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Genetic Variability, Correlation and Path Coefficient Studies in Soybean (*Glycine max* (L.) Merr.) Genotypes

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ABSTRACT

The analysis of variance revealed significant variation for all the character except for number of primary branches, pod length and number of seeds per pod. In the present study high PCV and GCV were recorded for seed yield per plant, test weight, number of pods per plant, plant height and days to 80% maturity indicating presence of variation for these traits in the present population. High heritability coupled with high GA as percent of mean was recorded for days to 50% flowering, days to 80% maturity, plant height and test weight. Thus selection for these traits is likely to accumulate more additive genes leading to further improvement of their performance and may also be used as selection criteria in soybean breeding programme. At genotypic level, days to 50% flowering, days to 80% maturity, plant height and pod length were found to be significantly and positively correlated with seed yield per plant indicating relative utility of this trait for selection. The path analysis revealed that direct selection for days to 80% maturity and pod length would likely be effective in increasing seed yield.

1. Introduction

Soybean (*Glycine max (*L.) Merr. 2n=40) is known as the *"Golden Bean"* of the twentieth century. Soybean possesses a very high nutritional value. It contains about 20 per cent oil and 40 per cent high quality protein. In addition, it contains a good amount of minerals, salts and vitamins and its sprouting grains contain a considerable amount of vitamin C. It is grown over 11.40 million hectares area with the production of 11.50 million tons and average productivity of 10.1 q/ha in 2016 (Anonymous 2017). The large amount of variability present in any genetic material indicates the scope for further improvement of the crop. In general, diverse landraces traditionally are considered important for future food security due to their ability to sustain in changing climate (Huang *et al*., 2012; Pusadee *et al*., 2009 and Doebley *et al*., 2006). Therefore, the present study was undertaken to assess the nature and magnitude of genetic variability present in different collections of soybean. An attempt has also been made to study the correlation and path coefficient which are helpful in selecting the desirable traits.

2. Material and Methods

The present investigation was carried out at the experimental farm of Department of Genetics and Plant breeding, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema during *kharif* 2016. The experiment was carried out following randomized complete block design in three replications with twenty genotypes. Soybean seeds were sown on 23rd June, 2016. Two-three seeds per hole were dibbled at 50 cm x 15 cm inter row and inter plant distance. Before sowing the seeds were treated with Bavistin® @ 3g per kg of seed. Hand weeding was done in regular intervals after sowing to avoid growth of unwanted plants. All the recommended agronomic practices were followed for raising a good crop. Data were recorded on five randomly sampled plants from each plot leaving all the border plants. The data were collected on the nine quantitative traits of the crop *viz.,* days to 50% flowering, days to 80% maturity, plant height, number of primary branches, number of pods per plant, pod length, number of seeds per pod, test weight and yield per plant. The mean values were subjected to statistical analysis to work out analysis of variance for all the characters as suggested Panse and Sukhatme (1957). The phenotypic, genotypic and environmental coefficient of variation was calculated according to Burton and De Vane (1953). Heritability and genetic advance were calculated according to Allard (1960) and genetic gain was estimated using the method of Johanson et al. (1955). Phenotypic and genotypic correlation coefficients were worked out to study the interrelationship between various pairs of characters as suggested by Al-Jibouri *et al.* (1958). The path coefficient analysis was carried out by the formula apply by the Dewey and Lu (1959).

3. Results and Discussion

Genetic Variability

The analysis of variance revealed presence of significant variations for all the characters except for number of primary branches, pod length and number of seeds per pod indicating the presence of sufficient amount of genetic variability among the genotypes for seed yield per plant and other yield contributing traits. The estimates of Genotypic coefficient of variation (GCV) and Phenotypic coefficient of variation (PCV) indicated that the values of PCV was higher than the corresponding GCV (Table- 1) for all the characters due partly to interaction of the genotypes with the environment or other environmental factors influencing the expression of these characters. High PCV and GCV were recorded for seed yield per plant, test weight, number of pods per plant, plant height and days to 80% maturity. Moderate PCV were recorded for pod length and number of seeds per pod and GCV were recorded for days to 50% flowering and number of primary branches indicating the prevalence of additive gene action in controlling of these characters. Similar results have been

reported by Aditya *et al*. (2011) for seed yield, Aggrawal *et al*.(2001) for intermediate growth habit and branches per plant, Bangar *et al.* (2003) for number of branches per plant and plant height, Sultana et al. (2005) for 100 seed weight, number of pods per plant, grain yield, branches per plant and plant height and Gupta and Punetha (2007) for number of pods per plant, seed vigour, seed yield per plot, seeds per pod and 100 seeds weight.

