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GENETIC DIVERGENCE AND CORRELATION STUDIES OF SOYBEAN [*GLYCINE MAX* (L.) MERRILL.] GENOTYPES

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Abstract

A study was carried out in National Agriculture Research Centre, Islamabad during autumn 2004 and 2005 to determine the variability and association among 9 traits in 139 soybean genotypes. The traits viz., days to maturity, plant height at maturity, number of branches per plant, number of pods per plant, 100-seed weight (g), oil content, grain yield per plant (g), biological yield per plant (g) and harvest index were studied. Results of analysis of variance showed significant differences among genotypes in terms of traits under study, which indicate the existence of genetic variation. Correlation coefficient indicated that the grain yield was positively and significantly correlated with all studied traits except plant height, which showed non-significant association during both years. Oil content showed significant and positive correlation with grain yield, 100-seed weight, and harvest index while significantly negative correlation were observed with days to maturity, plant height and number of branches per plant. Significantly positive correlations were observed for: days to maturity and plant height and number of branches per plant; number of branches per plant and number of pods per plant; number of pods per plant and biological yield per plant and harvest index; 100-seed weight and oil content; harvest index and 100-seed weight and biological yield per plant. Results obtained from this study can make better choice for soybean breeders for selecting genotypes among large number of accessions.

Introduction

The soybean [*Glycine max* (L.) Merrill] is a papilionoid legume that has a fairly wide range of adaptation involving a wide array of climatic, soil and growth conditions though it is mostly grown on rain-fed land (Lackey, 1977; Fageria *et al*., 1997). It is now cultivated throughout East and South East Asia for food, animal feed and medicine. It is a miraculous crop due to its extraordinary qualities, it contains about 37-42% of good quality protein, 6% ash, 29% carbohydrate and 17-24% oil comprising 85% poly unsaturated fatty acid with two essential fatty acids (lenoleic and linolenic acid) which are not synthesized by the human body (Antalina, 2000; Balasubramaniyan & Palaniappan, 2003). At present, in Pakistan it is grown on a very small area only in NWFP province. Average yield of soybean is low as compared to other soybean growing countries. On average of 5 years (2001-2005), the yield was 1000 kg ha^{-1} (Anon., 2007-2008).

The genetic diversity is a key component of any agricultural production system. The material from diverse geographical origin of the crop species can help to ensure conservation of co-adapted gene complexes (Brown, 1978; Frankel & Souel, 1981; Frankel, 1984; Frankel *et al.*, 1995). The application of genetic variation can also be manipulated either for selecting superior genotypes or to be utilized as parents for the development of future cultivars through hybridization. Many tools are now available for studying genetic variability among accessions including total seed protein, isozymes and various types of

molecular markers. However, morphological characterization is the first step in the description and classification of the germplasm (Smith & Smith, 1989; Rabbani *et al*., 1998). The scope of plant genetic improvement through the manipulation of available genetic variability is still equally believed by all plant scientists. The importance of genetic diversity in plant breeding is obvious from the results obtained in different crops (Smartt, 1990; Ghafoor *et al*., 2001; Upadhyaya *et al*., 2002; Upadhyaya, 2003).

Grain yield, an extremely complex trait, is the result of the expression and association of several plant growth components. Correlation coefficients, although very useful in quantifying the size and direction of trait associations, can be misleading if the high correlation between two traits is a consequence of the indirect effect of other traits (Dewey & Lu, 1959). High and positive correlations were observed between all the pairs of characters evaluated in the field, indicating the possibility of obtaining indirect gains through the selection of high heritability characters (Oliveira *et al*., 2000). Zeinali *et al*., (2002) reported significant differences among cultivars in terms of traits under study, which indicate the existence of genetic variations. Results showed that protein percentage, 100 seed weight, flowering date, seed filling period and maturity date had significant negative correlation, while number of seeds per pod had significant positive correlation with oil percentage. Bangar *et al*., (2003) evaluated 16 soybean genotypes to determine the correlation among component characters and yield. Correlation coefficients indicated that the seed was positively and significantly correlated with 100 seed weight and followed by days to maturity, plant height and days to 50% flowering. Days to maturity, plant height, pod number per plant and 100 seed weight among themselves were positively significant. Chamundeswari *et al*., (2003) estimated that seed yield showed positive correlation with number of pods per cluster, number of clusters per plant, number of pods per plant and biological yield per plant. The objective of this study was to determine genetic variability from the available germplasm pool and association between yield and yield components.

