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ASSESSMENT OF SEED YIELD AND CORRELATION STUDIES OF SOYBEAN (*GLYCINE MAX* (L.) MERR.) VARIETIES

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Abstract
A field trial was conducted during the 2020 cropping season at the experimental farm of National Cereals Research Institute, Badeggi, Niger State, Nigeria and National Cereals Research Institute, Mokwa Station, Niger State, Nigeria. Four soybean varieties obtained from National Cereals Research Institute, Badeggi, Niger State, Nigeria. The plots were laid in Randomized Complete Block Design with three replications. The analysis of variance showed significant difference in for all traits studied. The varieties TGx1951-3F and TGx1448-2E recorded the highest performance index of 66.67%, followed by TGx1989-19F. The variety Sc signa have zero performance index. Correlation studies revealed that seed yield significantly correlated with days to 50% flowering, days to 95% maturity, plant height at maturity, number of pods per plant, and fodder weight. Whereas seed yield was negatively associated shattering and lodging scores.

Keywords: Soybean, cultivar performance index, LSD, DMRT, correlation, varieties and seed yield

Introduction

Soybean [*Glycine max* (L.) Merr.] is the most widely grown legume in the world and the fourth most important crop after wheat (Triticum aestivum L.), maize (Zea mays L.), and rice (Oryza sativa L.) in terms of area harvested and production (FAO 2018). It is the most important oil seed in the world with a contribution of > 60% to the total oil seed production and > 70% to the total protein meal consumption (SoyStats 2018). It contained maximum amount of protein and other important essentials vitamins that play important role in our daily life. It is also an important cash crop for our industry and also used as a biofuel. Soybean called "Golden bean" or "Miracle bean" or "Protein hope of future" (Sathe et.al. 2009 and Sarkar et. al. 2002). Soybean is a legume that grows in tropical, subtropical, and temperate climates. Soybean is not an indigenous crop in Nigeria, although, it is gaining popularity

in the country because of its numerous potentials that rank it even better than cowpea in the supply of high-quality protein (Akande et. al., 2007). Soybean grains contain about 40% protein, 20% oil, an optimal supply of essential amino acids and nutrients, and a high calorie value.

Since ancient times, soybean has been considered one of the most important cultivated legumes. Now, it is classified as one of the most important cultivated oilseed crops in the world because of its high oil content and protein (Liu et al., 2017). Soybean is used as food in its 51 simple forms, more either as a vegetable or as any of soy derivatives or products. It also serves as feed for livestock and aquaculture; and is used for biofuel production. Soybean forms a greater part of oil and protein in the human diet (Pedro et al., 2015; Valencia et al., 1979; Willaarts et al., 2014).

Food is the most basic human needs, without them, life on earth for higher organisms would be impossible. As the world population increases, there would be a need for an agricultural production system that is apace with the growth of population. Consequently, more food will have to be produced on less land. This calls for improved and high yielding varieties to be developed by plant breeders. Plant breeding is a deliberate effort by humans to nudge nature with respect to the heredity of plants to an advantage (Acquaach 2009). Yield increase in crops has been accomplished in a variety of ways including targeting yield per se or its component, or breeding for plant that are responsive to production environment (Acquaach 2009).

Usually, the identification of a better performing variety with respect to a particular trait is based on the assessment of differences among the variety means for the trait under investigation and their statistical significance using LSD, Duncan multiple range test, t-test and Z-test. Significance tests are used to distinguish the performance of varieties. In the process, the variety means are usually arranged in a descending order i.e. from the highest to the lowest. Any pair of means that do not differ significantly between themselves are either assigned the same letter or alphabet or underscored by the same line. Conversely, significantly different means are assigned different alphabets or underscored by different lines. This is an established procedure, although, it tends to be cumbersome especially if the number of varieties are many, thereby making visual discrimination difficult (Fasoulas, 1983). The number of means "m", from which a particular genotype differs significantly, is used to arrange genotypes in order of descending superiority. For n genotypes under study, the maximum "m" value corresponding to the best genotype is n-1, indicating that it exceeds significantly the n-1 other genotypes, and the minimum zero. Because "m" represents an objective and reliable statistical measure of genotype performance, it has been used to calculate performance index, P= 100m/(n-1), giving the percentage of which, a particular genotype exceeds significantly. Rating genotypes according to "P", gives an overall picture of the relative superiority of the entries. Therefore, research efforts are initiated to determine the extent of variability among the selected genotypes using "P" and also determine association between seed yield and yield components to aid selection.