Heritability and Genetic Advance

A fair measure of efficiency of selection for any quantitative traits can be derived from the estimates of heritability for the character under consideration because heritability in broad sense is the ratio of genotypic variance to the total phenotypic variance. But reliability of selection depends not only on heritability but it should be also accompanied by genetic advance as well (Johnson *et al*. 1955). High heritability coupled with genetic advance shows that progress can be made through selection. Heritability is usually considered to be low if it is less than 30%, moderate between (30- 60%) and high if it is more than 60% (Johnson *et al*. 1955).High values of heritability in broad sense are helpful in identifying the appropriate character for selection and in enabling the breeder to select superior genotypes on the basis of phenotypic expression of quantitative traits. The maximum heritability (broad sense) was observed for test weight followed by plant height, days to 50% flowering and days to 80% maturity. High heritability estimates indicated that the characters were least influenced by the environmental effects and high capacity of the characters for transmission to subsequent generation. This also suggested that the phenotypes were the true representative of the genotypes for these characters and selection based on phenotypic value could be reliable. Similar results were reported by Banger *et al*. (2003). The estimates of genetic advance expressed as percentage of mean was found maximum for test weight followed by plant height, number of seeds per pod and number of pods per plant. Heritability and genetic advance when considered together would be more reliable and useful in predicting the resultant effects of selection. In the present study, high heritability coupled with high genetic advance as percentage of mean (Table- 1) were observed for days to 50% flowering, days to 80% maturity, plant height and test weight, which may be attributed to the preponderance of additive gene action and possess high selective value and thus, selection pressure could profitably be applied on these characters for their rationale improvement.

Correlation coefficient

Seed yield is a complex character that is outcome of interaction between many plant traits, which are in turn influenced by their genetic makeup and the environment, where crop is grown. Therefore, the direct evaluation and improvement of seed yield itself may be misleading due to involvement of environmental component. Therefore, it is important to analyze the data for relative contribution of various components to yield performance. The simple correlation analysis is an important tool for this purpose. In the present study, correlations between nine characters were studied in all possible combinations both at phenotypic and genotypic level.

In general, the values of genotypic correlation were higher than their corresponding phenotypic correlation in the present investigation for most of the characters (Table- 2). Similar results were reported by Banger *et al*. (2003). At genotypic level, days to 80% maturity, plant height, pod length, number of seeds per pod and number of pods per plant were found to be significantly and positively correlated with seed yield per plant. Thus, these traits were proved to be the outstanding characters influencing seed yield per plant and needs to be given due importance in selection to achieve higher seed yield.

Path coefficient analysis

The path analysis (Table- 3) revealed that days to 80% maturity and pod length contributed positive direct effect on yield. Days to 80% maturity and pod length exerted positive direct effect and also exhibited significant positive correlation with the yield indicating a true relationship between the traits. This suggested that the direct selection for days to 80% maturity and pod length would likely be effective in increasing seed yield. The residual effect of the present study was 0.0518 indicating that the traits under study are sufficient to account for variability. However, inclusion of some characters like leaf area index, spikelet fertility, chlorophyll content could be considered important in order to derive a much clear picture of casual relationship. The present study suggests that while selection, emphasis should be given on days to 80% maturity and pod length per plant for improvement in seed yield.

