GENETIC PARAMETERS AND CORRELATION COEFFICIENT STUDY OF SOME QUANTITATIVE TRAITS IN SOYBEAN (*GLYCINE MAX (L.) MERILL*)

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Abstract

Selection is a continuous activity in plant breeding programs that must be carried out by plant breeders in order to obtain superior plant genotypes 50 genotypes of soybean were evaluated through alpha lattice incomplete design with three replications in 2019 and 2020 rain seasons to determine the extent of genetic parameters and correlation coefficient for genotypes improvement in 12 agro-morphological traits: Plant height at 4weeks, Plant height at 8weeks, Plant height at 12weeks, Days to 50 % flowering, Number of branches, Days to maturity, Above ground biomass, Pods per plant, Seeds per pod, Seed yield per plot, 100 seed weight and Harvest index. Data from the two years trials were subjected to analysis of variance following the procedure of Statistical Tools for Agricultural Research (STAR 2.0.1) and Plant Breeding Tools (PBTools 1.3, 2014). Significance means separation was done using Least Significant Difference (LSD) at $P < 0.05$. The results showed there were significant differences between genotypes. Phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for the traits studied. Broad sense heritability ranges from low (value <30) to high (value>60). Combined correlation coefficient for the two cropping seasons revealed that the yield components exhibited varying trends of correlation relationship between themselves, Seed yield had significant positive correlation with Number of branches, Pods per plant and Harvest Index with correlation coefficient values of 0.477, 0.525 and 0.639 respectively. The results obtained suggested that, Number of branches, Pods per plant and Harvest index were the most important traits that determined seed yield and could be used for future yield improvement in soybean breeding programme.

Keywords: Soybean, Genotypic, Phenotypic, Heritability, Correlation, Traits

Introduction

Soybean (*Glycine max (L.)* Merrill) is well known all over the world to be one of the most important oil and protein leguminous crops; it is a self-pollinated crop and belongs to the family Fabaceae (Santosh et al., 2018). In Nigeria there are different varieties of this crop available throughout the year. It varies in sizes as well as seed coat colours, such as; black, brown, blue, yellow or mottled. Soybean is an erect bushy plant with a well-defined main stem and branches, with numerous leaves (Kolawole et al., 2022). The crop is mainly cultivated for its seeds and for several uses in the food and industrial sectors. It is a source of edible vegetable oil and proteins for livestock feed. It is also used for food as soy-milk, soy-cheese, local seasoning, and infant weaning food, among others. Soybean plants helps in improving the fertility as trap crops controlling the parasitic weed, *Striga hermonthica.* Soybean cake is an excellent livestock feed, especially for poultry, the haulms provide good feed for sheep and goats. For these reasons demand for soybean as a raw material for the oil and poultry industries has been on the rise for many years. The increase in population together with gradual reduction of cultivable land as a result of climate change and farmers' herders' clashes in most areas where soybean is predominantly planted has remained a challenge to its production in Nigeria. In this regard, the diet pattern in Nigeria has remained highly imbalanced with deficit consumption of both pulse and oils. However, Soybean can be an excellent source of balance diet to meet the nutritional deficiencies in Nigeria where the human population increases faster than food production. Plant genetic diversity is recognised as a specific area since exploding population with urbanisation and decreasing cultivable lands are the critical factors contributing to food insecurity in developing countries. The information on genetic diversity which plays a major role in choosing parents for generation of new varieties needs continuous evaluation of germplasm for useful characters (Govindaraj et al., 2015). Diversity in plant genetics provides opportunity for plant breeders to develop new varieties and improved genotypes with desirable characteristics in crops like soybean that are able to meet future global challenges in relation to food and nutritional security (Shipa et al 2020). Lack of research in genetics diversity of crop like soybean will gradually lead to genetic erosion and extinction of some land races. Therefore, the objectives of the study was to determine the extent of genetic parameters and correlation coefficient of 50 soybean genotypes for breeding programs.

