Data pertaining to the characters such as vine length (cm), number of primary branches per plant, number of nodes per plant, terminal leaf breadth (cm), terminal leaf length (cm), days to first flowering, days to 50% flowering, days to first harvest, length of harvesting period, pod length (cm), pod girth (mm), number of clusters per plant, length of cluster stalk, number of pods per cluster, number of pods per plant, seed number per pod, ascorbic acid content (mg/100g), TSS (°Brix), protein content (mg/100g), titrable acidity (%), 100 seed weight, pod yield per plant (kg), pod yield per plot (kg) and pod yield per hectare (tonnes) were collected from 5 randomly selected plants from each plot in each replication and subjected to statistical analysis. Genotypic and phenotypic coefficients of variation, heritability in broad sense were computed according to Burton and De vane (1953). Genetic advance for each character was worked out by adopting the formula given by Johnson *et al.* (1955) [3].

Results and discussion

Analysis of variance revealed that high and significant differences were observed among the genotypes for all the characters studied indicating presence of great amount of variability among the genotypes for all the characters studied (Table 1).

The mean performance of 24 genotypes of yardlong bean are presented in table 2. These values exhibited a great range of variation. The results revealed that PCV was greater than GCV for all the characters indicating the influence of environment in expression of characters. These results are in support with the findings of Hasan Khan *et al.* (2015) [5]. The details of these variability parameters are presented in table 2.

High PCV and GCV values were recorded for the traits like number of primary branches per plant, pod length, number of pods per plant, ascorbic acid content, 100 seed weight, pod yield per plant, pod yield per plot and pod yield per hectare which indicated greater scope for improvement of these characters by simple selection. Several earlier workers also reported high PCV and GCV values for number of primary branches per plant (Hasan Khan *et al.*, 2015 in cowpea, Titumeer *et al.*, 2014 in mung bean and Mahesh *et al.*, 2017 in cowpea) [5, 7], pod length (Hazra *et al.*, 1999, Hasan Khan *et al.*, 2015 in cowpea, Malaghan *et al.*, 2013 in cluster bean) [6, 5, 8], number of pods per plant (Suganthi *et al.*, 2008 in cowpea) [11], 100 seed weight (Mahesh *et al.*, 2017 in cowpea, Muthuselvi and Shanthi 2013 in cluster bean) [9], pod yield per plant (Khanpara *et al.*, 2015 in cowpea and Vidya *et al.*, 2002 in cowpea) [10, 12] and pod yield per plot (Vikas *et al.*, 2015 in cluster bean) [13].

Low PCV and GCV values were recorded for the traits like terminal leaf length, days to first flowering, days to 50 % flowering, days to first harvest, length of harvesting period, number of pods per cluster, TSS and titrable acidity indicating less influence of environment on these traits. These results are in accordance with the findings of Vikas *et al.* (2015) [13] in cluster bean for days to first flowering, Mahesh *et al.* (2017) in cowpea for days to 50 % flowering, Singh *et al.* (2015) [16, 17] in cluster bean for days to first harvest, Vidya *et al.* (2002) [12] in cowpea for length of harvesting period and Kumar *et al.* (2017) [14] in cluster bean for number of pods per cluster.

The heritability estimates alone do not provide reliable information about the gene governing the expression of a particular character and this do not provide the information of the amount of genetic progress that would result from the selection of best individuals had pointed about that the heritability estimates along with genetic advance were more useful than heritability estimates alone in predicting the response to selection.

In the present investigation high heritability coupled with high genetic advance as percent of mean were observed for the characters like vine length, number of primary branches per plant, terminal leaf breadth, number of clusters per plant, number of pods per plant, pod length, 100 seed

Table 1: Analysis of variance for different traits of Yardlong bean genotypes

S. No	Character	Mean sum of squares		
		Replications df = 2	Treatments df= 23	Error df=46
1	Vine length (cm)	675.23	9051.67**	534.08
2	Number of primary branches per plant	0.28	3.77**	0.11
3	Terminal leaf breadth (cm)	0.52	1.80**	0.29
4	Terminal leaf length (mm)	2.54	4.07**	1.35
5	Number of nodes per plant	2.01	22.33**	2.60
6	Days to 1st flowering	0.79	7.56**	2.07
7	Days to 50% flowering	0.51	6.57**	2.14
8	Days to 1st harvest	7.88	9.61**	2.88
9	Length of harvesting period	4.22	30.97**	7.15
10	Pod length (cm)	3.94	414.34**	6.71
11	Pod girth (mm)	0.87	13.87**	0.71
12	Number of clusters per plant	8.12	132.00**	4.59
13	Cluster stalk length	2.68	8.06**	2.21
14	Number of pods per cluster	0.00	0.26**	0.01
15	Number of pods per plant	43.48	3050.58**	443.24
16	Number of seeds per pod	2.41	4.62**	2.27
17	Ascorbic acid content (mg/100g)	0.83	48.84**	0.54
18	TSS (° Brix)	0.00	0.18**	0.02
19	Protein content (mg/100g)	0.54	21.44**	0.58
20	Titrable acidity (%)	0.00	0.00**	0.00
21	100 seed weight (g)	0.96	37.22**	0.91
22	Pod yield per plant (kg)	0.00	0.69**	0.02
23	Pod yield per plot (kg)	0.07	37.44**	1.25
24	Pod yield per hectare (tonnes)	0.01	14.70**	0.48

