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Genetic Analysis in Pre-breeding Lines of Greengram [*Vigna radiata* (L.) Wilczek]

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ABSTRACT

Background: Greengram is third most important pulse crop which is widely adapted and can improve soil fertility. The genetic variability and association studies help in selection which would increase the yield potential of greengram.

Methods: Two hundred stabilized lines (F_9) obtained from the cross VBN (Gg) 2 and *Vigna radiata* var. *sublobata* were evaluated. The yield and yield contributing traits were recorded to evaluate genetic variability, heritability, genetic advance as % of mean and correlation among the yield and its component traits.

Result: Analysis of variance exhibited significant differences among the lines for all the ten quantitative traits indicating the presence of genetic variability. The high GCV values were found for the traits *viz*., single plant yield (30.18) and the number of pods per plant (26.80). High heritability combined with high genetic advance as per cent of mean was observed for the number of pods per plant (90.19, 52.43), single plant yield (89.58, 58.84), the number of pods per cluster (79.28, 22.70) and the number of clusters per plant (69.50, 30.22) which indicates additive gene effects. In the present study, the number of pods per plant had a high positive direct effect (0.919) on a single plant yield. Therefore, the selection for these characters would improve yield in greengram.

Key words: Correlation, Genetic advance, Greengram, Heritability, Pre-breeding lines, Variability.

INTRODUCTION

Greengram [*Vigna radiata* (L.) Wilczek], the native crop of India belongs to the family Fabaceae. It is grown as a sole crop as well as sequential crop, mixed crop and catch crop. Greengram plays an important role in crop rotation due to its ability to fix atmospheric nitrogen thus improving soil fertility and provides benefits to the subsequent crops. Greengram is rich in protein (22-24%), lysine and is easily digested (Srinivastava and Ali, 2004). The variability present in the population mainly depends on the parents used in the crossing programme (Bertan *et al*., 2007). The inter sub-specific cross between the cultivated and wild species helps to bring out the genetic improvement for yield, resistance to pest and disease, helps in wider adaptation and increases variability in crop species. The progenies of inter sub-specific cross acts as a genetic reservoir for desirable genes and also contributes to the improvement of yield and yield components. The mode of inheritance of quantitative traits can be understood by estimation of genotypic and phenotypic coefficients of variation, heritability and genetic advance as per cent of mean. The correlation coefficient is helpful to analyse the degree and extent of the relationship among the biometrical traits. Path analysis is helpful to identify the interrelationship between the traits and their direct and indirect effects on single plant yield. Based on the above criteria, the present study was undertaken to find out the genetic variability for different traits among the derivatives of inter sub-specific cross of greengram and also the association of different traits with single plant yield in greengram.

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MATERIALS AND METHODS

The present study was performed with two hundred stabilized lines (F_9) obtained from the cross VBN (Gg) 2 and *Vigna radiata* var. *sublobata*. The lines were planted in a randomised block design with two replications at the Department of Pulses, Tamil Nadu Agricultural University, Coimbatore raised during Summer, 2021. The lines were sown in a row of 4 m length with a spacing of 30 × 10 cm. The check varieties *viz.,* VBN (Gg) 3, VBN (Gg) 4, Co 6, Co 7 and Co 8 were grown along with the pre-breeding lines. The observations were taken on three randomly selected plants in each genotype and of ten quantitative traits *viz*., days to

