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RESEARCH ARTICLE

Studies on heritability and character relationship in soybean (*Glycine max* L. Merrill) genotypes grown in two contrasting environments

I.T. Lawal[1], C.O. Alake[2], J.B. Porbeni[2], P.M.Olorunmaiye[2], O.A. Oyetunde[3], D.J. Ogunniyan[4]

1 Department of Crop and Animal Science, Ajayi Crowther University, Oyo 200001 Oyo State, Nigeria

2 Department of Plant Breeding and Seed Technology, Federal University of Agriculture, Abeokuta, 110001 Ogun State, Nigeria

3 Department of Horticulture and Landscape Management, Lagos State University of Science and Technology, Ikorodu, 100001 Lagos State, Nigeria

4 Institute of Agricultural Research and Training, Ibadan, 200001Oyo State, Nigeria

Corresponding authors email: it.lawal@acu.edu.ng

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Abstract

Twenty soybean (*Glycine max* (L.) Merrill) genotypes were grown using randomized complete block design at two distinct agro climatic environments (rainforest and Sudan savannah, Nigeria) to determine the inter-character association with seed yield and their direct and indirect contribution to total seed yield in soybean genotypes. Heritability, correlation and path coefficient analyses were carried out. The phenotypic coefficient of variability (PCV) was observed to be higher than the genotypic coefficient of variability (GCV) for the twelve traits. Seed yield had a significant and positive phenotypic and genotypic correlation with 100 seed weight, number of seed per plant, number of seeds per pod and number of pods per plant. Number of seeds per pod had the largest positive direct effect to seed yield while number of seeds per plant had a negative direct effect on seed yield in spite of its significant positive genotypic correlation with yield. This study states that selection based on inter character relationship alone is not sufficient, hence, simultaneous selection of traits for soybean improvement programme is recommended.

Keywords: Soybean, yield, character association, path analysis, selection

Introduction

Soybean (*Glycine max* (L.) Merrill) is a self-pollinated plant, propagated by seed. It is aptly called "Golden Bean" or "Miracle Crop" of the 20th century and is one of the most important oil crops in the world. The crop is believed to have originated in North Eastern China from which it was distributed to other parts of the world (Adoloju *et al.*, 2009). The success in breeding program of any crop species depends greatly on variation that exists within the crop. The higher the genetic variability, the greater the chances of success to be achieved through selection process. Genetic parameters such as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance are useful biometrical tools for determining genetic variability. Grain yield is a complex character, quantitative in nature and is influenced by a number of yield contributing characters controlled by polygenes and also highly influenced by environment (Aravind *et al.*, 2006; Baria *et al.*, 22).

Consequently, other yield contributing characters should be considered when selection for yield. Correlation studies enable a breeder to know the strength of relationship between various characters as well as the magnitude and direction of changes expected during selection. Correlation and path-coefficient analyses would assist in the choice of characters whose selection would direct or indirectly result in the improvement of a complex character such as yield. A knowledge of the genetic basis of important traits in soybean, and their interactions with diverse environments is crucial to developing appropriate breeding strategies and agronomic practices for soybean improvement and cultivation. This study determined the characters that contribute directly or indirectly to total seed yield in soybean genotypes.

Materials and methods

Twenty soybean genotypes were grown during the raining season of 2018 in two diverse weather conditions at Lagos State Polytechnic, Ikorodu, Lagos State (Lat. 6°37′N and Long. 3°30′E), a rainforest agro-ecology zone and Institute of Agricultural Research and Training, Ibadan, Oyo State (Lat. 7°23′N and Long. 3°27′E), a Sudan savannah agro-ecology zone. In both locations, fields were ploughed twice and harrowed to a fine tilth, genotypes were laid out in randomized complete block design (RCBD) with three replicates. Cultural practices such as weeding, spraying insecticide (40ml of Cypermethrin in 15 liters of water) and harvesting were done manually as the need arose. The weather parameters during the period of evaluation were sourced from the meteorological stations of the respective institutions and used for further analysis and interpretation of results. Data collected on the following agronomic characters: number of days to 50% emergence; number of days to 50% flowering; plant height at flowering (cm); number of days to 50% maturity; number of days to 50% pod formation; pod length (cm); number of pods per plant; number of seeds per pod, number of seeds per plant, pod width (cm), 100 seed weight (g) and yield per plant (g) were subjected to broad sense heritability, phenotypic and genotypic correlation and path co-efficient analyses.

