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Original Research Article

Genetic Variability, Heritability and Genetic Advance of Newly Developed Soybean (Glycine Max) Genotypes Based on Yield and Yield-Related Traits

Sheidu A.*, Ismail S, Jibrin I. M

Department of Agronomy, Faculty of Agriculture, Nasarawa State University Keffi, Nigeria

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Abstract: This study aimed to estimate important genetic parameters such as genotypic coefficient of variance (GCV), phenotypic coefficient of variance (PCV), heritability (h2) and expected genetic advance (EGA) for newly developed soybean (Glycine max) genotypes based on yield and yield-related traits. Fifteen genotypes collected from the University of Agriculture Makurdi were studied. The results showed that there was sufficient variability in the material for all the studied traits, with high heritability estimates coupled with high expected genetic advance observed for number of leaves (4, 6 and 8) weeks, plant height (4, 6 and 8) weeks, leave length (6 and 8) weeks and yield per plant.

Keywords: Genetic Parameters, Soybean Genotypes, Yield, Heritability, Variability.

INTRODUCTION

Soybean (Glycine max) is a highly valuable crop due to its nutritional composition, containing around 37-42% of good quality protein, 6% ash, 29% carbohydrate, and 17-24% oil with two essential fatty acids (Aditya *et al.*, 2011). It is an autogamous plant with a diploidized allotetraploid (2n = 40) genome. Soybean is widely grown globally for human and animal consumption and industrial purposes. In 2018, worldwide soybean production was recorded at 348,712,311 tonnes, with the United States, Brazil, and Argentina being the highest producers. Africa's production was recorded at 3,556,163 tonnes in 2018 (FAO, 2020).

Morphological characterization of germplasm can help assess the extent of genetic diversity. The characterized material can then assist plant breeders in selecting accessions for use in hybridization programs (Ghafoor *et al.*, 2002). Quantitative traits, such as yield and yield parameters, are observable and useful in determining yield performance of various genotypes, with their performance being dependent on the environment and agro-ecology. Determining the genetic parameters of genotypes is crucial for parental selection and farmer recommendations. Hence, proper study of genetic variability due to genetic and non-genetic causes and other genetic parameters is necessary for the effective selection of superior genotypes for use in hybridization programs and the development of superior varieties. Genetic parameters such as the genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, and genetic advance (GA) are useful biometric tools for measuring genetic variability (Aditya *et al.*, 2011). Thus, characterizing the genetic background of soybean and determining breeding values should be done before carrying out any improvement program. The objective of this study was to assess genetic variability, heritability, and yield and yield-related traits among newly developed soybean genotypes.

MATERIALS AND METHODS

The study utilized 15 newly developed genotypes of soybean (Glycine max (L.) Merrill) from University of Agriculture Makurdi. The experiment was conducted at the teaching and research farm of the faculty of agriculture Shabu-Lafia campus during the 2021-2022 period using a randomized block design with three replications. Each entry was planted in two rows, 5m in length, with a row-to-row distance of 45cm and plant to plant distance of 5cm. The recommended fertilizer dose of 30:60:30:30 NPKS (kg/ha.) was applied during sowing. Two hand weeding were done at the interval of 20 and 45 days after sowing, and two sprayings of insecticides were conducted to control leaf

***Corresponding Author:** Sheidu Abdullaziz
Department of Agronomy, Faculty of Agriculture, Nasarawa State University Keffi, Nigeria

miner and leaf rolling caterpillar. Observations were recorded on 18 yield and yield contributing and morphological characters including the number of leaves, number of branches, plant height, leaf length and weight, yield per plant, days to first flowering and days to 50% flowering. All recommended agronomic practices were followed, and the analysis of variance for the randomized block design was conducted using the method provided by Panse and Sukhatme (1955). Data was collected and analyzed for genotypic and phenotypic coefficients of variation, broad-sense heritability, and expected genetic advance as a percentage of the mean. The genotypic and phenotypic coefficient of variation (GCV and PCV) was calculated following Burton's (1952) method, while broad-sense heritability was estimated using Allard's (1960) method. The genetic advance (at 10% selection intensity) for each character was calculated using the formula suggested by Johnson et al. (1955).