Materials and Methods

One hundred and thirty nine genotypes of soybean including three approved varieties viz., NARC-I, NARC-II and Ajmeri were evaluated for some morphological traits under field conditions at the National Agricultural Research Center (NARC), Islamabad (33.40 ^{o}N and 73.07 ^{o}E). The meteorological data of the experimental location during soybean growing seasons are shown in Table 1. The experiment was planted on 13 July 2004 and 7 July 2005 in augmented field design (Federer & Ragavarao, 1975); each plot consisted of two rows of 5 meter long, row to row spacing was 45 cm and maintaining 20 plants per meter. Data were recorded for 9 quantitative traits viz., days to maturity, plant height at maturity, number of branches per plant, number of pods per plant, 100-seed weight (g), oil content (%), grain yield per plant (g), biological yield per plant and harvest index. The data for days to maturity were recorded on line basis at 90% pod maturity and each genotype was represented by a single value. Ten plants randomly selected from each plot were used to record data viz., plant height, number of branches per plant, number of pods per plant, 100-seed weight (g) grain yield per plant (g), biological yield per plant (g) and harvest index (%). The oil contents were analyzed through nuclear magnetic resonance (NMR), whole seeds were used after drying at 50^{o}C for more than 3 hours subsequently cooled at room temperature in a desiccator. The NMR used in this study was Newport 4000 Analyzer from Oxford Analytical Instruments Ltd. UK, and study was conducted by following method described previously by Tomi *et al*., (1995). The data recorded were analyzed for analysis of variance and correlation coefficients were computed using "SPSS" for Windows following the methods of Steel & Torrie (1980).

Table 1. Meteorological data of NARC, Islamabad during soybean growing seasons.

	Year 2004			Year 2005		
	Temperature °C		Rainfall	Temperature °C		Rainfall
	Minimum	Maximum	mm	Minimum	Maximum	mm
July	22.76	36.33	162.50	22.45	34.05	193.00
August	21.58	33.62	343.10	23.12	34.24	214.10
September	20.81	34.61	30.50	22.44	34.03	58.60
October	12.65	27.84	80.80	14.80	31.55	54.30
November	6.86	25.63	19.80	7.00	25.52	6.30
Annual	**14.26**	**29.56**	**1037.12**	**13.44**	**28.34**	**949.60**

Table 2. Analysis of variance of 139 soybean genotypes for nine quantitative traits evaluated at NARC, Islamabad during 2004 and 2005.

Source	D.F	DM	PH	BR	PD	HSWT	OC	GY	BY	HI
Genotypes	138	84.6**	554.96**	2.72**	957.40**	11.13**	6.70**	103.67**	453.62**	86.33**
Years	1	19.16	182.51	11.50**	159.60	13.17**	3.27*	144.84**	297.78**	61.69**
Error	138									
Total	**277**									

DM= Days to maturity, PH= Plant height, BR= No of branches per plant, PD= No. of pods per plant, HSWT= 100-Seed weight, OC= Oil content, GY= Grain yield per plant, BY= Biological yield per plant, HI= Harvest index

M.S= Mean square

* = Significant at the 0.05 probability level

** = Significant the 0.01 probability level

Results and Discussion

Analysis of variance: Results from the combined analysis of variance (Table 2) showed that highly significant difference existing among all genotypes in term of all traits measured; thus indicating that there is variability in genotypes studied. This result implied that this population of soybean genotypes would respond positively to selection. The results of present study are in line with those of Zafar *et al*., (2008), Arshad *et al*., (2006) Jyoti & Tyagi (2005), Rajesh *et al*., (2004) and Gawande *et al*., (2002) who observed a wide range of variability for traits under study.