Materials and Methods

Fifty genotypes of soybean were evaluated in the study using alpha lattice incomplete design with three replications. Each replication had 5 blocks and each block had 10 entries allotted randomly. There were inter block of 1m alleyways and 1.5m inter rep. The research was carried out at the Research Farm, National Biotechnology Development Agency (NABDA), Abuja during the 2019 and 2020 rainy seasons. The coordinates of the experimental sites was determined using Geographical Positioning System (GPS) equipment (GPS- 4300; Ethrex Garmin GPS, Taiwan) and the land was at Latitude 8.98694 N8059'12.984 and a Longitude of 7.38041 E7022'49.488". In each replication fifty treatments were grown in five blocks of 5m long and 20cm apart. Five randomly selected plants from each treatment were tagged, observations on the following on the following characters: Plant height, Days to 50 % flowering, Number of branches, Days to maturity, Above ground biomass, Pods per plant, Seeds per pod Seed yield per plot, 100 seed weight and Harvest index. The phenotypic and genotypic correlations were determined among the seed yield and its components in all possible character combinations. Genotypic correlation coefficients were estimated following the procedure of Akintunde (2012).

Results and Discussion

Genetic Parameters for Yield and Yield Components

The result of estimated genetic parameters showed significant differences ($p < 0.05$) among genotypes studied for the 12 Morpho- Agronomic traits (Table 1) Significant variation observed in morpho-agronomic traits among the genotypes in this studies with different trait favouring different genotypes could be an indication of diverse nature of crops reflecting large number of the genotypes from different locations. This claim is in conformity with the result of Medagam et al. (2015) who reported that landraces/genotypes are most often heterogeneous with a blend of different individual plant maintaining significant portion in the gene pool of cultivated crops. Hence, the high significant differences recorded in all the morpho-agronomic parameters among the genotypes studied. The high variabity in the plant could also be as a result of self-fertilisation nature and temperature that favoured pollination in the plant, resulting in high morphological diversity among the genotypes. The highly significant variations for all the traits indicate that both the genotypes and the environmental factors had enormous effects on the agronomic and yield traits (Jandong et al., 2020). Zanon et al (2016), had earlier reported that nature provide the major environmental factor (temperature) that influence soybean development and yield.

Phenotypic Variance (PV) were higher than Genotypic Variance in all the traits. Seed yield recorded the highest PV value of 11081.077 and GV of 8445.358. Biomass and Harvest Index recorded the lowest PV and GV. The environmental variance EV for most of the character studied were higher than their corresponding GV except plant height at 8weeks and seed yield that recorded higher GV than EV having the values of 30.87 and 2635.72 respectively. The high phenotypic variance (PV) than the corresponding genotypic variance, coupled with the higher environmental variance (EV) for most of the traits, aside the plant height at 8 weeks and seed yield indicating the effects of environmental factors on the expression of the genotypes. Similar results were reported by Mahbub and Shirazy (2016) who evaluated 28 genotypes of soybean for genetic diversity and recorded higher phenotypic variance than genotypic variance. Phenotypic coefficient of variation PCV showed higher values than the correspondence genotypic coefficient of variation GCV for most of the traits studied. This indicated influenced of the environment on the genotypes, this is in agreement with Mofokeng, (2021) in the study of 82 genotypes of soybean for Genetic variability, heritability and genetic advance based on yield and yield-related traits. Harvest Index recorded highest value of PVC with the value of 38.983 while Days to Maturity recorded lowest PVC and GVC with the values of 5 and 1.971. Height at 8weeks recorded highest value of 16.

