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Pattern of Genetic Diversity and Variability in Greengram (*Vigna radiata* L. Wilczek) Genotypes for Morpho-Physiological Traits and Seed Yield Under Rainfed Condition

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Abstract: *A set of 19 diverse greengram genotypes was studied for genetic variance, character association and genetic divergence with respect to 22 morpho- physiological and yield attributes under rainfed condition of Assam. Based on the estimates of genetic parameters of variation, three traits viz., seeds per plant, pods per plant and reproductive part dry weight having highest genotypic coefficient of variation coupled with high heritability and genetic advance were observed to be the most potential for effective selection. Character association study in relation to the genetic parameters indicated that selection for these three traits would bring about improvement in seed yield as well. Positive association of several other traits with seed yield and with lower magnitude of genetic variance indicated scope for induction of variation and further selection for improving seed yield. Four diverse clusters were obtained out of the set of 19 genotypes based on Euclidian cluster analysis. Based on the* per se *performances of the genotypes and their relative position in the diverse clusters appropriate crossing programme was suggested to obtain desirable segregants. The the two genotypes Pratap (Cluster I) and KM-5-168 (Cluster III) may be crossed with the genotypes viz. SGC 6 and SGC 20 (For earliness), AAU 34 (For seed weight), ML 131 (For pod length), K 851 (For nodes per plant), SP 206 (For root length and stem dry weight), and SP 14 for more green leaves at harvestas belonging to cluster II and IV for further improvement of physiological efficiency and yield potentials in greengram, under rainfed upland condition of Assam.*

Key words: *Genetic variance, genetic divergence, correlation, greengram, morpho-physiological traits, seed yield.*

INTRODUCTION

Greengram is the third most important pulse crop in India. The crop is grown marginally as both *Rabi* and *Kharif* seasons in the state of Assam. Like any other grain legumes its national average productivity is very low. The average productivity in the state of Assam is only 470 kg/ha. The lower productivity of greengram in the state can be attributed to lack of improved variety in farmers' field and in general to poor physiological efficiency of the crop, viz., poor partitioning of the assimilates to the economic sink, abscission of floral parts, canopy architecture, poor pod setting, etc. (Alberda and Bower, 1983). Attempt for genetic improvement of the crop has been very much limited in the region. An understanding of the genetic variability and genetic diversity is the prerequisite for undertaking an effective breeding programme. Moreover, interrelationship of various attributes of grain yield and other associated morpho-physiological traits is essential for initiating a meaningful selection programme. Thus with a view to arrive at a basic understanding on the nature and magnitude of genetic parameters of variation and diversity pattern along with character association the present investigation was carried out in a set of 19 diverse greengram genotypes as a basis for undertaking effective breeding programme.

MATERIAL AND METHODS

The experiment was carried out during summer seasons of 2009, 2010 and 2011 with 19 greengram genotypes belonging to varying yield potentials under rainfed condition in the research field of B N College of Agriculture, AAU, Biswanath Chariali, Assam. The experiment was laid out in a randomized block design with three replications. Each plot consisted of five

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rows of three meter length. Seeds were sown on 15th of March in each year and the crops were raised following the recommended package of practices under rainfed condition of Assam.

Ten plants were tagged randomly in each plot avoiding boarder rows for recording morphological parameters, yield attributes and seed yield. Plant height was measured from the ground level to the growing tip. The number of leaves, the number of primary branches and nodes on the main stem were counted from the bottom to the tip of the plant. Five plants were randomly selected from each plot, uprooted carefully without destroying the root system and the root length was measured. The roots were washed in running water and the nodules were separated and dried in an oven at 80 ^{0}C temperature for 72 hours to record the dry weight. The days required from sowing to 50% flowering and physiological maturity was recorded on plot basis. Five plants were sampled randomly from each plot and separated into leaf, stem and reproductive parts (flowers and pods) and dried separately in a hot air oven until a constant weight was attained and recorded the dry weight. Seed yield and yield components were taken from ten randomly taken plants which were used for recording the morphological parameters. Harvest index was worked out by dividing the seed yield by total dry weight of the plant and expressed in percentage. The data of three seasons were pooled and subjected to the analysis of variance following the method of Panse and Sukhatme (1976).