Correlation: Knowledge of the relationship among plant characters is useful while selecting traits for yield improvement. The correlation coefficients among quantitative traits were computed for the years 2004 and 2005 and are presented in Tables 3 and 4, respectively. Results showed that grain yield per plant had significant and positive correlation with all studied traits except plant height per plant which had positive association but non-significant (Tables 3 and 4). The highest positive correlation were observed in number of pods per plant (r = 0.84** and 0.87**) and biological yield per plant (r = 0.92** and 0.95**) followed by harvest index, 100-seed weight, number of branches per plant, days to maturity and oil content during both years. There was significant and positive correlation of oil contents with 100-seed weight (r = 0.51** and 0.57**), grain yield per plant (r = 0.17* and 0.20*) and harvest index (r = 0.45** and 0.52**) while significantly negative association with plant height (r = -0.27** and -0.42**) and number of branches per plant (r = -0.22** and -0.18*) were observed during both years (Tables 3 and 4). Significantly positive correlations were also observed for days to maturity and plant height and number of branches per plant; number of branches

Table 3. Correlation coefficient of 139 soybean accessions among quantitative traits evaluated during 2004.

Traits	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	100-seed weight (g)	Oil content (%)	Grain yield per plant (g)	Biological yield per plant (g)
Plant height (cm)	0.10^{ns}							
No. of branches per plant	0.35**	0.09^{ns}						
No. of filled pods per plant	0.16^{ns}	0.15^{ns}	0.33**					
100-seed weight (g)	-0.02^{ns}	-0.15^{ns}	-0.21*	0.13^{ns}				
Oil content (%)	-0.13^{ns}	-0.27**	-0.22**	0.01^{ns}	0.51**			
Grain yield per plant (g)	0.17*	0.13^{ns}	0.19*	0.84**	0.43**	0.17*		
Biological yield per plant (g)	0.25**	0.26**	0.26**	0.80**	0.28**	0.02^{ns}	0.92**	
Harvest index (%)	-0.09^{ns}	-0.13^{ns}	-0.03^{ns}	0.48**	0.60**	0.45**	0.65**	0.33**

* = Significant at the 0.05 probability level
** = Significant the 0.01 probability level

Table 4. Correlation coefficient of 139 soybean accessions among quantitative traits evaluated during 2005.

Traits	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	100-seed weight (g)	Oil content (%)	Grain yield per plant (g)	Biological yield per plant (g)
Plant height (cm)	0.39**							
No. of branches per plant	0.59**	0.17*						
No. of filled pods per plant	0.43**	0.14^{ns}	0.57**					
100-seed weight (g)	-0.10^{ns}	-0.19*	-0.24**	0.13^{ns}				
Oil content (%)	-0.31**	-0.42**	-0.18*	0.05^{ns}	0.57**			
Grain yield per plant (g)	0.45**	0.13^{ns}	0.47**	0.87**	0.40**	0.20*		
Biological yield per plant (g)	0.58**	0.26**	0.56**	0.87**	0.32**	0.08^{ns}	0.95**	
Harvest index (%)	-0.15^{ns}	-0.25**	0.03^{ns}	0.50**	0.58**	0.52**	0.67**	0.45**