Materials and Methods

On-Station field experiment was carried out during the cropping seasons of 2020 at experimental farm of National Cereals Research Institute, Badeggi, Niger State, Nigeria and National Cereals Research Institute, Mokwa Station, Niger State, Nigeria. Four soybean varieties obtained from National Cereals Research Institute, Badeggi, Niger State, Nigeria were laid in a randomized complete block design with 3 replications. Each plot consisted of 4 rows of 5m length with a row-to-row distance of

50cm maintaining 20 plants m^{-1} in length. The experimental area was ploughed and harrowed twice. Seeds were planted by hand drilling and latter thinned to one seedling per stand at three weeks after planting. Fertilizer was applied at the rate of 20kg N, 40kg P and 20kg K per hectare two weeks after planting. Weeds were controlled using butachlor a pre-emergence selective herbicide sprayed within 24 hours after sowing at the rate of 2 litres per hectares. Supplemental weeding was manually carried out as weeds occurred. Observations were recorded from five plants selected at randomly. All good agronomic practices to raise healthy plants were followed. Data collected were subjected to analysis of variance using STAR statistical package.

Results and Discussions.

The analysis of variance showed that, the genotypes were statistical different for all the traits studied Table1. The highly significant and significant variability exhibited in the characters of soybean as revealed by analysis of variance showed that the genotypes are diverse. Such variations are useful in plant breeding as they provide heterogeneous population for a wide spectrum of genotypes for selection for the characters. Generally, all tested genotypes exhibited highly significant differences among the studied characters and across the tested environments which indicated differences in the genetic makeup of the materials used. This finding is in agreement with that of Nkhoma et al. 2020, Shaahu et. al. (2012, 2014) who also found that soybean genotypes differed significantly for yield component traits. Similarly, Iqbal et al. 2008 revealed significant differences among different soybean genotypes for all the traits studied.

The Table 2 revealed that seed yield ranged from 917kg/ha (Sc- signa) to 1834kg/ha (TGx1951-3F). The highest pod clearance was observed in variety Sc-signa. The lowest shattering score was recorded by TGx1448-2E, followed by Sc-signa. The most early maturing variety was TGx1989-19F (103days), followed by Sc-signa and TGx1951-3F (108days). The variety TGx1448-2E (111days) matured lately.

The results revealed that the performance index (P) gives information that are normally not given by LSD. While it is true that the indicated LSD values in each case would detect statistical differences between entries, entry ranking given by both M and P gives value is not indicated by the LSD. In agreement with Fasoulas (1983) explanation on the possible or attainable value of P values ranging from zero (for minimal performance) to 100 (for maximal performance). The varieties TGx1951-3F and TGx1448-2E recorded the highest performance index of 66.67%, followed by TGx1989-19F. The variety Sc signa have zero performance index Table 3. The attraction of the performance index approach in the rating of cultivars across environments is in relation to its ease of computation and interpretation especially when the number of entries and test environments are large, a situation which makes other conventional methods more cumbersome. According to Echekwu and Shawemimo 2001 the attraction of the performance index approach in the rating of cultivars across environments is in relation to its ease of computation of entries and test environments are large, a situation which makes other conventional methods more cumbersome. This approach has been used by Bodunde 2002 in “performance index efficacy for cultivar rating in tomatoes evaluated for heat tolerance in a dry hot Eco-zone. Fasoulas 1983 in “rating cultivar and trials in applied plant breeding. Shaahu et al., 2014 in “Assessment of yield and yield components of some improved soybean genotypes using performance index. Yisa et al., 2018 in “application of cultivar performance index analysis on some selected rice varieties.

The correlation studies revealed that seed yield significantly correlated with days to 50% flowering, days to 95% maturity,

plant height at maturity, number of pods per plant, and fodder weight. Whereas seed yield was negatively associated shattering and lodging scores Table 4. Hundred seed yield significantly positive correlated with days to 95% maturity, nodulation scores, plant height, pod clearance, and number of pods. It also recorded non-significant and positive correlation with days to 50% flowering, plant height, shattering scores, lodging scores, fodder weight and seed yield. Number of pods recorded significant and positive association with days to 50% maturity, days to 95% maturity, plant height, pod clearance, fodder weight, seed yield and hundred seed weight.

The present results are in agreement with the results obtained by Shaahu et al., (2013), Abimaje et al. (2018) and Pawar, et.al. (2020) also reported positive significant relation between seed yield and pods per plant. Ghodrati et al., (2013) revealed that seed yield had significant correlations with 100 seed weight, number of pods plant^{-1} and days to maturity. Aditya et al., (2011) reported positive significant correlation of seed yield with dry number of pods per plant. Malik et al., (2011) reported positive significant correlation for seed yield with pods per plant and 100-seed weight.