50 per cent flowering, plant height (cm), the number of branches per plant, the number of clusters per plant, the number of pods per cluster, the number of pods per plant, pod length (cm), the number of seeds per pod, hundred seed weight (g) and single plant yield (g). The statistical analysis was done according to the procedure outlined by Panse and Sukhatme (1967). Genetic variability parameters namely phenotypic coefficient of variation, genotypic coefficient of variation, genetic advance and genetic advance as per cent of mean were estimated according to the procedure outlined by Johnson *et al*. (1955). GCV and PCV were categorized based on the suggestions of Sivasubramanian and Menon (1973). Heritability in a broad sense was calculated according to the method given by Lush (1940). As per the suggestions of Johnson *et al.* (1955) the categorization of heritability range was carried out. The range of genetic advance as per cent of mean was categorized as per the suggestions of Johnson *et al.* (1955). Correlation and path coefficient analyses were carried out based on the method proposed by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Analysis of variance revealed that a vast range of variability was recorded for all the traits in greengram lines (Table 1). The results on variability parameters are given in Table 2. Mean performance of all inter sub-specific lines exhibited a wide range of variation for all the biometrical traits *viz*., days to 50 per cent flowering (38-44), plant height (37.22-59.92 cm), number of branches per plant (5.33-8.33), number of clusters per plant (8.50-19.83), number of pods per cluster (3.18-6.42), number of pods per plant (24.80-89.50), pod length (6.37-8.85 cm), number of seeds per pod (9.33-13.59), hundred seed weight (2.03-4.21 g) and single plant yield (3.32-10.84 g). The number of lines that exhibited more than the general mean values for yield attributing traits was: 97 lines for the number of pods per cluster, 95 lines for the number of pods per plant, 100 lines for the number of seeds per pod, 102 lines for hundred seed weight and 87 lines for single plant yield. More number of seeds (upto 13) per pod was observed in many lines and was due to small seeds, which were inherited from the *Vigna radiata* var. *sublobata*. The study showed that a significant amount of variation was observed for all the traits. Rao *et al.* (2006) and Reddy *et al.* (2011) also reported significant variations for all the characters studied.

The GCV for various traits ranged from 4.00 per cent (days to 50 per cent flowering) to 30.18 per cent (single plant yield). Moderate GCV was found for the characters *viz.*, number of clusters per plant (17.59%) and the number of pods per cluster (12.38%). The low GCV values were found for hundred seed weight (9.35%), plant height (9.09%), number of branches per plant (8.62%), pod length (5.07%), number of seeds per pod (4.86%) and days to 50 per cent flowering (4.00%). The high GCV values were found for single plant yield (30.18%) and the number of pods per plant (26.80%).

Table 1: ANOVA for biometrical traits in pre- breeding lines of greengram.

Source	Df	Days to 50 per cent flowering	Plant height	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Pod length	Number of seeds per pod	Hundred seed weight	Single plant yield
Genotypes	199	5.689**	62.560**	0.842**	16.478**	0.781**	427.948**	0.508**	1.442**	0.340**	7.050**
Replication	1	3.105	21.967	1.129	10.235	0.782	71.695	0.559	0.246	0.881	3.704
Error	199	0.358	19.391	0.234	2.965	0.090	22.078	0.213	0.787	0.158	0.387

**Significant at 1 per cent level.

Table 2: Genetic parameters for different traits in pre-breeding lines.

	Mean	Range	Number of lines above mean value	PCV %	GCV %	Heritability (h2) %	Genetic advance	GA as per cent of mean
Days to 50 per cent flowering	41	38-44	80	4.26	4.00	88.14	3.15	7.74
Plant height (cm)	51.09	37.22-59.92	108	12.53	9.09	52.68	6.95	13.60
Number of branches per plant	6.40	5.33-8.33	99	11.47	8.62	56.48	0.85	13.34
Number of clusters per plant	14.77	8.50-19.83	123	21.11	17.59	69.50	4.46	30.22
Number of pods per cluster	4.75	3.18-6.42	97	13.90	12.38	79.28	1.08	22.70
Number of pods per plant	53.16	24.80-89.50	95	28.22	26.80	90.19	27.87	52.43
Pod length (cm)	7.56	6.37-8.85	96	7.94	5.07	40.83	0.50	6.68
Number of seeds per pod	11.77	9.33-13.59	100	8.97	4.86	29.34	0.64	5.42
Hundred seed weight (g)	3.23	2.03-4.21	102	15.50	9.35	36.35	0.37	11.61
Single plant yield (g)	6.05	3.32-10.84	87	31.89	30.18	89.58	3.56	58.84

The PCV for various traits ranged from 4.26 per cent (days to 50 per cent flowering) to 31.89 per cent (single plant yield). The moderate PCV was found for hundred seed weight (15.50%), number of pods per cluster (13.90%), plant height (12.53%) and the number of branches per plant (11.47%). The low PCV was found for number of seeds per pod (8.97%), pod length (7.94%) and days to 50 per cent flowering (4.26%). The high PCV was found for single plant yield (31.89%), the number of pods per plant (28.22%) and the number of clusters per plant (21.11%).