* = Significant at the 0.05 probability level
** = Significant the 0.01 probability level

per plant and number of pods per plant; number of pods per plant and biological yield per plant and harvest index; 100-seed weight and oil content; harvest index and 100-seed weight and biological yield per plant. In general a significant positive correlation was observed between most of the traits. However, negative correlation was also found among certain characters in the present study. The results are in agreement with Faisal *et al*., (2007) who observed significant and positive correlation of grain yield with days to maturity, plant height and number of branches per plant. Arshad *et al*., (2006) also reported significant correlation of grain yield with days to maturity, number of branches per plant and 100-seed weight. Basavaraja *et al*., (2005) determined the positive correlation of seed yield with 100-seed weight and harvest index. Jyoti & Tyagi (2005) revealed significant and positive correlation of seed yield per plant with biological yield per plant and 100-seed weight. Liu *et al*., (2005) also reported positive association of yield with days to maturity. Bangar *et al*., (2003) observed that the seed yield was positively and significantly correlated with 100-seed weight and followed by days to maturity, number of pod per plant and 100-seed weight among themselves were also positively significant. Chamundeswari *et al*., (2003) reported positive correlation of seed yield with number of pods per plant and biological yield per plant. Significant positive correlation of yield with number of pods per plant and 100-seed weight characters has been reported by Khanghah & Sohani, (1999) in soybean.

In conclusion, the study showed the significant differences among genotypes in terms of traits which indicate the existence of genetic variation. The results revealed that days to maturity, number of pods per plant and number of branches per plant correlated significantly with grain yield. Similarly, 100-seed weight, grain yield per plant and harvest index showed significant positive correlation with oil content. These findings suggest that the characters showing positive correlation could effectively be utilized in crop improvement program and develop new soybean varieties.

References

Anonymous. 2007-2008. *Agricultural Statistics of Pakistan.* Ministry of Food, Agriculture and Live stock (Economic Wing), Islamabad. pp.107

Antalina, S. 2000. Modern processing and utilization of legumes. Recent Research and Industrial achievement for soybean food in Japan. *Proceeding of RILET-JIRCAS*. Workshop on Soybean Research. September 28, Malang-Indonesia.

Arashad, M., N. Ali and A. Ghafoor. 2006. Character correlation and path coefficient in soybean *Glycine max* (L.) Merrill. *Pak. J. Bot*., 38(1): 121-130.

Balasubramaniyan, P. and S.P. Palaniappan. 2003. *Principles and practices of agronomy*. Pub. By agrbios (India). pp. 45-46. chapter 1. Field crops. *An overview*.

Bangar, N.D., G.D. Mukhekar, D.B. Lad and D.G. Mukhekar. 2003. Genetic variability, correlation and regression studies in soybean. *J. Mah. Agri. Univ*., 28(3): 320-321.

Basavaraja, G.T., G.K. Naidu and P.M. Salimath. 2005. Evaluation of vegetable soybean genotypes for yield and component traits. *Karnat. J. Agri. Sci*., 18(1): 27-31.

Brown, A.D.H. 1978. Isozymes, plant population genetic structure and genetic conservation. *Theor. Appl. Genet*., 52: 145-147.

Chamundeswari, N. and R.P. Aher. 2003. Character association and component analysis in soybean [*Glycine max* (L.) Merrill]. *Ann. Biol*., 19(2): 199-203.

Dewey, D.R. and K.H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheatgrass seed production. *Agron. J.*, 51: 515-518.

Fageria, N.K., V.C. Baligar and C.A. Jones. 1997. *Growth and mineral nutrition of field crops*. 2nd Ed. Marcel Dekker, Inc., New York.

Faisal, M.A.M., M. Ashraf, A. Qureshi and A. Ghafoor. 2007. Assessment of genetic variability, correlation and path analysis for yield and its components in soybean. *Pak. J. Bot*., 39(2): 405-413.

Federer, W.T. and D. Ragavarao. 1975. *On augmented designs*. *Biometrics*, 31: 29-35.

Frankel, O.H. 1984. Genetic perspectives of germplasm conservation, In: *Genetic manipulation: impact on man and society*. (Eds.): W. Arber, K. Limensee, W.J. Peacock and P. Starlinger. p. 161-170. Cambridge Univ. Press, Cambridge.

Frankel, O.H. and M.E. Souel. 1981. *Conservation and evolution*. Cambridge Univ. Press, New York. pp 13-21.

