

Field Evaluation of Soybean (*Glycine Max* (L.) Merrill) Genotypes at Badeggi and Makurdi in the Southern Guinea Savannah Ecology of Nigeria

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Abstract

Field experiments were carried out in 2024 cropping season at Makurdi and Badeggi to study the relationship between yield and yield related traits of soybeans genotypes. The experiments were laid out in a Randomized Complete Block Design (RCBD) with three replications. Data were collected on the following parameters; plant height, days to 50 %flowering, days to 95 % maturity, nodulation, lodging, pod clearance, pod shattering, number of branches per plant, number of pods per plant, number seeds per pod, 100 seeds weight and grain yield per hectare. Grain yield showed highly significant and positive correlation with plant height, number of branches per plant, number of pods per plant and 100 seeds weight. In addition, phenotypic path coefficient analysis revealed that 100 seeds weight had positive direct effect on grain yield. This suggests that selection for plant height, number of branches per plant, number of pods per plant and 100 seeds weight would lead to simultaneous improvement of grain yield in soybeans. Hence, plant breeders are to prioritize genotypes with large seed size (highest weight) as this exerts the strongest direct effects on yield and to optimize number of pods per plant, number of branches per plant and plant height to exploit their indirect contributions.

Keywords: Soybeans, genotypes Grain Yield, Yield components, Correlation, Path Coefficient Analysis

Introduction

Soybean (*Glycine max* L.) is one of the very important leguminous and oil crops with worldwide importance as food and market crop. This is mainly because of its high grain nutritional value with 40 % protein and 20 % oil, that makes it an important raw material for food and oil processing industries (Omoigui *et al.*, 2020). It has wide adaptability coupled with unique ability to fix high amount of nitrogen, thereby improving soil fertility and permitting farmers to use less fertilizer and reduce farm cost (Azu *et al.*, 2019). In addition, soybean provides health benefits in consumption, and is as such also considered as a strategic crop in fighting the worlds' food shortage and malnutrition problems, and most food aids to displaced and malnourished people are fortified with soybean (Abush *et al.*, 2017).

Despite its numerous importance, its productivity is very low (below 2.0 t ha⁻¹) in many of these countries as compared to more than 2.7 t ha⁻¹ productivity obtained in some other countries (FAOSTAT, 2018). The low yield is due in part to lack of improved varieties, as a result, in order to generate high-yielding soybean genotypes, it is needed to examine the determinants and interrelationships among agronomic traits (Yoosefzadeh-Najafabadi *et al.*, 2021.). Seed yield, as a complex trait, is the result of the expression of the association of several plant growth components.

In the last two decades, soybean breeders have made tremendous efforts to increase the yield by selecting superior genotypes not necessarily based on yield per se but yield components as well, these components directly explained the variation of yield in genotypes (Nagreg, 2017)). The grain yield is a complex character, quantitative in nature, direct selection is challenging due to its low heritability, thus, direct selection methods can be less effective (Shaahu *et al.*, 2014; Nagreg, 2017; Liu *et al.*, 2021; Christabell Nachilima, 2021 and Yoosefzadeh-Najafabadi *et al.*, 2021). Therefore, indirect selection strategies targeting traits associated with improved yield are highly important. The aim of this study is to determine which yield components have the greatest impact on soybean production.

Materials and Methods

The study was carried out at Teaching and Research Farm of Joseph Sarwuan Tarkaa University Makurdi, (Latitude 07°:45⁰E Longitude 08:37⁰E), Nigeria and Nigeria Cereals Research Institute, Badeggi, Bida, Niger State, Nigeria, (Latitude 9.0568⁰N Longitude 6.1434⁰E). A total of 70 genotypes were used. The trials were laid out in Randomized Complete Block Design (RCBD) with three (3) replications in each of the two locations. The 70 genotypes were planted each on 4m X 1.5m plot size having 4 rows including 2 borders with inter-row spacing of 50cm, intra-row spacing of 5cm and alleyways of one (1m). Fertilizer was applied as mixture of Single super phosphate (SSP) and Nitrogen Phosphorus potassium (N.P.K), at the ratio of 3kg to 2kg and applied before planting. Data were collected on the following parameters; plant height, number of branches per plant, days to 50 % flowering, days 95 % to maturity, number of pods per plant, number of seeds per pods, lodging, number of shattered pods, pod clearance, nodulation 100 seed weight and grain yield.

Estimation of phenotypic correlation coefficient (r)

Correlation coefficient (r) is a measure of the association between two or more than two variables. The phenotypic correlation and genotypic correlation coefficients between two variables including genotype were estimated as described by Singh and Chaudhary (1985).

Path coefficient analysis

Path coefficient analysis was calculated using as suggested by Dewey and Lu (1959) to determine direct and indirect effect of different variables on grain yield.