Results and discussion

Phenotypic and genotypic variances, phenotypic and genotypic coefficients of variability and broad sense heritability estimates for the characters evaluated in twenty soybean genotypes are presented on Table 1. Generally, the phenotypic variances (PV) were higher than the genotypic variance (GV). However, wide variations were observed between PV and GV for plant height at 50% flowering (9.1), number of days to 50% maturity (0.9), number of pods per plant (79.9), number of seeds per plant (676.3), 100 seed weight (0.8) and yield per plant (11.4). The phenotypic coefficients of variability (PCV) were observed to be higher than the genotypic coefficients of variability (GCV) for all traits evaluated. Variation was observed between PCV and GCV for number of days to 50% emergence (0.31), number of days to 50% flowering (0.23), plant height at 50% flowering (4.9), number of days to 50% pod formation (0.2), number of days to 50% maturity (0.2), pod length (0.6), pod width (1.1), number of pods per plant (4.3), number of seeds per pod (2.0), number of seeds per plant (5.6), 100 seed weight (3.7) and yield per plant (4.2). The close correspondence between the PCV and GCV values suggested limited influence of environmental factors in observed phenotype, and that the observed phenotype indicates a genetic value (Reni and Rao, 2013; Malek *et al.*, 2014; Ekka and Lal, 2016).

Table 1: Phenotypic and genotypic variations and heritability of agronomic characters of soybean genotypes

	Means	PV	GV	EV	PCV	GCV	Heritability (B)
Days to emergence	6.3	1.2	1.2	0.0	17.8	17.5	96.5
Days to flowering	51.4	2.4	2.1	0.3	3.0	2.8	85.4
Plant height	54.1	9.3	0.1	9.1	5.6	0.7	1.6
Days to podding	57.9	2.6	2.2	0.3	2.8	2.5	85.0
Days to maturity	98.8	4.4	3.4	0.9	2.1	1.8	78.3
Pod length	3.7	0.0	0.0	0.0	5.3	4.7	78.2
Pod width	4.8	0.0	0.0	0.0	4.3	3.1	53.1
Number of pods	76	188.7	108.8	79.9	18.0	13.7	57.6
Number of seeds/pod	2.3	0.0	0.00	0.0	4.3	2.3	28.9
Number of seeds/plant	184.8	1339.9	683.5	656.3	19.8	14.1	51.0
100-Seed weight	13.9	1.2	0.3	0.8	8.0	4.2	28.3
Seed yield	26.6	31.8	20.4	11.4	21.2	16.9	64.2

All the measured characters exhibited high broad-sense heritability ranging from 51.0 to 96.548 except plant height at 50% flowering, number of seeds per pod and 100 seed weight which had the low heritability values of 1.6, 28.9 and 28.3, respectively. Johnson et al. (1995) reported that heritability estimates shows the effectiveness with which selection of genotypes could be based on phenotype. The combined use of genetic coefficient of variation and heritability is vital information for effective improvement of a particular trait in a population. The phenotypic and genotypic correlation coefficients paired characters evaluated are presented in Table 2. The result showed that number of seeds per pod had significant ($p<0.01$) and positive genotypic correlation with pod width, pod length, days to maturity, days to 50% pod formation and days to flowering but negatively correlated with plant height. Also, seed yield recorded significant and positive phenotypic and genotypic correlation with 100 seed weight, number of seed per plant, number of seeds per pod and number of pods per plant, indicating that seed yield could be improved by selecting for these characters. Mahbub *et al.*, (2015) said that number of pods per plant, 100-seed weight significantly had a positive genotypic and phenotypic correlation with seed yield. However, Seed yield had negatively genotypic correlation with plant height, suggesting that high yielding varieties were not tall. The positive and significant phenotypic correlation of seed yield per plant and number of pods per plant as well as number of seeds per plant implies that both traits (number of pods per plant and number of seeds per plant) could be used as selection criteria in selecting for seed yield in soybean genotypes. The direct and indirect effects of twelve agronomic characters on seed yield of 20 soybean genotypes are presented in Table 3. The path-coefficient analysis showed that days to emergence, days to maturity, number of pods per plant, number of seeds per pod and 100-seeds weight had positive and direct effect in soybean seed yield. However, number of seeds per plant had a negative direct effect on seed yield in spite of its significant positive genotypic correlation with seed yield. These highlight the inadequacy of selecting only on the basis of inter character correlation alone. The results also revealed that the effect of plants height on seed yield was largely masked by the indirect effect of number of days to 50% pod formation, days to 50% maturity, number of pods per plants and number of seeds per pod.