High GCV and PCV estimates for the number of pods per plant and single plant yield were reported by Raturi *et al.* (2015), Susmitha and Jayamani (2018); Parimala *et al.* (2020) and Salman *et al.* (2023) in greengram. High GCV and PCV for the number of pods per plant was observed by Talukdar *et al.* (2020) in greengram. Moderate PCV for plant height, the number of branches per plant and hundred seed weight were observed by Salman *et al.* (2023) in greengram. Moderate PCV for the number of branches per plant was observed by Mehta *et al.* (2019) in greengram. Low PCV for days to 50 per cent flowering and pod length were observed by Zuge *et al.* (2019) and Salman *et al.* (2023) in greengram. Low PCV for days to 50 per cent flowering was observed by Asari *et al.* (2019) in greengram.

The GCV was found to be lower than the PCV for all the traits studied. This showed that these characters are not only expressed through genotype but also influenced by environmental factors. The difference between PCV and GCV ranged from 0.26 per cent (days to 50 per cent flowering) to 6.16 per cent (hundred seed weight). The lowest difference is exhibited by plant height indicating the highest contribution of genotypic value to the phenotype and low influence of environmental factors suggesting a genetic gain for this trait through selection.

The heritability ranged from 29.34 per cent (number of seeds per pod) to 90.19 per cent (number of pods per plant). High heritability was found for the number of pods per plant (90.19%), single plant yield (89.58%), days to 50 per cent flowering (88.14%), number of pods per cluster (79.28%) and number of clusters per plant (69.50%). Moderate heritability was found for the number of branches per plant (56.48%), plant height (52.68%), pod length (40.83%) and hundred seed weight (36.35%). Low heritability was found for number of seeds per pod (29.34%) (Table 2). High heritability helps in the identification of traits that are transmissible from one generation to another generation and have environmental influence at a minimal level. High heritability was reported by Asari *et al.* (2019) and Salman *et al.* (2023) for the number of pods per plant, single plant yield, number of clusters per plant and number of pods per cluster. High heritability for plant height and number of pods per plant was reported by Zuge *et al.* (2019) in greengram. Moderate heritability for pod length was reported by Zuge *et al.* (2019).

The genetic advance as the per cent of mean ranged from 5.42 (number of seeds per pod) to 58.84 (single plant yield). High genetic advance as per cent of mean was observed for single plant yield (58.84), number of pods per plant (52.43), number of clusters per plant (30.22) and number of pods per cluster (22.70). Moderate genetic advance as per cent of mean was observed for plant height (13.60), the number of branches per plant (13.34) and hundred seed weight (11.61). Low genetic advance as per cent of mean was observed for days to 50 per cent flowering (7.74), pod length (6.68) and the number of seeds per pod (5.42) (Table 2). High genetic advance as the per cent of mean was reported by Asari *et al.* (2019) and Salman *et al.* (2023) for the number of pods per plant, single plant yield and number of clusters per plant.

High heritability combined with high genetic advance as per cent of mean was observed for the number of pods per plant (90.19, 52.43), single plant yield (89.58, 58.84), the number of pods per cluster (79.28, 22.70) and the number of clusters per plant (69.50, 30.22) which indicates additive gene effects which would be improved by simple selection. High heritability along with low genetic advance as per cent of mean was observed for days to 50 per cent flowering (88.14, 7.74) indicates the presence of non-

Table 3: Genotypic correlation coefficients among the ten characters of pre-breeding lines of greengram.

	Days to fifty per cent flowering	Plant height	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Pod length	Number of seeds per pod	Hundred seed weight	Single plant yield
Days to 50 per cent flowering	1.000	0.237**	0.158*	0.058	0.001	0.094	-0.001	-0.036	-0.079	0.067
Plant height		1.000	0.119	0.181**	0.181**	0.166*	0.344**	0.195**	0.053	0.164*
Number of branches per plant			1.000	0.417**	0.328**	0.407**	0.187**	0.050	0.076	0.332**
Number of clusters per plant				1.000	0.341**	0.620**	0.271**	0.181**	0.193**	0.484**
Number of pods per cluster					1.000	0.798**	0.210**	0.202**	0.214**	0.706**
Number of pods per plant						1.000	0.348**	0.356**	0.106	0.919**
Pod length							1.000	0.649**	0.305**	0.339**
Number of seeds per pod								1.000	-0.297	0.322**
Hundred seed weight									1.000	0.182**

*Significant at 5 per cent level; **Significant at 1 per cent level.

