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Study of genetic variability in winged bean (*Psophocarpus tetragonolobus* (L.) DC.)

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Abstract
Variability in forty genotypes for twelve characters were studied in winged bean. The number of pods per plot showed maximum GCV and PCV among the traits followed by seed yield per plot, number of pods per plant and seed yield per plant suggested presence of more variability. The least GCV were recorded for days to first pod maturity followed by days to 50% flowering. In the present study all characters showed high heritability except pod length and pod width. Characters like number of pods per plot, seed yield per plant, 100 seed weight, seed yield per plot, number of pods per plant and number of seeds per pod having high heritability estimates associated with high genetic advance as per cent of mean suggesting additive genetic control. Thus, these characters could be improved through simple selection. The expected genetic advance expressed as percentage over mean exhibited high magnitude for traits no. of pods per plot (61.06), seed yield per plot (53.29), no. of pods per plant (52.30). On the contrary low estimates were found for pod width (1.86), days to 50% flowering (11.72), days to first pod maturity (11.72).High heritability coupled with high genetic advance as percent of mean was observed for no. of pods per plot and 100 seed weight suggesting the role of additive gene action in these traits. Thus, these characters could be improved through simple selection.

Keywords: Genetic combining ability, specific combining ability, okra, variance

Introduction
Psophocarpus tetragonolobus commonly known as Winged bean a potential legume crop, also called goa bean & princess bean. It is regarded as "SOYBEAN OF TROPICS", "GREEN GOLD". It is tropical legume found growing abundantly in hot, humid equatorial countries, like India, Burma, Sri Lanka, Thailand and Philippines. It is a diploid ($2n = 2x = 18$), self-fertilizing leguminous crop with multifarious usage. It can be grown as a grain legume, green vegetable, tuber-crop or a forage and cover-crop. In recent years, increasing emphasis has been placed on several under-utilized/under exploited plants of the new and the old world, for growing them in diverse agro-climatic conditions. Amongst these, winged bean *(Psophocarpus tetragonolobus* (L.) DC.) has assumed considerable importance as a protein rich multipurpose crop (Leena Bhatacharya *et al*., 2005) [5]. Much awareness exists at present in this less known legume in the tropical/subtropical regions. Winged Species in the *Psophocarpus* genus have tuberous roots and bean is nutrient-rich, and all parts of the plant are edible. Leaves can be eaten like spinach, flowers can be used in salads, tubers can be eaten raw or cooked, seeds can be used in similar ways as Soybean. The mature dry seeds are the most nutritious part of the winged bean. Their outstanding nutritive quality is based, above all, on their high protein content (30-42 percent) and their favourable amino acid composition. When fried or baked, winged bean seeds make a delicious nut-like snack. The high temperature breaks open the tough seed coat. Flowers have a sweet taste because of the nectar they contain. Its leaves, flowers, pods, green seeds, dried seeds and tuberous roots are all edible and nutritious (Sanjive kumar singh *et al*. (2013) [10]. The percentage of protein is among the highest in the legume crop. (K. Prasanth* and I. Sreelatha Kumary (2014) [3]. It is a logical and suitable crop for farmers with little resources, in great diversity of environment. It can be used as food crop, as animal food supplement, as a cover crop and green manure. Knowledge of genetic variability within and among genotypes of any crop is fundamental to estimate the potential of genetic gain in breeding programs and for effective conservation and sustainable utilization of available genetic resources. Keeping with this facts, the investigation was aimed to elucidate the variability in winged bean.

Material and Method
The present investigation on "Study of Genetic Variability in Winged bean (*Psophocarpus tetragonolobus* (L.) DC.)" was conducted during *kharif* 2016 at All India Co-ordinated

Research Network on Potential Crop. Department of Agril. Botany, MPKV, Rahuri. The material used in the present study consisted of 40 genotypes which were obtained from Plant Breeder, AICRN on Potential Crop, Department of Agril. Botany, M.P.K.V., Rahuri. The details of genotypes are given in table no. 1.The field experiment was laid out in Randomized Block Design with two replications with two no. of rows of each genotype. In each replication, the plot size was 1.80 m x 4.5 m with 90 cm spacing between the rows and 45 cm between plants. The 12 observations were recorded on five randomly selected competitive plants from each treatment in each replication and averages were worked out. Recommended agronomic practices were followed to raise a good crop stand. Morphological observtations were recorded on days to 50% flowering, days to maturity, no. of branches per plant, pod length, pod width, days to first pod harvest, days to last pod harvest, no. of pods per plant, no. of seeds per pod, 100 seed weight, seeds per plant, seeds per plot. The analysis of variance was carried out following the Panse and Sukatme (1954) [6] procedure.

Result and Discussion

The analysis of variance for twelve characters is presented in table no.1. It is revealed that there were highly significant differences among the genotypes for all the characters under study, showing wide range of variation in 40 genotypes of winged bean except days to 50% flowering, days to first pod maturity and days to last pod maturity.

Table 1: Analysis of variance for 12 characters of Winged bean.