RESULTS AND DISCUSSIONS

The study analyzed the variance of various traits of soybean plants. The results showed significant differences in most of the studied traits, except for the number of branches and leaf weight at 8 weeks (Table 1). The study also compared the performance of different soybean varieties in terms of the traits studied. The means performance across the varieties showed that some varieties performed better than others in terms of certain traits. TGX2022-1E had the highest mean performance for the number of leaves at 4 weeks, while TGX1835-10C had the highest mean performance for the number of branches at 6 and 8 weeks. TGX1981-62F had the highest mean performance for plant height at 4, 6, and 8 weeks, and TGX2022-2E had the highest mean performance for leaf length at 6 weeks. TGX2024-7E had the highest mean performance for grain yield (Table 2).

Table 1: ANOVA for the Studied Traits of Soybean

SOV	Df	NL-4	NL-6	NL-8	NB-4	NB-6	NB-8	PH-4	PH-6	PH-8	LL-4	LL-6	LL-8	LW-4	LW-6	LW-8	CROP-Y	DFF	D50%F
Rep	2	40.84**	93.77**	147.33	0.73	41.24	108.57	24.84	52.2	150.64	23.54	41.83	75.13	6.27	24.23	52.12	6180.4	32.29	59.62
Variety	14	13.86**	28.34**	32.54**	5.46	2.81**	3.34**	24.81**	53.24**	68.04**	11.45	5.69**	5.27**	5.61	2.49**	3.13**	3940.3**	18.64	21.26*
Error	28	1.52	4.45	3.48	3.69	1.52	1.01	5.13	3.83	1.94	10.77	0.83	0.26	4.65	0.79	1.02	658	18.81	7.88

Table 2: Means performance for the studied traits of soybean

Variety	NL-4	NL-6	NL-8	NB-4	NB-6	NB-8	PH-4	PH-6	PH-8	LL-4	LL-6	LL-8	LW-4	LW-6	LW-8	CROP-Y	DFF	D50%F
TG×2022-1E	14.13cdef	22.27bcd	28.03bcde	8.63a	7.63ab	10.47bcde	15.07bc	20.17bc	21.83c	5.53b	7.40bcd	8.20cd	3.93b	5.37abcd	5.50bcd	238.20ab	39.33b	44.00d
TG×2020-4E	14.67cde	16.83f	22.67fg	4.20b	6.00b	10.80bcde	13.03cde	14.00defg	16.97ef	7.57ab	6.17def	9.73b	3.70b	4.43cde	6.90abc	238.53ab	40.00ab	45.00cd
TG×2024-3E	18.03ab	23.80abc	28.50abcd	6.57ab	7.77ab	11.43abcd	16.10bc	21.43ab	24.53b	7.23ab	9.03ab	10.70a	4.83b	6.20ab	6.67abcd	240.03ab	43.00ab	47.33bcd
TG×1981-62F	17.63ab	23.80abc	28.53abcd	6.53ab	7.20ab	10.80bcde	20.37a	23.90a	27.03a	5.13b	5.77def	7.77cde	4.03b	5.67abc	6.30abcd	232.17ab	42.00ab	46.67cd