Table 4: Direct and indirect effect of nine characters on single plant yield in pre-breeding lines of greengram.

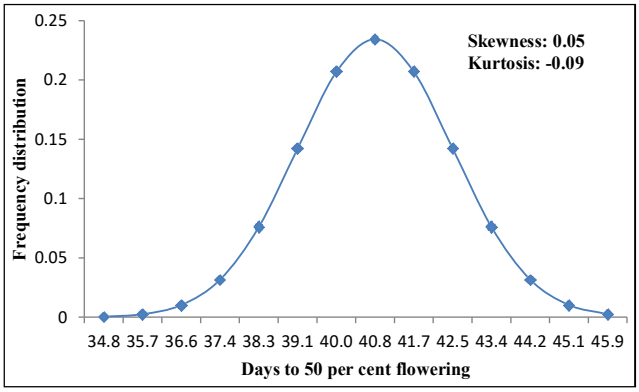
	Days to fifty per cent flowering	Plant height	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Pod height	Number of seeds per pod	Hundred seed weight	Genotypic single correlation for plant yield
Days to 50per cent flowering	-0.034	0.017	0.002	-0.014	0.000	0.119	0.000	-0.005	-0.019	0.067
Plant height	-0.008	0.073	0.002	-0.045	-0.051	0.210	-0.054	0.025	0.012	0.164*
Number of branches per plant	-0.005	0.009	0.015	-0.103	-0.092	0.515	-0.030	0.006	0.018	0.332**
Number of clusters per plant	-0.002	0.013	0.006	-0.248	-0.096	0.785	-0.043	0.023	0.045	0.484**
Number of pods per cluster	0.000	0.013	0.005	-0.085	-0.281	1.011	-0.033	0.026	0.050	0.706**
Number of pods per plant	-0.003	0.012	0.006	-0.154	-0.224	1.266	-0.055	0.046	0.025	0.919**
Pod length	0.000	0.025	0.003	-0.067	-0.059	0.440	-0.158	0.084	0.071	0.339**
Number of seeds per pod	0.001	0.014	0.001	-0.045	-0.057	0.451	-0.103	0.129	-0.070	0.322**
Hundred seed weight	0.003	0.004	0.001	-0.048	-0.060	0.135	-0.048	-0.038	0.234	0.182**

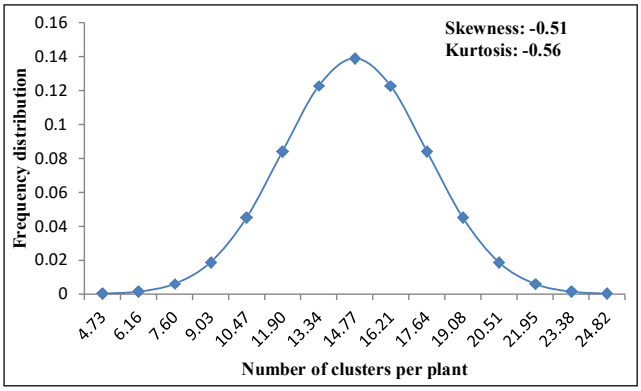
Residual effect: 0.331.

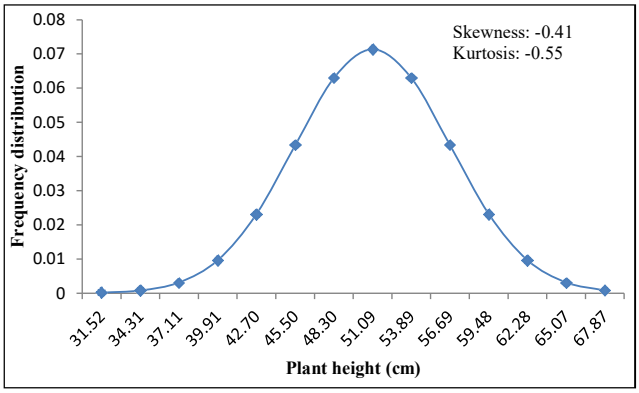
additive gene action. Similar results were reported by Muthuswamy *et al.* (2019); Mehta *et al.* (2019); Asari *et al.* (2019) and Salman *et al.* (2023) for the number of pods per plant and single plant yield.