Observed data were subjected to Analysis of Variance (ANOVA) of RBD design with three replications following Panse and Sukhatme (1967). The mean sum of squares obtained from ANOVA analysis were subjected to estimation of genetic parameters of variation as per Singh & Choudhury (1988). Estimates of variability parameters, heritability and genetic advance were calculated using standard methods of Burton and Devane (1953) and Johnson *et al.* (1955). Phenotypic and genotypic correlation coefficients were calculated using the method adopted by Johnson *et al.* 1955). The mean data set pooled over the years were subjected to Diversity analysis using Euclidian Cluster Analysis following single linkage rule (Sneath and Socal, 1973) and using the software STATISTICA.

RESULTS AND DISCUSSION

Analysis of variance indicated significant mean sum of squares for all the 22 traits under study indicating wide variability in the set of 19 greengram genotypes. Several other workers also reported earlier wide genetic variance for similar traits in greengram (Naidu *et al*., 1993; Sahu and Patra, 1997; Dodwad, 1997, Katiyar *et al*, 2009 and Lavanya and Toms, 2009, Goswami *et al*., 2011). The estimates of genetic parameters of variation are presented in Table 1. Highest Genotypic variance was observed for the attribute number of seeds per plant followed by pods per plant and plant height. Similar pattern was also observed for variance due to phenotype which indicated good agreement between the phenotypic observations with the genotypic values. Mere studying the magnitude of variance does not justify the comparison of variability exhibited by different traits. Estimation of coefficient of variation which takes into account the mean of each characters, gives the real basis for comparison. In this investigation, highest genotypic coefficient of variation was exhibited by seeds per plant followed by pods per plant and reproductive part dry weight. There was good agreement between the genotypic coefficient of variation and phenotypic coefficient of variation indicating less influence of environmental variance. Mere presence of high magnitude of variation does not indicate the effectiveness of selection (Burton, 1952). Here lies the essence of estimation of heritability and genetic advance (Sarma and Richharia, 1995). Heritability in broad sense was highest for Harvest Index followed by fruiting clusters per plant and total dry weight. More than 90% heritability in broad sense was, however, observed for all the traits except primary branches per plant, pod length, nodes per plant and stem dry weight. Genetic advance as per cent of mean was observed highest for seeds per plant followed by pods per plant and reproductive part dry weight. These three traits also exhibited more than 90% heritability in broad sense. High heritability coupled with high genetic advance indicates effectiveness of selection (Johnson *et al.,* 1959, and Gandhi *et al.*, 1964). Based on the above observation it may be predicted that selection for the traits, seeds per plant, pods per plant and reproductive part dry weight would be most effective for further genetic improvement in the set of germplsm under study.

Genetic improvement of any crop chiefly aims at increasing yield of economic part. Seed yield being the ultimate trait of concern which in turn is a complex trait governed by many other attributes of plant, it is important to find out the association of other morpho-physiological traits as well. Correlation coefficient is

Table 1
Genetic parameters of variation for 22 morpho-physiological traits in greengram under rainfed upland condition