Results and Discussion

Correlation among Yield and Yield related Traits

The result of correlation analysis as shown in Table 1. Grain yield was found to be positively and significantly associated with plant height, number of pod per plant, number of branching per plant, and 100 seed weight. This underscores that genotypes with higher pod load, more branching, larger seeds, and taller stature tend to achieve greater productivity. The present result was supported by

the findings observed by Pawar *et al.* (2020), Admasu *et al.* (2025). Also, the strong positive intercorrelation between Branches and Pods ($r = 0.733$) further supports the architectural contribution to sink capacity, as greater branching facilitates more pod-bearing nodes, a pattern repeatedly observed in soybean germplasm evaluation (Malek *et al.*, 2014). Days to maturity showed negative correlations with several important yield-related traits, including plant height, branches, pods per plant, and grain yield notably, the substantial negative correlation between GY and DM ($r = -0.472$) suggests a trade-off whereby later-maturing genotypes experience reduced yield potential, possibly due to extended vegetative growth at the expense of reproductive allocation or exposure to terminal stresses. The result was supported by findings observed by (Lodhi *et al.*, 2023).

Conversely, the negative correlations between grain yield and days to maturity, days to flowering as well as pod shattering suggest that breeding for early maturity and shattering resistance could help improve soybean productivity and reduce harvest losses.

Overall, the results highlight the importance of considering relationships among traits when selecting superior soybean genotypes.

TABLE 1: Correlation coefficient between phenological, growth, yield and yield contributing traits of soybeans at phenotypic levels.

Trait	PH	DF	DM	Nod	Lodging	PClear	PShat	Branches	Pods	SeedsPod	SW100	GY
PH	1	-0.059	-0.459	0.078	0.042	0.076	-0.189	0.351	0.36	-0.08	0.156	0.269
DF	-0.059	1	0.066	0.054	0.135	0.074	-0.008	-0.028	-0.172	0.084	-0.269	-0.153
DM	-0.459	0.066	1	-0.092	0.007	-0.024	0.389	-0.503	-0.45	0.094	-0.19	-0.472
Nod	0.078	0.054	-0.092	1	-0.075	0.155	-0.031	0.041	-0.048	-0.139	-0.109	0.124
Lodging	0.042	0.135	0.007	-0.075	1	-0.07	-0.045	-0.077	-0.087	0.05	-0.073	-0.12
PClear	0.076	0.074	-0.024	0.155	-0.07	1	-0.059	0.112	0.06	0.117	0.085	0.2
PShat	-0.189	-0.008	0.389	-0.031	-0.045	-0.059	1	-0.398	-0.395	-0.035	-0.126	-0.282
Branches	0.351	-0.028	-0.503	0.041	-0.077	0.112	-0.398	1	0.733	0.065	0.188	0.425
Pods	0.36	-0.172	-0.45	-0.048	-0.087	0.06	-0.395	0.733	1	0.032	0.216	0.376
SeedsPod	-0.08	0.084	0.094	-0.139	0.05	0.117	-0.035	0.065	0.032	1	-0.012	0.073
SW100	0.156	-0.269	-0.19	-0.109	-0.073	0.085	-0.126	0.188	0.216	-0.012	1	0.36
GY	0.269	-0.153	-0.472	0.124	-0.12	0.2	-0.282	0.425	0.376	0.073	0.36	1

PH = Plant height, DF = Days to 50% flowering, DM = Days to 95% maturity, NOD = Nodulation, Pclear = Pod clearance, PShat = pod shattering, GY = Grain yield per hectare in kg.

Path Coefficient Analysis

The results of phenotypic path coefficient analysis are presented in Table 2. It was performed to partition the phenotypic correlations between various soybean traits and grain yield (GY) as the dependent variable into direct and indirect effects.

These findings demonstrate that while some traits exert primarily direct influences on grain yield (e.g., SW100, nodulation, seeds per pod, days to maturity and PClear), others contribute mainly indirectly (e.g., Pods, Branches, PH, days to flowering and pods shattering), highlighting complex interdependencies among yield components in the studied soybean germplasm.

Overall, path coefficient analysis highlights SW100, pod per plant, plant height, and branches per plant as key drivers of yield in this germplasm, guiding targeted selection for high-yielding, soybean genotypes.

Table 2. Path Coefficient Analysis (Grain Yield as Dependent Variable)

Trait	Correlation with GY (r)	Direct Effect on GY	Total Indirect Effect
PH	0.269	0.007	0.262
DF	-0.153	-0.073	-0.079
DM	-0.472	-0.307	-0.165
Nod	0.124	0.109	0.015
Lodging	-0.120	-0.067	-0.053
PClear	0.200	0.122	0.078
PShat	-0.282	-0.048	-0.233
Branches	0.425	0.149	0.277
Pods	0.376	0.032	0.344
SeedsPod	0.073	0.103	-0.030
SW100	0.360	0.237	0.122

Conclusion

Correlation and path analysis reveal that the plant height, number of pod per plant, number of branching per plant, 100 seed weight, influenced grain yield either directly or indirectly. Therefore, these traits should be included in the breeding programme of soybeans. The favourable direct effects of these traits on grain yield indicate other variables kept constant, improvement of these traits will increase grain yield.

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