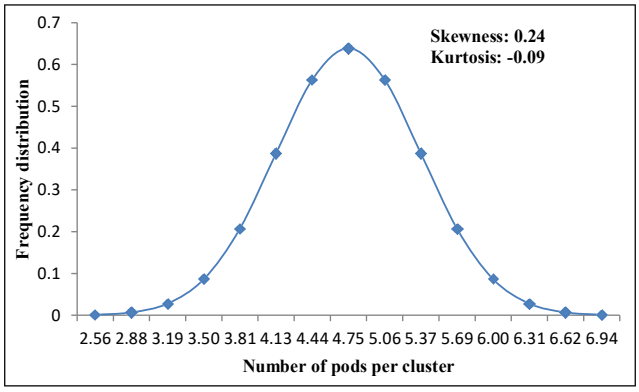
The frequency distribution for ten biometrical traits was represented in Fig 1. The traits number of branches per plant and the single plant yield showed positive skewness. The normal distribution was observed for days to 50 per cent flowering, plant height, the number of clusters per plant, the number of pods per cluster, the number of pods per plant, pod length, the number of seeds per pod and hundred seed weight which indicates the presence of adequate variability for the traits.

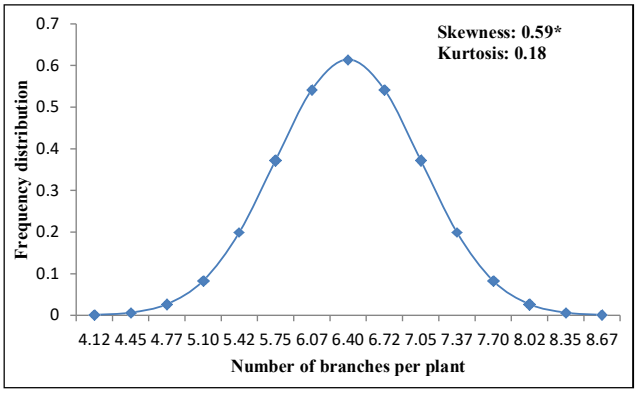
Correlation analysis helps find out the relationship among two or more variables. The genotypic correlation was indicated in Table 3. The traits *viz*., plant height, number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, number of seeds per pod, hundred seed weight were positively correlated with single plant yield. The number of cluster per plant showed a significant and positive association with plant height and number of branches per plant. The number of pods per plant showed significant and positive inter-correlation with plant height, number of branches per plant, number of clusters per plant and number of pods per cluster. Hundred seed weight showed positive