Table 2: Combined phenotypic and genotypic correlations coefficients of twelve agronomic characters of soybean genotypes

		Days to flowering	Plant height	Days to podding	Days to maturity	Pod length	Pod width	Number of pods/ plant	Number of seeds/ pod	Number of seeds/ plant	100-Seed weight	Seed yield
Days to emergence	r_p	0.6**	-0.2*	0.6**	0.8**	0.0	-0.0	0.0	-0.0	0.0	-0.1	0.1
	r_g	0.6**	-1.0	0.6**	0.9**	0.1	-0.1	0.1	0.0	0.1	-0.4**	0.2*
Days to flowering	r_p		0.0	0.9**	0.7**	-0.1	-0.1	0.1	0.0	0.2*	-0.1	0.1
	r_g		-0.4	0.9**	0.7**	-0.2*	-0.2**	0.1	0.2**	0.3**	-0.4**	0.1
Plant height	r_p			0.0	-0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.0
	r_g			-0.2**	-1.0**	-1.0**	-1.0**	-1.0**	-1.0**	-1.0**	0.2*	-1.0**
Days to podding	r_p				0.7**	-0.1	-0.1	0.1	0.0	0.2*	-0.2*	0.0
	r_g				0.7**	-0.2*	-0.3**	0.1	0.2**	0.3**	-0.5**	0.1
Days to maturity	r_p					0.0	-0.2*	0.0	0.1	0.1	-0.3**	0.1
	r_g					-0.0	-0.3**	0.1	0.2**	0.2*	-0.9**	0.2*
Pod length	r_p						0.6**	-0.4**	0.4**	-0.3**	0.1	-0.0
	r_g						0.8**	-0.7*	0.5**	-0.6**	0.3**	-0.2*
Pod width	r_p							-0.3**	0.2**	-0.1	0.2**	0.0
	r_g							-0.6**	0.6**	-0.3**	0.6**	-0.1
Number of pods	r_p								0.0	0.8**	-0.3**	0.4**
	r_g								-0.0	0.8**	-0.7**	0.3**
Number of seeds/pod	r_p									0.3**	0.0	0.2*
	r_g									0.4**	0.1	0.5**
Number of seeds/plant	r_p										-0.3**	0.5**
	r_g										-0.7**	0.5**
100-Seed weight	r_p											0.3**
	r_g											0.4**

*, ** = Significant at 5 and 1% levels, respectively; G and P = Phenotypic and genotypic correlation coefficients, respectively

Table 3: Direct and indirect effects of some characters on seed yield in soybean genotypes