Broad sense heritability estimate ranges from low (value 30) to high (>60%) for the traits studied. Moderate (30-60%). Plant height at 8 weeks (54.05 %) and 100 seed weight (32.91 %) recorded moderate heritability. In all the characters assessed, high magnitude (>60%) of heritability was obtained only in seed yield with the value of 76.21 %, while most of the traits had low heritability values. Genetic Advance as percentage of mean (GA) recorded Pods per Plant, Seed Yield and 100 Seed weight with moderate GA (10-20 %) Plant Height at 8weeks recorded the highest percentage of GA with the value of 24.31. Heritability of a plant trait is very important in determining the response to selection because it implies the extent of transmissibility of traits into next generations. In addition, high genetic advance coupled with high heritability estimate offers the most effective condition for selection for a particular trait. High magnitude (76.21 %) of heritability and moderate genetic advanced obtained in seed yield indicate that the traits is suitable and reliable in terms of selection for crop improvement. This finding is in conformity with the results of Ibidunni et al. (2020), Jandong et al. (2020), who reported high heritability and genetic advance for plant height in soya bean. Kamara et al. (2017) reported that traits that displayed high heritability and high genetic advance such as Height at 8 Week in this study might be controlled by additive gene effects; indicates that selection in the segregating generation may be effective. Also, Jandong et al. (2020) reported that this indicates that selection based on phenotypic levels would be useful for the improvement of the traits by repeated mass selection or hybridization between selected genotypes, showing varying degree of variation for such traits.

Table 1: *Estimate of genetic parameters for yield and yield components in 50 genotypes of soybean evaluated for two cropping seasons of 2019 and 2020 in Abuja Nigeria*

Parameters	Means	Genotype variance	Phenotypic variance	Year variance	Genotype x Year Variance	Broad sense Heritability (H^2)	Genotypic Coefficient of Variability	Phenotypic coefficient of variation	Genotype x Year coefficient of Variation	Genetic Advance as Percentage of Mean
Height at 4 Week	14.640	0.404	3.632	3.228	3.450	11.121	4.341	13.017	12.687	2.982
Height at 8 Week	37.540	36.303	67.168	30.865	37.332	54.048	16.05	21.832	16.276	24.307
Height at 12 Week	42.120	5.228	32.865	27.637	38.622	15.907	5.428	13.611	14.755	4.460
Days to Flowering	50.56	3.499	24.341	20.842	16.976	14.376	3.700	9.758	8.149	2.890
Number of Branches	4.660	0.056	0.786	0.73	1.224	7.172	5.096	19.03	23.744	2.812
Days to Maturity	101.92	4.034	34.056	30.021	20.76	11.847	1.971	5.726	4.47	1.397
Biomass	0.316	0.000	0.007	0.007	0.006	4.167	5.485	26.869	25.134	2.306
Pods per Plant	110.31	249.838	883.218	633.38	1512.715	28.287	14.329	26.941	35.258	15.699
Seeds per Pod	44.92	2.376	26.681	24.306	22.232	8.904	3.431	11.499	10.497	2.109
Seed Yield (kg/ha)	1192.82	8445.358	11081.077	2635.719	36851.13	76.214	7.704	8.825	16.093	13.855
100 Seed weight	11.87	2.168	6.588	4.420	3.980	32.907	12.404	21.623	16.808	14.658
Harvest Index	0.260	0.000	0.010	0.010	0.009	1.303	4.450	38.983	35.528	1.046

Note: *Genetic Advance as Percentage of Mean was estimated at 5% selection index; the values appear as 0.000 is an approximation of the original value to 3 decimal*

Correlation Coefficients Analysis

Genotypic correlations of seed yield and other characters studied were determined in all possible combinations and presented in table 2. Seed yield exhibited significant positive correlation with number of branches, pods per plant and Harvest Index with correlation coefficient values of 0.477, 0.525 and 0.639 respectively. Moderately correlated with Biomass having the value of 0.356, negatively correlated with 100 seed weight having the value of -0.005. Height at 4weeks showed significant positive correlation with height at 8 weeks, 12weeks with the values of 0.829 and 0.550 respectively, negatively correlated with days to flowering. Height at 8 weeks exhibited significant positive correlation with height at 4weeks and height at 12 weeks, low and insignificant correlation with Days to flowering, Days to maturity and Harvest Index with the values of -0.359, -0.084 and 0.167 respectively. Number of branches showed significant positive correlation with seed yield having the value of 0.477, moderately correlated with pods per plant having the value of 0.394 and negative insignificantly correlated with Days to flowering, Days to maturity and Seed per pod having the value of -0.198. Pods per plant showed positive significant relationship with seed yield with the value of 0.523 and moderately with Number of Branches. Harvest Index exhibited significant positive correlation with Seed yield with the value of 0.639 low relationship with other variables. A significant positive correlation between desirable variables is favourable because it helps in simultaneous improvement of both the characters.