TG×2024-7E	18.27ab	23.37abc	29.57abc	5.07ab	6.90b	11.30abcde	12.23cde	14.40defg	17.23ef	5.83b	7.03cde	8.63c	4.00b	4.60bcde	4.93d	279.40a	43.00ab	47.67abcd
TG×2019-2E	13.97def	18.20ef	23.03fg	3.70b	6.37b	9.90cde	12.37cde	14.23defg	16.03ef	5.13b	5.33ef	6.97ef	3.60b	3.60e	4.93d	217.17bc	43.67ab	50.00abc
TG×2025-15E	17.90ab	21.70cde	27.57cde	5.50ab	7.10ab	11.10abcde	15.07bc	15.80def	18.17de	5.93b	6.43cdef	9.53b	4.33b	5.63abc	8.20a	166.83de	41.67ab	52.67ab
TG×2018-1E	16.23bcd	21.33cde	27.67cde	4.70b	6.60b	9.63de	9.70e	9.23h	10.97h	5.40b	6.43cdef	7.03ef	3.67b	4.67bcde	5.23cd	145.47e	48.00a	53.00a
TG×2018-2E	15.07cd	20.13cdef	25.73def	4.83b	6.97b	9.33e	14.33bcd	14.57defg	16.40ef	6.60ab	6.97cde	6.00g	8.97a	6.47a	5.10cd	231.57ab	46.67ab	49.67abc
TG×2025-7E	12.30f	18.63def	24.77ef	3.70b	6.30b	9.40e	10.17de	12.40fgh	12.97gh	4.27b	5.90def	6.57fg	3.33b	4.30cde	4.80d	173.60cde	45.33ab	49.33abcd
TG×2018-3E	12.57ef	17.83ef	20.27g	4.17b	6.33b	12.83a	11.73cde	11.43gh	12.33h	12.47a	6.37def	7.33def	3.77b	4.30cde	5.60bcd	177.83cde	45.33ab	48.67abcd
TG×2022-2E	18.63a	27.30a	31.33ab	5.93ab	7.97ab	11.67abc	14.17bcd	16.60de	19.97cd	7.50ab	9.57a	9.53b	4.73b	5.93abc	6.93abc	222.20bc	45.00ab	47.67abcd
TG×1835-10C	17.57ab	25.83ab	31.93a	5.97ab	9.43a	12.33ab	18.17ab	22.20ab	24.23b	6.87ab	8.77ab	7.67de	4.10b	6.17ab	7.27ab	201.23bcd	43.67ab	46.00cd
SCSL-01	16.40abc	23.47abc	30.00abc	4.80b	7.97ab	10.93abcde	12.60cde	13.23efg	15.17fg	6.00b	8.10abc	8.60c	4.07b	5.20abcde	6.30abcd	195.53bcd	43.67ab	49.00abcd
TG×1987-10F	13.93def	19.23def	27.80bcde	3.90b	5.63b	9.70de	16.03bc	17.17cd	21.87c	4.70b	4.97f	7.43def	3.27b	3.83de	6.67abcd	174.70cde	40.00ab	44.67cd
MSerror	1.52	4.45	3.48	3.69	1.51	1.01	5.13	3.83	1.94	10.77	0.83	0.26	4.65	0.79	1.02	658.05	18.81	7.88
Mean	15.82	21.58	27.16	5.21	7.08	10.78	14.08	16.05	18.38	6.41	6.95	8.11	4.29	5.09	6.09	208.96	43.36	48.09
CV	7.79	9.77	6.87	36.82	17.37	9.33	16.1	12.19	7.58	51.19	13.08	6.27	50.27	17.41	16.55	12.28	10	5.84

Means with the same alphabet are not significantly different

The study also reported the environmental and genotypic variances, phenotypic variances, environmental and genotypic coefficient of variation, heritability, and genetic advance of the studied traits (Table 3). The results suggested that some traits, such as plant height and number of leaves, were less influenced by the environment. However, some traits, such as number of branches, leaf length, leaf weight, and crop yield, showed wide variations due to the environment. The study concluded that some traits, such as plant height, number of branches, and seed yield, had high PCV and GCV, indicating their wider adaptability in the genotypes studied. This is in accordance with the findings of Aditya *et al.,* (2011), Datt Shiv *et al.,* (2011) and Puspa and Koteswara, (2013), Karnwal and Singh (2009), Malik *et al.,* (2011), Ngalamu *et al.,* (2012), Athoni *et al.,* (2012), Sawale Swapnil *et al.,* (2014), Malek *et al.,* (2014), Chandel *et al.,* (2013), Osekita and Ajayi, (2013), Mahbub *et al.,* (2015). The study also found high heritability estimates and genetic advance for number of leaves and plant height across different weeks. This is in accordance with the findings of Aditya *et al.,* (2011), Datt Shiv *et al.,* (2011) and Puspa Reni *et al.,* (2013).