Genetic parameters/ Traits	Days to 50% flowering	Days to maturity	Plant Height (cm)	Primary branches per plant	Fruiting clusters per	Pods per fruiting	Pod length (cm)	Pods per plant	Seeds per pod	Sees per plant	100- seed weight (g)	Seed yield (g/plant)	Nodes/ plant	Green trifoliate	Green trifoliate	Root Length (Cm)	Root Nodule dry weight (g)	Leaf dry weight (g)	Stem dry weight (g)	Repro-ductive Part dry weight (g)	Total dry weight (g)	Harvest Index
Range	38.00-48.00	70.00-81.00	47.93-75.82	1.54 - 2.52	2.44-6.33	3.11-5.58	6.76-8.94	8.03-34.46	9.89-12.22	93.78-410.47	2.82-3.67	3.42-14.85	7.00-8.43	7,22-11.66	4.22-7.33	7.79-17.36	0.09-0.19	1.39-2.23	3.81-6.42	3.49-12.49	10.42-21.62	15.85-37.62
Mean	44.05	77.26	57.78	2.11	4.16	4.18	7.79	18.24	11.03	199.15	3.17	8.70	7.74	9.69	5.73	11.84	0.13	2.27	5.21	7.03	14.69	25.02
SEm (+/-)	0.77	0.82	1.22	0.10	0.67	0.09	0.25	1.70	0.08	9.79	0.03	0.79	0.27	0.28	0.14	0.20	0.01	0.10	0.29	0.33	0.346	0.22
Phenotypic variance	11.15	14.31	120.09	0.08	1.51	0.64	0.49	80.79	0.56	10203.82	0.07	14.30	0.35	1.34	0.82	5.13	0.009	0.34	0.86	10.47	14.42	25.29
Genotypic variance	10.26	13.32	61.97	0.06	1.50	0.63	0.40	76.46	0.55	10059.95	0.06	13.37	0.24	1.22	0.79	5.07	0.008	0.32	0.73	10.30	14.25	45.22
PCV	7.59	4.89	19.30	13.72	29.53	19.20	8.95	49.27	6.76	50.72	8.1	43.46	7.67	11.94	15.78	19.12	24.21	25.63	17.48	46.03	25.87	26.90
GCV	7.28	4.72	13.87	12.38	29.47	19.03	8.80	47.93	6.70	50.36	8.0	42.01	6.38	11.42	15.48	19.00	23.19	25.02	16.13	45.66	25.71	26.88
Heritability % (Hbs)	91.95	93.03	96.38	81.47	99.56	98.29	81.46	94.64	98.30	98.59	97.70	93.44	89.26	91.39	96.26	98.8	91.78	95.29	85.14	98.40	98.7	99.84
Genetic advance (GS)	6.33	7.25	15.60	0.49	2.52	1.63	1.17	17.52	1.51	205.16	0.52	7.28	0.84	2.17	1.79	4.61	0.06	1.14	1.63	6.55	7.73	13.84
GS as % of mean	14.38	9.38	27.00	23.02	60.57	38.88	15.02	96.05	13.68	103.01	16.30	83.65	10.95	22.38	31.28	38.92	45.77	50.30	30.67	93.31	52.65	55.33
CV (%)	2.15	1.29	2.59	5.90	1.96	2.50	3.85	11.41	0.88	6.02	1.23	11.12	4.25	3.50	3.05	2.09	6.94	5.56	6.74	5.82	2.87	1.06
CD 5%	1.57	1.66	2.48	0.21	0.13	0.17	0.50	3.45	0.16	19.88	0.06	1.60	0.51	0.56	0.29	0.41	0.01	0.21	0.59	0.68	0.70	0.44

the most efficient statistic to indicate the direct contribution of different attributes on seed yield which gives guideline for undertaking indirect selection and also to select parents for hybridization programme. Simple *inter-se* correlation coefficients (Table 2) were calculated for the 22 traits under study. Seed yield per plant was observed to be significantly and positively correlated with plant height, fruiting cluster per plant, pods per fruiting cluster, pods per plant, Seeds per plant, seed weight, green trifoliate leaves at 45 days, root nodule dry weight, reproductive part dry weight, total dry weight and harvest index. Similarly, several other workers also found a significant positive association of seed yield with these attributes (Borah and Hazarika, 1995, Singh and Malik, 1985, Malik *et al*., 1987; Dodwad, 1997). Significant association of primary branches and seed yield reported by these workers are, however, in contrary with the present investigation. Correlation study in relation to the genetic parameters indicated that selection for seeds per plant , pods per plant and reproductive part dry weight would bring about improvement in seed yield as well. Generation of variability for the other traits showing positive association with seed yield may be suggested for further improvement in seed yield based on them. The correlation matrix indicated the *inter se* positive association of the traits viz., seed yield, fruiting cluster per plant, pods per fruiting cluster, pods per plant, seeds per plant, green trifoliate leaves at 45 days, root nodule dry weight, reproductive part dry weight, total dry weight and harvest index. Higher harvest index coupled with optimum dry matter production per unit area with determinate and compact growth habit constitute an ideal plant type for improving yield (Jain, 1975). Since Harvest Index is approaching a ceiling value, further increase in yield has to come through increase in crop biomass (Sharma- Natu and Ghildiyal, 2005). Therefore, the positive and significant association of harvest index with reproductive part and total dry matter production along with other yield attributing traits is desirable in the present set of germplasm. It is necessary to identify the morpho-physiological parameters, particularly dry matter accumulation and its partitioning which govern the productivity and also to screen those genotypes on the basis of these characters. The urgent need of the hour is to manipulate plant morphology and physiology for crop improvement (Sheehy, 2003).