Conclusions

The analysis of variance showed that, the genotypes were statistical different for all the traits studied. seed yield ranged from 917kg/ha (Sc- signa) to 1834kg/ha (TGx1951-3F). The highest pod clearance was observed in variety Sc-signa. The lowest shattering score was recorded by TGx1448-2E, followed by Sc-signa. The earliest maturing variety was TGx1989-19F (103days), followed by Sc-signa and TGx1951-3F (108days). The variety TGx1448-2E (111days) matured lately. The varieties TGx1951-3F and TGx1448-2E recorded the highest performance index of 66.67%, followed by TGx1989-19F. The variety Sc signa have zero performance index. The correlation studies revealed that seed yield significantly correlated with days to 50% flowering, days to 95% maturity, plant height at maturity, number of pods per plant, and fodder weight. Whereas seed yield was negatively associated shattering and lodging scores.

Table 1: Mean squares from analysis of variance for various agronomic characters of four soybean varieties planted at Badeggi and Mokwa in 2022 cropping season.

SOV	DF	DTF	DTM	NODU	PLHT	PC	PODS	Shat	LODG	FWT	SY	HSWT
LOC	1	42.67**	222.04**	4.42**	358.05**	26.2**5	2926.04**	0.17**	0.04ns	243815.04**	977680.67**	17.91*
REP	4	0.08**	0.04ns	0.02ns	3.25ns	0.25ns	8.29ns	0.08ns	0.04ns	5454.96ns	5020.67ns	2.65ns
VAR	3	86.5**	65.71**	0.83**	214.43**	25.54**	46.38**	13.5**	3.04**	62202.38**	1057836.78**	35.68**
Loc x Var	3	3.44**	18.71**	0.37**	340.26**	13.79**	117.26**	0.61*	0.71**	38434.15*	640300.78**	19.69*
Error	12	0.14	0.04	0.02	3.95	0.18	3.79	0.14	0.04	8583.01	8423.61	3.91

Key: *,** Significant at P< 0.05 and P<0.01 respectively; ns= non-significant; SOV= sources of variation; Loc= location; REP= replication; VAR= varieties; DF= degree of freedom; DTF= days to 50% flowering; DTM= days to 95% maturity; PLHT= plant height at maturity (cm); PDHT= lowest pod height or first pod height at maturity (cm); SY= seed yield in kg/ha; NODU= nodulation scores; PC= pod clearance (cm); PODS= pods per plant; Shat= shattering scores; Lodg= lodging scores; FWT= fodder weight in kg/ha, HSW T= hundred seed weight in grams.

Table 2: Mean performance of four soybean varieties plant at Badeggi and Mokwa in 2022 cropping season using performance index.

Designation	Entry	DTF	DTM	NODU	PLHT	PC	PODS	SHAT	LODG	FWT	SY	HSWT
SC-SIGNA	1	37	108	3.1	44.35	12.9	34	1.3	1.5	1861	917	16.40
TGX1951-3F	2	46	108	2.5	58.43	9.0	39	2.3	2.0	1977	1834	11.41
TGx 1448-2E	3	44	111	2.8	49.70	8.3	41	1.0	1.0	2097	1771	11.98
TGx 1989-19F	4	44	103	3.4	47.97	11.0	39	4.3	2.7	2045	1579	15.24
	MEAN	43	107	2.9	50.11	10.31	38.13	2.25	1.79	1995	1525	13.76
	CV%	0.9	0.2	5.1	3.90	4.40	6.10	16.80	11.40	4.4	5.6	13.9
	SE	0.15	0.08	0.06	0.79	0.19	0.95	0.15	0.08	36.0	34.8	0.8
	LSD	0.47	0.25	0.18	2.41	0.56	2.89	0.47	0.25	109.1	105.6	2.4

Key: DTF= days to 50% flowering; DTM= days to 95% maturity; PLHT= plant height at maturity (cm); PDHT= lowest pod height or first pod height at maturity (cm); SY= seed yield in kg/ha; NODU= nodulation scores; PC= pod clearance (cm); PODS= pods per plant; Shat= shattering scores; Lodg= lodging scores; FWT= fodder weight in kg/ha, HSWT= hundred seed weight in grams.

Table 3: Rating of four soybean varieties plant at Badeggi and Mokwa in 2022 cropping season using performance index.

Designation	Entry	SY	SY	SY	M	P (%)
TGX1951-3F	2	1834	1834a	1834	2	66.67
TGx 1448-2E	3	1771	1771a	1771	2	66.67
TGx 1989-19F	4	1579	1579b	1579	1	33.33
SC-SIGNA	1	917	917c	917	0	0
	LSD	105.6	105.6	105.6		

Key: SY = seed yield, M = the number of significantly inferior varieties, P= cultivar performance index (%); LSD= least significant difference; DMRT= Duncan's multiple range test.