Table 3: genetic parameters of the studied traits of soybean

Traits	**NL-4**	**NL-6**	**NL-8**	**NB-4**	**NB-6**	**NB-8**	**PH-4**	**PH-6**	**PH-8**	**LL-4**	**LL-6**	**LL-8**	**LW-4**	**LW-6**	**LW-8**	**CROP-Y**	**DFF**	**D50% F**
GM	15.82	21.58	27.16	5.21	7.08	10.78	14.08	16.05	18.38	6.41	6.95	8.11	4.29	5.09	6.09	208.96	43.36	48.09
SEm	0.71	1.22	1.08	1.11	0.71	0.58	1.31	1.13	0.80	1.89	0.52	0.29	1.24	0.51	0.58	14.81	2.50	1.62
CD 5%	2.06	3.53	3.12	3.21NS	2.06NS	1.68	3.79	3.27	2.33	5.49NS	1.52	0.85	3.61NS	1.48	1.69	42.90	7.25NS	4.70
CD 1%	2.78	4.76	4.21	4.33NS	2.77NS	2.27	5.11	4.42	3.14	7.40NS	2.05	1.15	4.86NS	2.00	2.27	57.88	9.79NS	6.34NS
$EV(\delta^2 e)$	1.52	4.45	3.48	3.69	1.51	1.01	5.13	3.83	1.94	10.77	0.83	0.26	4.65	0.79	1.02	658.05	18.81	7.88
$GV(\delta^2 g)$	4.11	7.96	9.68	0.59	0.43	0.78	6.56	16.47	22.03	0.23	1.62	1.67	0.32	0.57	0.70	1094.09	-0.06	4.46
$PV(\delta^2 P)$	5.63	12.41	13.17	4.28	1.94	1.79	11.69	20.30	23.98	11.00	2.45	1.93	4.97	1.35	1.72	1752.14	18.76	12.34
$ECV(\%)$	7.79	9.77	6.87	36.82	17.37	9.33	16.10	12.19	7.58	51.19	13.08	6.27	50.27	17.41	16.55	12.28	10.00	5.84
$GCV(\%)$	12.82	13.07	11.46	14.74	9.29	8.18	18.20	25.28	25.54	7.43	18.33	15.93	13.20	14.80	13.78	15.83	0.55	4.39
$PCV(\%)$	15.00	16.32	13.36	39.66	19.70	12.41	24.29	28.07	26.64	51.72	22.52	17.12	51.97	22.85	21.54	20.03	9.99	7.31
h^2b	0.73	0.64	0.74	0.14	0.22	0.43	0.56	0.81	0.92	0.02	0.66	0.87	0.06	0.42	0.41	0.62	0.00	0.36
GA	3.57	4.66	5.50	0.59	0.64	1.20	3.95	7.53	9.27	0.14	2.14	2.48	0.30	1.00	1.11	53.84	-0.03	2.61
$GA(\%)$	22.57	21.57	20.24	11.29	9.03	11.10	28.08	46.91	50.43	2.20	30.73	30.53	6.90	19.74	18.17	25.77	-0.06	5.44

PCV: Phenotypic coefficient of variation; GCV: Genotypic coefficient of variation, PV (δ^2p): Phenotypic variance, GV (δ^2g): Genotypic variance, GA: Genetic advance, GA (%): Percentage genetic advance; h2b; Heritability in broad sense., CD: Critical Difference

CONCLUSIONS

The study revealed that there were significant differences among the studied traits, and some varieties performed better than others. The results suggest that genetic factors play a significant role in determining the performance of these traits, especially for the number of leaves at 4, 6, and 8 weeks. The study also highlights the importance of considering both genetic and environmental factors when evaluating crop performance. The findings of this study could be useful in the development of improved varieties that can withstand environmental stress and produce higher crop yields.

RECOMMENDATIONS

Based on the results presented, it is recommended to select soybean varieties with higher mean performance for traits such as number of leaves, number of branches, plant height, leave length, and leave weight. It is also suggested to consider the narrow differences observed between PCV and GCV for traits such as number of leaves and plant height, indicating that these traits are less influenced by environmental factors. However, for traits such as number of branches, leave length, leave weight, and crop yield, which showed wider differences between PCV and GCV, it is important to carefully consider environmental factors when selecting for these traits. Finally, high heritability estimates coupled with high expected genetic advance were observed for number of leaves and plant height at all time points, indicating that these traits are highly heritable and have potential for genetic improvement through selection.