Significant positive correlation of seed yield per plant with number of branches per plant, Biomass, pod per plant, and harvest index suggest that improvement of any of these traits will lead to better-quality yield. Positive and significant correlation of days to flowering with days to maturity and seed per pod indicates that these two characters are dependent of one another and selection of one of the traits could lead to the other and subsequent increase seed per pod. Also, this suggest that long vegetative phase, along with late reproductive phase in the plant could contribute higher seed yield. Thus, late flowering and maturity genotypes would possess higher seed per pod due to enough period of mobilization for assimilates of vegetative and seed production. Similar to this result Malek et al. (2014) reported strong positive genotypic correlations of pods per plant and seeds/pod with days to flowering and maturity indicating that late maturing genotypes have more number of pods per plant and seeds per pod and consequently give higher seed yield. In conformity with the result of this study Machikowa and Laosuwan (2011) had earlier reported that seed weight always showed negative correlations with other desirable yield traits which indicates that the increase in one trait would result in the reduction of the other. This indicated that, higher seed size would give rise to fewer seeds. Furthermore, it was suggested that the negative correlation of seed weight with other yield traits indicated it would be very difficult to identify a soybean genotype having higher seed weight simultaneously with higher number of pods per plant, seeds per pod (Malek et al., 2014), number of branches per plant and harvest index.

Conclusion

The results of the study revealed that information about genetic parameters and correlation coefficient analysis in respect of soybean yield and yield contributing traits obtained could be used as guide for the improvement of soybean breeding programme. Plant height has a moderate heritability trait value and could be used as a criteria for selection, plant height not only have moderate

Table 2: *Genetic Correlation Coefficient for yield and yield components in 50 genotypes of soybean evaluated for two cropping seasons of 2019 and 2020 in Abuja Nigeria*

	Seed Yield (kg/ha)	Height at 4 Week	Height at 8 Week	Height at 12 Week	Days to Flowering	Number of Branches	Days to Maturity	Biomass	Pods per Plant	Seeds per Pod	100 Seed Weight (g)	Harvest Index
Height at 4 Week	0.012	1	0.829**	0.550**	-0.385*	0.079	-0.052	0.021	0.009	-0.044	0.216	-0.167
Height at 8 Week	0.15	0.829**	1	0.686**	-0.35*	0.288	-0.084	0.112	0.063	0.069	0.211	-0.016
Height at 12 Week	0.138	0.55	0.686**	1	-0.106	0.224	0.152	0.133	0.022	0.102	0.153	0.031
Days to Flowering	0.092	-0.385*	-0.350*	-0.106	1	-0.059	0.411*	0.177	0.173	0.433*	-0.235	-0.031
Number of Branches	0.477**	0.079	0.288	0.224	-0.059	1	-0.088	0.183	0.394*	-0.198	-0.278	0.208
Days to Maturity	0.033	-0.052	-0.084	0.152	0.411*	-0.088	1	0.275	0.110	0.139	-0.078	-0.042
Biomass	0.356*	0.021	0.112	0.133	0.177	0.183	0.275	1	0.316	-0.011	0.211	-0.22
Pods per Plant	0.525**	0.009	0.063	0.022	0.173	0.394*	0.11	0.316	1	0.25	-0.12	0.247
Seeds per Pod	0.252	-0.044	0.069	0.102	0.433*	-0.198	0.139	-0.011	0.25	1	0.065	0.239
100 Seed Weight (g)	-0.005	0.216	0.211	0.153	-0.235	-0.278	-0.078	0.211	-0.12	0.065	1	-0.003
Harvest Index	0.639**	-0.167	-0.016	0.031	-0.031	0.208	-0.042	-0.22	0.247	0.239	-0.003	1

NB: ** and * indicate significance at 1% and 5% level of probability, respectively

heritability value but exhibited positive significant correlation with seed yield.

Declaration of interests

All authors declare that they have no conflict of interest.

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