Table 4: Correlation coefficient of agronomic traits of four soybean varieties plant at Badeggi and Mokwa in 2022 cropping season

	DTF	DTM	NODU	PLHT	PC	PODS	SHAT	LODG	FWT	SY
DTM	0.992**									
NODU	0.357^{ns}	0.355^{ns}								
PLHT	0.995**	0.987**	0.363^{ns}							
PC	0.891**	0.918**	0.598^{ns}	0.888**						
PODS	0.996**	0.991**	0.417^{ns}	0.990**	0.907**					
SHAT	-0.319^{ns}	-0.342^{ns}	0.745*	-0.303^{ns}	-0.064^{ns}	-0.264^{ns}				
LODG	-0.284^{ns}	-0.303^{ns}	0.773*	-0.264^{ns}	-0.021^{ns}	-0.228^{ns}	0.997**			
FWT	0.996**	0.997**	0.339^{ns}	0.987**	0.902**	0.995**	-0.352^{ns}	-0.317^{ns}		
SY	0.973**	0.941**	0.290^{ns}	0.969**	0.774*	0.965**	-0.326^{ns}	-0.299^{ns}	0.957**	
HSWT	0.685^{ns}	0.704*	0.886**	0.684^{ns}	0.897**	0.729*	0.371^{ns}	0.410^{ns}	0.686^{ns}	0.573^{ns}

Key: DTF= days to 50% flowering; DTM= days to 95% maturity; PLHT= plant height at maturity (cm); PDHT= lowest pod height or first pod height at maturity (cm); SY= seed yield in kg/ha; NODU= nodulation scores; PC= pod clearance (cm); PODS= pods per plant; Shat= shattering scores; Lodg= lodging scores; FWT= fodder weight in kg/ha, HSWT= hundred seed weight in grams.

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EVALUATION OF FIVE COWPEA (*Vigna unguiculata* (L.) Walp) GENOTYPES FOR FODDER YIELD AND FODDER YIELD COMPONENTS

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Abstract
The present study was carried out to evaluate five cowpeas (Vigna unguiculata (L.) Walp) genotypes for fodder yield and fodder yield components. The experiment was conducted at the Teaching and Research Farm of the Joseph Sarwuan Tarka University Makurdi, Benue State, Nigeria (Latitude 7.41°N and Longitude 8.39°E). The experiment was a Randomized Complete Block Design (RCBD) with three replications during the 2022 growing season. The treatment comprised of five varieties of cowpea which included: IT89KD-288, UAM09 1051-1, Golam white, UAM09 1055-6 and UAM10 2021-1. The five cowpea varieties were obtained from the Molecular Biology Laboratory of the University of Agriculture Makurdi. Mean performance of varieties revealed highly significant differences among growth parameters like plant height, dry stem weight, dry leaf weight and number of branches per plant among the five different varieties of cowpea. Cowpea fodder yield correlated positively with days to first flowering (0.62), dry leaf weight (1.00), dry stem weight (1.00) and number of branches per plant (0.64). Total plant biomass was positive and highly significant correlated with days to first flowering (0.69), dry leaf weight (0.76), dry stem weight (0,76), number of branches per plant (0.75) and fodder yield kg/ha (0.76). Even though this correlation was not significant at P=0.01, the result suggests that these traits may be used as indirect selection criteria for fodder yield. The results indicated that cowpea is important forage crop with their yield and quality. Therefore, there is need for new studies to determine fodder yield of different genotypes to improve high yielding forage type varieties in Makurdi. The varieties, IT89KD-288 and Golam white had the highest fodder yield over the others hence they are recommended to livestock farmers as animal feeds in Makurdi. Also, varieties UAM09 1055-6 and UAM09 1051-1 had the highest grain yield hence they are recommended to farmers for maximum yield and productivity in Makurdi.

Keywords*:* Cowpea, genotypes, fodder yield, correlation.

Introduction
Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important pulse crops; native to Central Africa and belongs to the family *Fabaceae*; Cowpea is called vegetable meat due to high amount of protein in the grain with better biological value on dry weight basis (Withanage, 2005). Cowpea grain on dry weight basis contains 23.4 per cent protein, 1.8 per cent fat and 60.3 per cent carbohydrates and it is a rich source of calcium and iron (Gupta, 1988). Apart from this, cowpea forms excellent forage and it gives a heavy vegetative growth which covers the ground so well that it checks soil erosion. As a leguminous crop, it fixes about 70 – 240 kg per ha of nitrogen per year Cowpea is mainly grown in tropical and sub-tropical regions of the world for vegetable and seed purpose and to a lesser extent as a fodder crop (Gupta, 1988). It is a versatile pulse crop because of its smothering nature, drought tolerant characters, soil restoring properties and multi-purpose uses. As a pulse crop, cowpea fits well into most of the cropping systems. It has been estimated that the total pulse requirement for consumption by 2010