The variability spectrum generated in the segregating generation depends on the genetic distance between the parents. The wider the genetic distance between the parents, wider is the variability generated in the segregating generation. The 19 genotypes were subjected to genetic diversity analysis following Euclidean cluster analyses based on single linkage rule. Katiyar *et al*. (2009) also used Euclidean cluster analyses for elucidating the genetic divergence among greengram genotypes. The diversity pattern obtained from the analysis is presented in the form of dendogram (Fig. 1). Cluster composition is presented in Table 3. At the intermediate linkage distance, we obtained four diverse clusters out of the 19 genotypes. In the present investigation, the cluster IV was the largest consisting of 14 genotypes followed by cluster II with three and single genotype in cluster I and III. The two varieties viz. Pratap and KM-5-168 remained distinct from the rest of the genotypes falling in cluster I and III, respectively. Based on the coefficient of variation it may be assumed that pods per plant, seed yield, seeds per plant and reproductive part dry weight contributed mostly to the total diversity. Cluster mean values for all the 22 traits are presented in Table 4. The diversity pattern and the *per se* performances of the genotypes indicated that there exist scope for further improving seed yield by accumulating more useful traits into the high yielding background. Thus, the two genotypes Pratap (Cluster I) and KM-5-168 may be crossed with the genotypes viz. SGC 6 and SGC 20 (For earliness), AAU 34 (For seed weight), ML 131 (For pod length), K 851 (For nodes per plant), SP 206 (For root length and stem dry weight), and SP 14 for more green leaves at harvest.

The assessment of genetic parameters of variation, correlation and genetic divergence in the present set of greengram genotypes indicated that here is scope for further genetic improvement for seed yield and physiological efficiency under rainfed situation of Assam. The study indicated that the three traits viz. seeds per plant, pods per plant and reproductive part dry weight having highest genotypic coefficient of variation coupled with high heritability and genetic advance and positive association with seed yield were of most efficient for selection *per se* and to bring about improvement in seed yield well. Besides, a number of other morpho- physiological traits showing positive significant association with seed yield but of lower genetic variance indicated scope for inducing variation for these traits for further effective selection. Based on Euclidian cluster analysis, the genotypes were groups into four diverse clusters. Clustering pattern and the per se performances of the genotypes

Table 2
Correlation coefficients at phenotypic level amongst 22 morpho physiological and yield attributes of green gram