* 5% level of significance, ** 1% level of significance

Table 2: Estimation of variability, heritability, genetic advance and GA as *per cent* of mean for different traits of yardlong bean genotypes

Characters	Range		Mean	Variance		PCV (%)	GCV (%)	h^2 (b) (%)	GA at 5%	GA % of Mean 5%
	Min.	Max.		phenotypic	genotypic					
Vine length (cm)	45.00	356.40	274.16	3373.28	2839.20	21.18	19.44	84	100.70	36.73
Number of primary branches per plant	3.93	7.23	5.07	1.33	1.22	22.79	21.82	92	2.18	43.02
Terminal leaf breadth (cm)	5.71	8.62	7.32	0.80	0.51	12.20	9.72	63	1.17	15.95
Terminal leaf length (cm)	13.07	18.35	15.97	2.26	0.91	9.42	5.96	40	1.24	7.77
Number of nodes per plant	5.13	19.67	16.95	9.18	6.58	17.87	15.13	72	4.47	26.38
Days to 1st flowering	41.87	48.23	44.73	3.90	1.83	4.42	3.02	47	1.91	4.27
Days to 50% flowering	42.90	48.73	45.95	3.62	1.48	4.14	2.64	41	1.60	3.48
Days to 1st harvest	48.97	56.67	52.82	5.13	2.24	4.29	2.83	44	2.04	3.86
Length of harvesting Period	37.84	50.57	43.29	15.10	7.94	8.98	6.51	53	4.21	9.72
Pod length (cm)	23.53	64.63	42.15	142.59	135.88	28.33	27.65	95	23.44	55.61
Pod girth (mm)	17.28	24.74	21.14	5.10	4.39	10.69	9.91	86	4.00	18.93
Number of clusters per plant	28.17	50.47	38.75	47.06	42.47	17.71	16.82	90	12.75	32.91
Length of cluster stalk (cm)	13.87	19.93	16.96	4.16	1.95	12.03	8.24	47	1.97	11.61
Number of pods per cluster	2.60	3.55	3.17	0.10	0.08	9.94	9.08	83	0.54	17.08
Number of pods per plant	73.08	179.07	124.15	1312.36	869.11	29.18	23.75	66	49.42	39.81
Seed number per pod	13.33	17.73	15.37	3.06	0.78	11.38	5.75	26	0.92	5.99
Ascorbic acid (mg/100g)	9.50	21.23	15.21	16.65	16.10	26.82	26.38	97	8.13	53.44
TSS (°Brix)	2.50	-3.63	3.19	0.08	0.05	8.78	7.20	67	0.39	12.14
Protein content (mg/100g)	20.13	31.97	27.10	7.54	6.96	10.13	9.73	92	5.22	19.26
Titrable acidity (%)	0.75	0.82	0.80	0.00	0.00	2.23	1.64	54	0.02	2.48
100 seed weight (g)	8.64	22.04	16.92	13.02	12.10	21.33	20.56	93	6.91	40.85
Pod yield per plant (kg)	1.06	2.77	1.87	0.25	0.22	26.74	25.37	90	0.93	49.58
Yield per plot (kg)	7.93	20.73	13.98	13.32	12.06	26.11	24.85	91	6.81	48.72
Yield per hectare (tonnes)	4.95	12.95	8.74	5.22	4.74	26.15	24.91	91	4.27	48.86

weight, pod yield per plant, pod yield per plot, pod yield per hectare and ascorbic acid content indicating the preponderance of additive gene action governing the inheritance of this character and offers the best possibility of improvement of this trait through simple selection procedures. Similar inclinations were observed by Hasan Khan *et al.* (2015) [5] in cowpea for number of primary branches per plant, number of pods per plant, pod length and 100 seed weight, Dinesh *et al.* (2017) [15] in cowpea for vine length, Kumar *et al.* (2017) [14] for number of clusters per plant, Khanpara *et al.* (2015) [10] in cowpea for pod yield per plant, Vikas *et al.* (2015) [13] in cluster bean for yield per plot and Diwaker *et al.* (2017) [16] in cowpea for yield per hectare.

Moderate heritability and genetic advance as per cent of mean were reported for length of cluster stalk. Low heritability and genetic advance as per cent of mean were recorded for seed number per pod indicated that the character was highly influenced by environment and selection would be ineffective for this trait. These findings were in according to Girish *et al.* (2013) [17].

High heritability with moderate genetic advance as per cent of mean were observed for number of pods per cluster, pod girth, TSS and protein content. Moderate heritability coupled with low genetic advance as per cent of mean were recorded for the characters like terminal leaf length, days to first flowering, days to 50 % flowering, days to first harvest, length of harvesting period and titrable acidity showed considerable influence of environment apart from non-additive gene action. Therefore, pedigree selection or population improvement programs bring about desired improvement.

Conclusion

Analysis of variance revealed that there are significant differences among all the characters except titrable acidity. The genotypes like Arka Mangala, Bobbili Local and Bhubaneswar Local reported high mean values for pod yield per plant. The characters like number of primary branches per plant, pod length, number of pods per plant, ascorbic acid content, 100 seed weight, pod yield per plant, pod yield per plot and pod yield per hectare could be improved through selection as they exhibited high heritability coupled with high genetic advance as per cent of mean.

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