	Direct effect	Days to emergence	Days to flowering	Plant height	Days to podding	Days to maturity	Pod length	Pod weight	Number of pods/ plant	Seeds/ pod	Seeds/ plant	100-Seed weight	Corr with yield
Days to emergence	0.1		-1.4	-0.1	0.5	1.9	-0.2	0.0	0.4	0.0	-0.4	-0.8	0.2*
Days to flowering	-2.2	0.1		-0.0	0.8	1.5	0.5	0.1	0.6	1.0	-1.4	-0.9	0.1
Plant height	0.0	-0.1	0.9		-0.2	-2.1	2.5	0.4	-3.1	-3.5	3.8	0.4	-1.0**
Days to podding	0.8	0.1	-2.2	-0.0		1.5	0.5	0.1	0.6	1.0	-1.4	-1.0	0.1
Days to maturity	2.1	0.1	-1.6	-0.0	0.6		0.0	0.1	0.6	0.9	-0.8	-1.9	0.2*
Pod length	-2.5	0.0	0.4	-0.0	-0.1	-0.0		-0.3	-2.4	1.8	2.3	0.7	-0.2*
Pod width	-0.4	-0.0	0.6	-0.0	-0.2	-0.8	-2.1		-2.0	2.4	1.2	1.3	-0.1
Number of pods	3.1	0.0	-0.4	-0.1	0.1	0.4	1.9	0.2		-0.1	-3.3	-1.5	0.3**
Number of seeds/pod	3.5	0.0	-0.6	-0.0	0.2	0.5	-1.3	-0.3	-0.1		-1.7	0.3	0.5**
Number of seeds/plant	-3.8	0.0	-0.8	-0.0	0.3	0.4	1.	0.1	2.7	1.6		-1.4	0.5**
100-Seed weight	2.0	-0.0	1.0	0.0	-0.4	-2.	-0.9	-0.3	-2.	0.7	2.8		0.4**

*, ** = Significant at 5 and 1% levels, respectively

With the observation of direct and indirect effect of different characters with respect to seed yield, it is important to consider more than one trait when selecting for seed yield in soybean improvement programme, as it has been reported earlier that yield is a complex character (Ariyo, 1995; Alake and Ayo-vaughan, 2017), hence the need for simultaneous selection of soybean traits.

Conclusively, it is being recommended that high heritability and genetic advance envisages a promising and high success in breeding for improvement on some of the qualitative traits. More so, selection based on inter character relationship alone is not sufficient, hence, simultaneous selection of traits for soybean improvement programme is recommend.

References

1) Adoloju, M. O., Mahamood, J. and Abayomi, Y. A. 2009. Genetic variability for seedling vigour traits and their association with seed yield and protein content in soybean (*Glycine max* (L.) Merrill). Afri. J. Agric. Res. 4: 556-563.

2) Alake, C.O. C and Ayo-Vaughan, M.A. 2017. Genotypic variation and correlations between yield system traits and yield components in African landraces of bambara groundnut, South African Journal of Plant and Soil, 34(2):125-137, DOI:10.1080/02571862.2016.1204017

3) Aravind G. and Hanchinal, R.R. 2006. Genetic Variability and Diversity Studies in Soybean [*Glycine max* (L.) Merrill], M.Sc. Thesis, University of Agricultural Sciences, Dharwad.
4) Ariyo, O.J. 1995. Correlations and path-coefficient analysis of components seed yield in soybean. African Crop Sci. J.. 3(1):29-33.
5) Baria, A.R., Akabari, V.R. and Gohil, V.N. 2022.Variability studies for seed for seed yield and its components in soybean. J. Genet., Genom. Plant Breed., 6(2): 54-59.
6) Ekka NP, Lal GM. 2016. Study on genetic variability and character association in soybean [Glycine max (L.) Merrill] germplasm at vindhyan zone of Uttar Pradesh. Agric. Sci. Digest. 36 (1): 69-71.
7) Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1995. Estimates of genetic and environment variability in soybean. Agron. J. pp194-195.
8) Mahbub MM. Rahman MM, Hossain MS, Mahmud F, Kabir MMM. 2015. Genetic variability, correlation and path analysis for yield and yield components in soybean. American-Eurasian J. Agril. Env. Sci. 15(2):231-236.
9) Malek M.A., Rafii, M.Y., Afroz, M.S.S., Nath, U.K., Mondal, M.M.A. 2014. Morphological characterization and assessment of genetic variability, character association, and divergence in soybean mutants. The Scientific World J. https://dx.doi.org/ 10.1155/2014/968796
10) Reni, Y.P.,and Rao, Y.K..2013. Genetic variability in soybean [*Glycine max* (L) Merrill]. In. J. Plant, Animal Environmen. Sci., 3(4): 35- 38.