Table- 1. Genetic parameters of yield and its related traits in soybean

Characters	Mean ± SEm	Range	Variance (σ^2)			Coefficient of variation		Heritability (%)	Genetic advance (GA)	Genetic advance as in % of mean
			$\sigma^2 g$	$\sigma^2 p$	$\sigma^2 e$	GCV%	PCV%			
Days to 50% flowering	71.59± 4.18	54.93-95.13	184.60	237.25	52.65	18.96	21.49	77.80	24.68	34.48
Days to 80% maturity	121.47± 11.20	90-162.66	658.21	1034.54	376.32	21.06	26.41	63.62	42.51	34.70
Plant height	57.15± 7.31	23.73-102.13	611.97	772.28	160.30	42.70	47.97	79.24	45.36	79.37
Number of primary branches	4.447± 1.42	3.06-10.8	0.741	6.80	6.06	19.30	58.51	10.88	0.58	13.15
Number of pods per plant	81.37± 20.13	22.1-163.53	1068.5	2284.67	1216.17	39.88	58.32	46.76	46.04	56.58
Pod length	3.57± 0.31	2.73-4.4	0.08	0.38	0.30	7.99	17.42	21.07	0.27	7.56
Number of seeds per pod	2.38± 0.17	2.06-2.93	0.02	0.10	0.08	6.02	13.81	19.05	1.38	58.30
Test weight	12.76± 0.74	3.46-22.63	30.54	32.22	1.67	43.26	44.43	94.80	11.085	86.82
Yield per plant	58.48± 11.76	19.13-106.64	474.12	889.06	414.94	37.08	50.78	53.32	32.75	56.01

Table- 2. Genotypic (G) and Phenotypic (P) correlation among nine characters in Soybean

Characters	Days to 50% flowering	Days to 80 maturity	Plant height	Number of primary branches	Number of pods per plant	Pod length	Number of seeds per pod	Test weight	Yield per plant
Days to 50% flowering	G P	1.010** 0.913**	0.920** 0.731**	-0.598** -0.235	0.299 0.248	0.685** 0.277	-0.225 -0.052	-0.810** -0.701**	0.522** 0.374*
Days to 80 maturity		G P	0.935** 0.733**	-0.292 -0.367*	0.427* 0.302	0.824** 0.285	-0.317 -0.019	-0.846** -0.674**	0.540** 0.361
Plant height			G P	-0.446* -0.153	0.415* 0.341	0.760** 0.332	-0.301 -0.105	-0.532** -0.456*	0.555** 0.433*
Number of primary branches				G P	-0.341 0.0181	-0.483* -0.085	2.385** 0.158	0.202 0.131	-0.816** -0.125
Number of pods per plant					G P	1.080** 0.396*	-0.045 0.221	-0.231 -0.106	0.229 0.251
Pod length						G P	0.160 0.200	-0.088 -0.049	0.695** 0.190
Number of seeds per pod							G P	0.145 0.107	-0.615** -0.03
Test weight								G P	-0.211 -0.131

*significance at 5%, **significance at 1%

Table- 3. Direct(diagonal) and Indirect effects of yield components at genotypic level in Soybean

Characters	Days to 50% flowering	Days to 80 %maturity	Plant height	Number of primary branches	Number of pods per plant	Pod Length	Number of seeds per pod	Test weight	Genotypic correlation with yield
Days to 50% flowering	-108.6	168.228	-43.023	-7.252	-9.987	14.459	5.282	-18.585	0.522
Days to 80% maturity	-109.79	166.403	-43.706	-3.547	-14.244	17.396	7.445	-19.419	0.540
Plant height	-100	155.659	-46.722	-5.414	-13.866	16.047	7.057	-12.205	0.555
Number of primary branches	65.013	-48.722	20.880	12.115	11.3735	-10.209	-55.919	4.650	-0.816
Number of pods per plant	-32.536	71.095	-19.433	-4.133	-33.338	22.796	1.075	-5.297	0.23
Pod length	-74.398	137.16	-35.524	-5.860	-36.00	21.105	-3.751	-2.028	0.695
Number of seeds per pod	24.472	-52.851	14.066	28.900	1.529	3.377	-23.441	3.33	-0.615
Test weight	88.014	-140.91	24.867	2.457	7.702	-1.866	-3.404	22.931	-0.211

Residual effect: 0.051

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