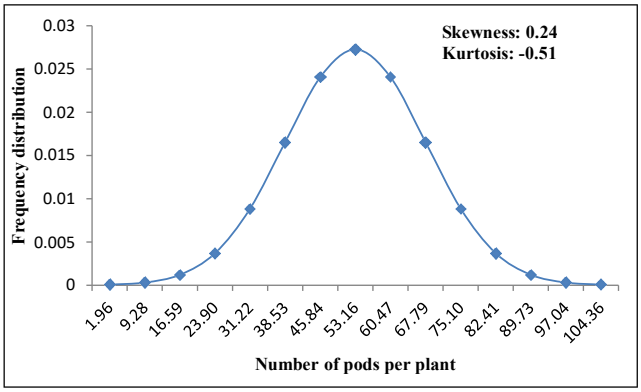












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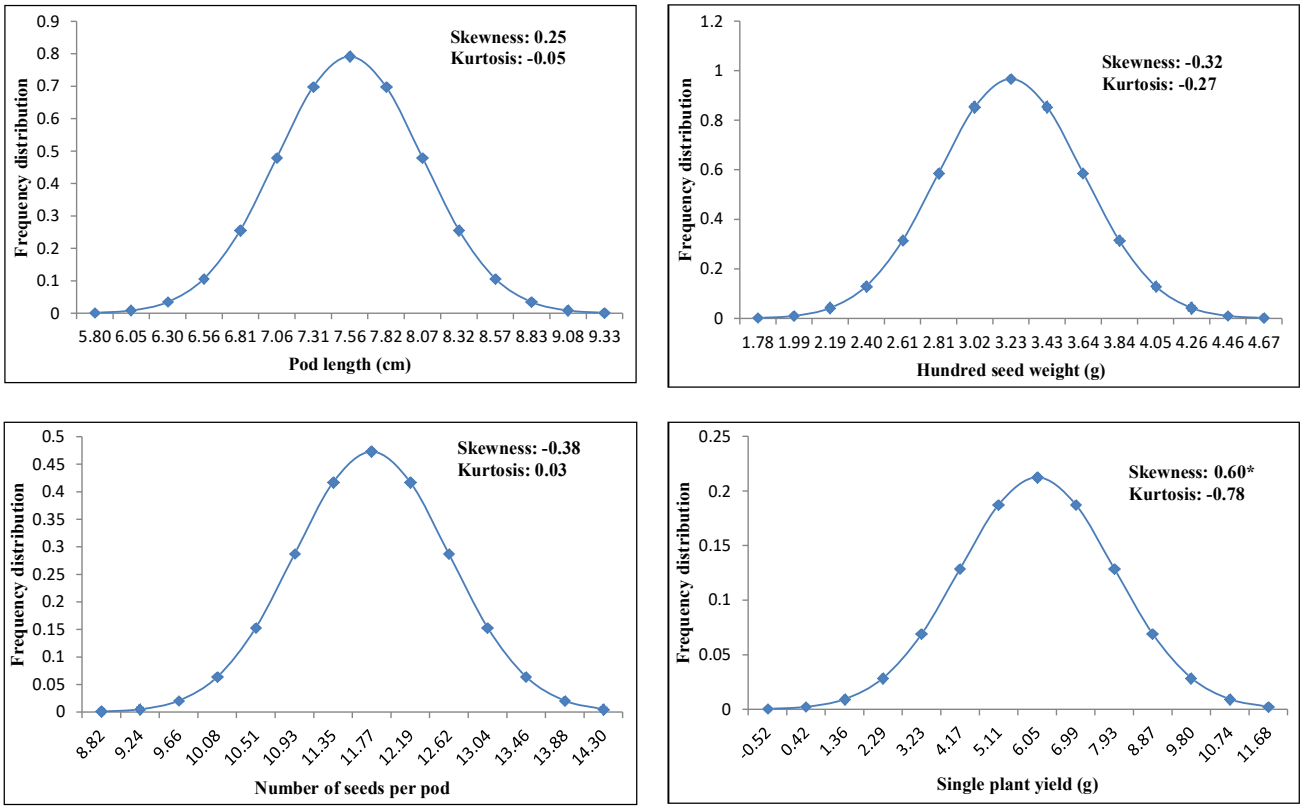

Fig 1: Frequency distribution of different traits in greengram.

significant inter-correlation with the number of clusters per plant, the number of pods per cluster and pod length. Dhunde *et al*. (2021) observed that the number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, plant height, number of seeds per pod and hundred seed weight had a positive significant correlation with single plant yield. Mohammed *et al.* (2020) observed that the plant height, number of branches per plant, number of clusters per plant, pod length, number of seeds per pod, number of pods per plant and hundred seed weight had a positive significant correlation with single plant yield in greengram.

Path analysis helps to determine the direct and indirect contributions of other traits towards the yield. In the present study, the number of pods per plant had a high positive direct effect on single plant yield (Table 4). Similar results were reported by Dhunde *et al*. (2021) where, the number of pods per plant had a high positive direct effect on single plant yield in greengram.

Number of branches per plant, the number of clusters per plant and the number of pods per cluster had a high indirect effect on seed yield through the number of pods per plant. The number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length and number of seeds per pod were found to be the yield attributing traits. Based on the direct effects of traits on a single plant yield, the number of pods per plant should be prioritized to execute the selection for genetic enhancement of seed yield in greengram. The residual effect in the present study was 0.331, which indicates that the characters contribute 68 per cent towards the expression of the trait single plant yield.

CONCLUSION

The results of the present study indicate that there were significant differences for all the traits included in the study which indicates the presence of a sufficient amount of variation among the inter sub-specific lines. The high heritability and genetic advance as per cent of mean were observed for the number of pods per plant, single plant yield, number of pods per cluster, number of clusters per plant and can be used in selection criteria for the future breeding program. From the association studies, it can be concluded that the traits *viz.,* number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, number of seeds per pod had a positive significant correlation with the single plant yield and selection of these traits will improve the yield potential in greengram. Association studies imply that the trait number of pods per plant had a high positive significant effect on single plant yield and selection based on this trait would enhance seed yield in greengram.

Conflict of interest

All authors declare that they have no conflicts of interest.

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