	Days to maturity	Plant Height (cm)	Primary branches per plant	Fruiting clusters per plant	Pods per fruiting cluster	Pod length (cm)	Pods per plant	Seeds per pod	Sees per plant	100- seed weight (g)	Seed yield (g/plant)	Nodes/ plant	Green trifoliate leaves / plant at 45	Green trifoliate leaves / plant at	Root Length (Cm)	Root Nodule dry weight (g)	Leaf dry weight(g)	Stem dry weight (g)	Repro-ductive Part dry weight (g)	Total dry weight (g)	Harvest Index
Days to 50% flowering	0.83**	0.25	-0.15	-0.02	0.26	-0.13	0.07	0.14	0.08	-0.04	0.10	-0.12	-0.03	-0.37	-0.21	0.08	0.03	0.00	0.03	0.16	0.06
Days to maturity		0.06	-0.11	-0.19	0.03	-0.01	-0.11	0.15	-0.10	-0.24	-0.09	-0.22	-0.24	-0.62**	-0.13	-0.12	0.00	0.01	-0.11	-0.02	-0.16
Plant Height (cm)			0.49*	0.26	0.27	0.14	0.28	0.38	0.32	0.32	0.37	0.64**	0.49*	0.23	-0.05	0.45*	0.03	0.39	0.23	0.31	0.35
Primary branches per plant				0.23	0.04	-0.15	0.20	0.35	0.24	0.13	0.25	0.39	0.24	0.08	0.21	0.26	0.13	0.55*	0.13	0.15	0.21
Fruiting clusters per plant					0.87**	-0.08	0.98**	0.25	0.97**	0.39	0.94**	0.26	0.69**	0.42	-0.16	0.83**	-0.05	0.08	0.92**	0.89**	0.94**
Pods per fruiting cluster						-0.13	0.93**	0.11	0.92**	0.44	0.92**	0.13	0.71**	0.32	-0.12	0.84**	-0.07	0.02	0.91**	0.91**	0.92**
Pod length (cm)							-0.10	0.35	-0.06	-0.30	-0.14	-0.07	-0.01	0.01	-0.42	-0.13	0.30	-0.08	-0.16	-0.13	-0.12
Pods per plant								0.21	0.99**	0.44	0.98**	0.20	0.75**	0.41	-0.12	0.88**	-0.07	0.08	0.95**	0.93**	0.97**
Seeds per pod									0.33	-0.14	0.22	0.37	0.13	0.19	-0.34	0.01	0.39	0.04	0.19	0.29	0.10
Sees per plant										0.42	0.98**	0.25	0.72**	0.43	-0.15	0.87**	-0.01	0.10	0.94**	0.93**	0.95**
100- seed weight (g)											0.55**	0.10	0.53**	0.64**	0.37	0.53**	-0.12	0.15	0.56*	0.57*	0.51*
Seed yield (g/plant)												0.23	0.30**	0.47*	-0.04	0.92**	-0.10	0.15	0.96**	0.95**	0.97**
Nodes/ plant													0.11	0.17	0.10	0.23	0.12	0.43	0.16	0.20	0.19
Green trifoliate leaves / plant at 45 days														0.71**	0.01	0.74**	-0.16	0.06	0.77*	0.77**	0.80*
Green trifoliate leaves / plant at harvest															0.09	0.35	0.09	-0.06	0.45*	0.49*	0.45*
Root Length (Cm)																-0.03	-0.02	0.56*	0.01	0.03	-0.14
Root Nodule dry weight (g																	-0.24	0.27	0.86**	0.81**	0.93**
Leaf dry weight(g)																		-0.18	-0.19	-0.02	-0.21
Stem dry weight (g)																			0.12	0.14	0.09
Repro-ductive Part dry weight (g)																				0.97**	0.93**
Total dry weight (g)																					0.88**

*= Significance at P=0.05, **= Significant at P= 0.01

Table 3
Genotyes under four different clusters

Cluster Number	*Number of genotypes*	*Name of genotypes*
I	1	Pratap
II	3	AAU 34, KM-6-130 and SGC-6
III	1	KM-5-168
IV	14	K-851, SP-206, SP-201, SP-10,KM 5-160, ML- 131, SGC-16, SGC-20, KM 6-133, SP-215, SP-14, SGC-2,, SP-16, and KM-6-134