REFERENCES

- Aditya, J. P., Bhartiya, P. and Bhartiya, A. (2011). Genetic variability, heritability and character association for yield and component characters in soybean (Glycine max (L.) Merrill). *J. Central European Agric., 12*(1), 27-34.
- Allard R. W. (1955). Principes of plant breeding. *Agron.J. 47*, 477-485.
- Athoni, B. K., and Basavaraja, G. T. (2012). Association analysis, genetic variability and genetic diversity studies in soybean [Glycine max (L.) Merrill]. *Asian J. of Bio Science, 7*(2), 114118.
- Burton, G. M. (1952). Quantitative inheritance in grasses. Proceedings of 6thInternational Grassland Cong., 1:277-285.
- Chandel, K. K., Patel, N. B. and Kulkarni, G. U. (2013). Genetic divergence studies in soybean (Glycine max (L.) Merill.). Society for Sci. Dev.in Agric. and Tech: 645-649.
- Datt, S., Sharma, P.R., Kumar, M. and Gupta, A. K. (2011). Genetic Variability and Trait Relationships among Yield and Other Quantitative Traits in Soybean (Glycine max (L.) Merrill). *Vegetos, 24* (2), 117-120.
- FAO (2020). https://www.fao.org/faostat/en/#home
- Ghafoor, A., Zahoor, A., Qureshi, A. S., and Bashir, M. (2002). Genetic relationship in Vigna mungo (L.) Hepper and V. radiate (L.) R. Wilczek based on morphoogcal traits and SDS-PAGE. *Euphytica, 123*, 367.
- Johnson, H. W., Robinsan, K. F., and Comstock, R. F. (1960). Genotypic and phenotypic correlations in grasses. In Proceedings of Sixth International Grassland Congress. 1952;1, 277-283. York.84-85
- Karnwal, M. K., and Singh, K. (2009). Studies on genetic variability, character association and path coefficient for seed yield and its contributing traits in soybean (Glycine max L. Merrill.). *Legume Res., 32*(1), 70-73.
- Mahbub, M.M., Mamunur, M. Rahman., Hossain, M.S., Mahmud, F. and Mir Kabir, M.M. (2015). Genetic variability, Correlation and Path anlaysis for yield and yield contributing components in soybean. *American-Eurasian J. Agric & Environ. Sci., 15*(2), 231-236.
- Malek, M.A., Mohd Refii Y., Nath, U.K., and Mondal, M.A. (2014). Morphological characterization and Assessment of genetic variability, character association and Divergence in soybean (Glycine max (L.) Merrill). Mutants. *Scientific World J.*, 1-12
- Malik, M. F. A., Ashraf, M., Qureshi, A. S. and Khan, M. R. (2011). Investigation and comparison of some morphological traits of the soybean populations using cluster analysis. *Pak. J. Bot. 43*(2), 1249-1255.
- Ngalamu, T., Meseka, S. and Ashraf, M. (2012) Performance of soybean (Glycine max L Merrill) genotypes under different planting dates. *J. of App. Bio.,49*, 3363-3370.
- Osekita O. S. and Ajayi A. T. (2013). Character expression and selection differential for yield and its components in soybean (Glycine max (L.) Merrill.) Academia J. of Agric. Res. 1(9):167-171.
- Panse, V. G., and Sukhatme, D. V. (1955). Statistica methods for agricultural workers, ICAR, New Delhi. *,**sig at 5% and 1% ,NL-4(number of leaves at 4 weeks), NL-6(number of leaves at 6 weeks), NL-8(number of leaves at 8 weeks), NB-4(number of branches at 4 weeks), NB-6(number of branches at 6 weeks), NB-8(number of branches at 8 weeks), PH-4(plant height at 4 weeks), PH-6(plant height at 6 weeks), PH-8(plant height at 8 weeks), LL-4(leave length at 4 weeks), LL-6(leave length at 6 weeks), LL-8(leave length at 8 weeks), LW-4(leave weight at 4 weeks), LW-6(leave weight at 6 weeks), LW-8(leave weight at 8 weeks), DFF(days to first flowering), D50%F(days to 50% flowering), CROP Y (crop yield)
- Reni, Y. P., & Rao, Y. K. (2013). Genetic variability in soybean [Glycine max (L) Merrill]. *International Journal of Plant, Animal and Environmental Sciences*, *3*(4), 35-38.

- Sawale S. S. and Vikram J. S. (2014). Assessment of Genetic variability of the main yield related characters in soybean (Glycine max (L.) Merrill). *Int. J. of Food, Agric. and Veterinary Sci., 4*(2), 69-74.

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