Frankel, O.H., A.D.H. Brown and J.J. Burdon. 1995. *The conservation of plant biodiversity*. Cambridge Uni. Press, Cambridge. UK. pp. 299.

Gawande, P., S. Patil, M. Kumari and V.J. Bailkwad. 2002. Selection of superior germplasm lines of soybean (*Gycine max* (L.) Merrill) for breeding. *J. Soils and Crops*, 12(2): 236-240.

Ghafoor, A., A. Sharif, Z. Ahmad, M.A. Zahid and M.A. Rabbani. 2001. Genetic diversity in blackgram (*Vigna mungo* L. Hepper). *Field Crops Res*., 69: 183-190.

Jyoti, S. and S.D. Tyagi. 2005. Direct and indirect contribution of different traits towards maximization of grain. *Adv. Plant Sci*., 18(1): 331-335.

Khanghah, H.Z. and A.R. Sohani. 1999. Genetic evaluation by multivariate analysis methods of some important agronomic traits of soybeans related to seed yield. *Iran. J. Agri. Sci*., 30(4): 807-816.

Lackey, J.A. 1977. *A synopsis of Phaseoleae* (*Leguminosae, Papilionoideae*). Ph.D. dissertation. Iowa State University. Ames, Iowa.

Liu, X.B., J. Jian, S.J. Herbert, S.J. Zhang, O. Ying and W. GuangHua. 2005. Yield components, dry matter, LAI and LAD of soybeans in Northeast China. *Field Crops Res*., 93(1): 85-93.

Oliveira, A.C.B., J.M.S. Viana, C.D. Cruz and C.S. Sediyama. 2000. Heritability and correlation in F2 soybean plants cultivated under different environmental conditions. *Acta Scientiarum*, 22(4): 889-893.

Rabbani, M.A., A. Iwabuchi, Y. Murakami, T. Suzuki and K. Takayanagi. 1998. Phenotypic variation and the relationship among mustard (*Brassica juncea* L.) germplasm from Pakistan. *Euphytica*, 101: 357-366.

Rajesh, S., J.S. Hooda, R.D. Vashishtha and B.P.S. Malik. 2004. Genetic divergence in soybean [*Glycine max* (L.) Merrill]. *Ann. Biol*., 20(1): 17-21.

Smartt, J. 1990. Evolution of genetic resources. In: *Grain legumes*, (Ed.): J. Smartt. pp. 140-175. Cambridge University Press, Cambridge.

Smith, J.S.C. and O.S. Smith. 1989. The description and assessment of distances between inbred lines of maize: The utility of morphological, biochemical and genetic descriptors and a scheme for the testing of distinctiveness between inbred lines. *Maydica*, 34: 151-161.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles and Procedures of Statistics*.2nd Edition, McGraw Hill Book Co., Inc., New York, USA. pp. 633.

Tomi, F., P. Bradesi, A. Bighelli and J. Casanova. 1995. Computer aided identification of individual components of essentials oils using carbon-13 NMR spectroscopy. *J. Magnetic Res. Anal.*, 1: 25-34.

Upadhyaya, H.D. 2003. Phenotypic diversity in groundnut (*Arachis hypogaea* L.) core collection assessed by morphological and agronomical evaluations. *Genet. Res. Crop Evol*., 50: 539-550.

Upadhyaya, H.D., R. Ortiz, P.J. Bramel and S. Singh. 2002. Phenotypic diversity for morphological and agronomic characteristics in chickpea core collection. *Euphytica*, 123(3): 333-342.

Zafar, I., M. Arshad, M. Ashraf, T. Mahmood and A. Waheed. 2008. Evaluation of soybean [*Glycine max* (L.) Merill] germplasm for some important morphological traits using multivariate analyses. *Pak. J. Bot*., 40(6): 2323-2328.

Zeinali, H., E. Hezarjaribi and M.R. Ahmadi. 2002. Evaluation of genetic correlation of seed oil with some important agronomic traits in soybean through path analysis. *Iran. J. Agri. Sci*., 33(4): 699-705.

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