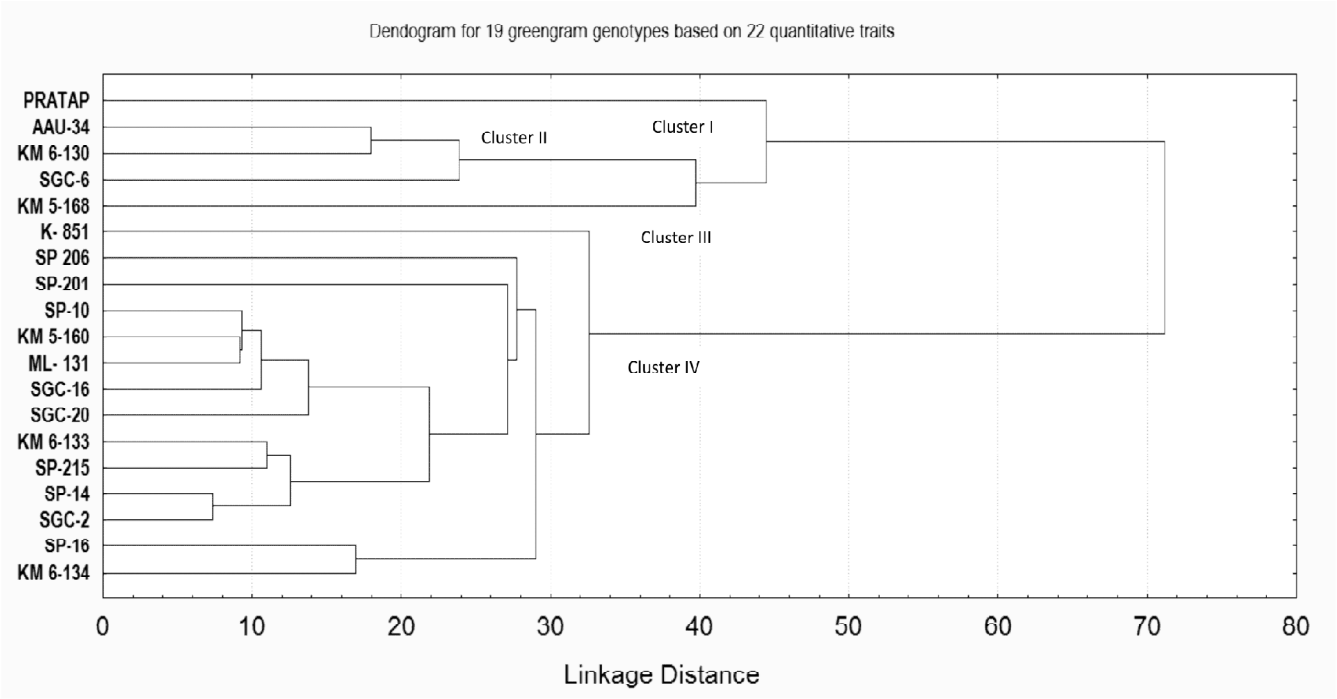

Figure 1: Clustering pattern of 22 greengram genotypes based on Euclidean distance following single linkage rule

indicated that crossing between Pratap (Cluster I) and KM-5-168 with the genotypes viz. SGC 6 and SGC 20 (For earliness), AAU 34 (For seed weight), ML 131 (For pod length), K 851 (For nodes per plant), SP 206 (For root length and stem dry weight), and SP 14 for more green leaves at harvest) would be effective for obtaining desirable segregants for further genetic improvement.

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Table 4
Cluster mean values for 22 morpho physiological and yield traits in green gram

Cluster/ Traits	Days to 50% flowering	Days to maturity	Plant Height (cm)	Primary branchee per plant	Fruiting clusters per plant	Pods per fruiting cluster	Pod length (cm)	Pods per plant	Seeds per pod	Sees per plant	100- seed weight (g)	Seed yield (g/plant)	Nodes/ plant	Green trifoliate leaves /	Green trifoliate leaves /	Root Length (Cm)	Root Nodule dry weight (g)	Leaf dry weight(g)	Stem dry weight (g)	Repro-ductive Part dry	Total dry weight (g)	Harvest Index
I	45.00	78.00	**73.68**	**2.52**	**6.33**	5.45	**8.07**	**34.46**	**12.22**	**410.47**	**3.59**	**14.85**	7.33	**11.33**	**6.73**	**12.73**	**0.19**	**2.89**	6.03	**12.49**	**21.62**	**37.62**
II	41.67	73.33	55.00	2.13	5.78	4.57	7.50	30.01	10.81	320.24	3.28	10.89	7.70	10.78	6.24	11.56	0.16	2.25	4.75	10.85	18.73	33.57
III	**47.00**	**80.00**	60.04	2.43	6.00	**5.58**	6.93	31.89	11.66	368.52	3.23	14.02	**8.00**	11.00	6.22	9.93	0.17	1.50	**6.28**	12.48	20.13	35.94
IV	44.29	77.86	57.08	2.05	3.52	3.91	7.90	13.56	10.95	146.02	3.11	7.42	7.75	9.24	5.51	11.98	0.11	2.28	5.18	5.43	12.95	21.50

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