Sr. No.	Characters	Mean sum of squares	
		Genotypes (D.F.)	Error (D.F.)
1.	Days to 50% flowering	17.95	95.25
2.	Days to first pod maturity	27.28	188.27
3.	No. of branches per plant	0.94**	0.23
4.	Pod length (cm)	3.40**	1.74
5.	Pod width(cm)	0.47**	0.40
6.	Number of pods per plant	178.95**	18.32
7.	Number of pods per plot	2359**	95.00
8.	Number of seeds per pod	2.74**	0.36
9.	Seed yield per plant (g)	707**	77.52
10.	Seed yield per plot(g)\	1027**	98.00
11.	Days to last pod maturity	16.96	296.17
12.	100 seed weight (g)	16.71**	1.08

The parameters of genetic variability *viz*., mean, range, PCV, GCV, heritability (b.s.), genetic advance and genetic advance as per cent of mean are summarized in table no 2. The estimates of GCV were lower than PCV for all the characters under study.The magnitude, phenotypic coefficients of variation were greater than genotypic coefficients of variation. The estimate of genotypic variance was highest for quantitative character was number of pods per plot (30.87) followed by seed yield per plot (28.49), number of pods per plant (28.13) and lowest for pod width (3.29). PCV for quantitative character was highest for number of pods per plot (32.14) followed by seed yield per plot (31.37), no. of pods per plant (31.18). Lowest PCV was observed for days to last pod maturity (7.56).

Table 2: Estimates of variability parameters for 12 characters of winged bean

Sr. No.	Name of the characters	Range	GCV (%)	PCV (%)	h^2 (b.s.) (%)	G.A.	G.A. as % of mean
1.	Days to 50% flowering	83.00-95.00	6.88	8.33	68.25	10.57	11.72
2.	Days to first pod maturity	120.50-141.50	6.73	7.78	74.74	15.96	11.98
3.	No. of branches per plant	3.00-6.00	14.57	18.80	60.12	0.95	23.28
4.	Pod length (cm)	7.85-13.17	8.68	15.30	32.23	1.06	10.15
5.	Pod width(cm)	4.75-6.22	3.29	12.03	7.5	0.10	1.86
6.	Number of pods per plant	17.00-52.50	28.13	31.18	81.43	16.65	52.30
7.	Number of pods per plot	169-577.50	30.87	32.14	92.21	210.47	61.06
8.	Number of seeds per pod	7.50-12.00	11.76	13.46	76.29	1.96	21.16
9.	Seed yield per plant (g)	32.23-101.96	25.64	28.62	80.24	32.73	47.31
10.	Seed yield per plot (g)	304.26-1146.9	28.49	31.37	82.45	402.99	53.29
11.	Days to last pod maturity	156.00-171.00	7.14	7.56	79.17	22.98	13.20
12.	100 seed weight (g)	17.05-30.03	11.70	12.49	87.80	5.39	22.59

The estimates of heritability in broad sense for quantitative characters studied are presented in table No. 4.4. Maximum heritability was recorded for no. of pods per plot (92.21%) followed by 100 seed weight (87.80%), seed yield per plot (82.45%), no. of pods per plot (81.43%), no. of pods seeds per plot (76.29%), branches per plant (60.12).The highest magnitude of genetic advance was observed for the character seed yield per plot (402.99) followed by number of pods per plot (210.47), seed yield per plant (32.73). The lowest magnitude of genetic advance was observed for the character pod width (1.76) followed by branches per plant (0.95) and pod length (1.06). Genetic advance as a percentage of mean highest for No. of pod per plot (61.05%) followed by seeds yield per plot (53.29%), number of pods per plant (52.30%) & seed yield per plant (47.31%). Heritability and genetic advance as a per cent of mean were higher for number of pods per plant, seed yield per plot. However pod width had comparatively lower estimates of genetic advance followed by pod width.

Discussion

The most basic requirement of any crop improvement programme is the presence of variation for the traits. Here, the high magnitude of variability for all characters studied suggests the opportunity for further improvement of this underutilised crop. Phenotypic coefficient of variation (PCV) was found to be marginally higher than the genotypic coefficient of variation (GCV) for all the characters, indicating the little role of environment in the expression of traits.While, comparing the genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), it was observed that the estimates were closer magnitude in respect of days to first pod maturity, days to 50 per cent flowering, pod length, pod width, no. of seeds per pod, days to first pod maturity. These results were in conformity with the findings of Rajeshwar Nandan *et al.* (2009) [9] for characters days to 50 per cent flowering and days to maturity, pod length, pod width in winged bean. The coefficients of variability at both genotypic and phenotypic level were high for no. of pods per

plant, seed yield per plant in field bean (Yassin, 1973) [11]. The estimates of GCV and PCV were low magnitude in respect of day to 50% flowering and days to maturity. This is reported by Khan *et al.* (2011) [4] & Jeena *et al.* (2005) [2] in chickpea. While evaluating 40 winged bean genotypes high heritability was observed for all characters except pod length and pod width. Characters like number of pods per plot, seed yield per plant, 100 seed weight, seed yield per plot, number of pods per plant and number of seeds per pod.These results were confirmed earlier by Prasanth *et al*. (2015) [8] for the characters seed per pods and pods per plant in winged bean. In the present study, high heritability coupled with high genetic advance as per cent of mean was observed for no. of pods per plot, seed yield per plot. whereas, high heritability and moderate genetic advance as per cent of mean were obtained for no. of pods per plot. These results suggest the role of additive genetic variance for expression of these traits. High heritability coupled with high genetic advance was reported earlier by the Mohammad A. (2007) for number of pods per plant, dry pod yield per plant and seed yield per plant in winged bean.

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