STUDIES ON THE INTERRELATIONSHIP BETWEEN YIELD AND AGRONOMIC TRAITS IN SOME SELECTED SOYBEAN LINES AT YANDEV IN SOUTHERN GUINEA SAVANNAH OF NIGERIA

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Abstract: A field trial was conducted during the 2010 cropping season at the experimental farm of Akperan Orshi College of Agriculture, Yandev–Gboko, Benue State. The plots were laid in Randomized Complete Block Design with three replications. The analysis of variance showed significant in difference in nodule dry weight; days to 50% flowering; days to maturity; plant height at maturity; number of branches; number of pods per plant; number of seeds/ plant; and weight of 100 seeds among the genotypes studied. The result of this experiment conducted showed that there were highly significant correlation on number of pods per plant, number of seeds per plant, and significant correlation of one hundred seed with seed yield. The results of the path coefficient analysis also showed that number of pods per plant exerted the highest direct effect on seed yield. Weight (g) of one hundred seeds showed the least direct effect among the traits evaluated. The regression on seed yield and its component character also showed that number of pods per plant had the highest contribution to seed yield with the proportion due to regression being 48%. The relative contribution of number of branches per plant to seed yield was 2%.

Keywords: Correlation, genotypes, path analysis, regression, soybean.

Introduction

Soybean (*Glycine max* (L.) Merrill) 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 & al. 2007]. Soybean grains contain about 40% protein, 20% oil, an optimal supply of essential amino acids and nutrients, and a high calorie value [SINGH & al. 2008]. The main goal of growing crops is to maximize net profit through increasing grain yield [ALGHAMDI, 2004]. Hence, the primary goal of most soybean breeding programs is high grain yield [TOLEDO & al. 2000]. According to GRAFIUS (1959) increasing total yield would be made easier by selecting for the yield components because the yield components are more simply inherited than the total yield itself. Thus, studies on correlation enable the breeder to know the mutual relationship between various characters and determine the yield components to select, to improve the yield of the crop. Seed yield, as complex trait, is the result of the expression of the association of several plant growth components. So, selection for seed yield should take into account related characters. Hence, the knowledge of correlation between yield and yield components and among the components themselves is essential for yield improvement through selection programs. The objectives of this study was to determine

the genetic variability that exist among the selected genotypes; to estimate the correlation coefficients between the seed yield of soybean and its components; and to identify traits that influenced yield of soybean and select them in order to improve its' yield.

Material and methods

The experimental material for the present study comprised of twenty(20) elite soybean genotypes. The sources and characteristics of these soybean genotypes used are presented in Table 1. A field trial was conducted during the 2010 cropping season at the experimental farm of the Akperan Orshi College of Agriculture, Yandev–Gboko, Benue State. Soil samples were taken from experimental site for analysis to determine the physical and chemical properties at the NICANSOL soil testing laboratory of the University of Agriculture, Makurdi. The textural class and the chemical properties of the soil are presented in Table 2a & Table 2b. The site is 117 m above sea level (a.s.l.m.) as altitude, $07^{\circ}22^{`}$ N and $08^{\circ}37^{`}$ E as longitude and latitude respectively.

Table 1. Soybean Genotypes, Sources and Characteristics.

S/N	Genotype Code	Sources	Variety's Characteristics
1	NCRI SOY 16	NCRI, Badeggi	Medium maturing, resistant to shattering
2	NCRI SOY 5	NCRI,Badeggi	Medium maturing, resistant to shattering
3	SAMSOY 2	UAM	Medium maturing, susceptible to shattering
4	TGX 1440 – 1E	IITA, IBADAN	Medium maturing, resistant to shattering
5	TGX 1448 – 2E	IITA, IBADAN	Medium maturing, resistant to shattering
6	TGX 1485 -1D	IITA, IBADAN	Early maturing, low shattering
7	TGX 1835 -10E	IITA, IBADAN	Early maturing, low shattering
8	TGX 1904 -6F	IITA, IBADAN	Medium maturing, resistant to shattering
9	TGX 1984 -17F	IITA, IBADAN	Late maturing
10	TGX 1984 19F	IITA, IBADAN	Late maturing
11	TGX 1984 -1F	IITA, IBADAN	Late maturing
12	TGX 1984 -22F	IITA, IBADAN	Late maturing
13	TGX 1984 -5F	IITA, IBADAN	Medium maturing
14	TGX 1985 -12F	IITA, IBADAN	Medium maturing
15	TGX 1986 -1F	IITA, IBADAN	Medium maturing.
16	TGX 1987 -10F	IITA, IBADAN	Extra early maturing, resistant to shattering
17	TGX 1987 -19F	IITA, IBADAN	Late maturing
18	TGX 1987 -57F	IITA, IBADAN	Medium maturing
19	TGX 1987- 62F	IITA, IBADAN	Extra early maturing, resistant to rust
20	TGX 923 -2E	IITA, IBADAN	Late maturing

Abbreviations: NCRI = National Cereals Research Institute, UAM = University of Agriculture, Makurdi, IITA = International Institute for Tropical Agriculture, Ibadan.

Tab. 2a. Physical properties of the **Yandev-Gboko, Benue State**.

Soil Parameters	Yandev-Gboko, Benue State	
Particle Size Distribution (%)	Sand	80.0
	Silt	15.9
	Clay	4.1
Textural Class	Loamy Sand	
pH	6.15	
H_2O	1:1	

Tab. 2b. Chemical properties of the soil at **Yandev-Gboko, Benue State**.

	Yandev-Gboko, Benue State	
Organic (%)	C	0.63
	M	1.09
	N	0.088
Available	P (ppm)	2.79
Exchangeable bases	(Cmol kg^{-1})	
	Ca	2.41
	Mg	1.92
	K	0.76
	Na	0.48
	CEC (Meq/100g)	5.87
Abbreviations: C = carbon, M = magnesium, N = nitrogen, CEC = cation exchange capacity		

The experimental site was cleared, ploughed, harrowed, and ridged in mid-June to mid-July of the year 2010. Plots were laid in a Randomized Complete Block Design (RCBD) with three replications. Plot size was 5 m x 1.5 m, giving a plot area of 7.5 m^2. Inter-row spacing was 0.75 m apart. Planting was done by drilling 200 seeds in each plot. All entries were planted on 12th July, 2010. Pendametalin was applied as pre-emergence herbicide within 24hrs after sowing. Hoe weeding was done later as often as weeds were observed in the field. Side dressing was done using P_2O_5 (26%) at the rate of 30Kgha^{-1}. Cypermethrin (a broad spectrum insecticide) was applied to the crop as often as infestation was observed in the field. Data collected were on the following parameters: number of seeds per pod, and 100 seed weight. nodule dry weight; days to 50% flowering; plant height at flowering; days to maturity; plant height at maturity; number of branches; number of pods per plant; pod weight; number of seeds / pod; number of seeds / plant; weight of 100 seeds; and yield in tons per hectare. The data was subjected to statistical analysis as described by STEEL & TORRIE (1980).

Table 3. Analysis of variance of traits of elite Genotypes of Soybean evaluated at Yandev during the 2010 cropping season.

Traits	Meansquares		
	Block	**Entries**	**Error**
d.f	2	19	38
NDW (g)	1.12	0.15*	0.07
DF	2.15	10.14*	44.32
PHF (cm)	17.08	10.62	6.84
DM	77.27	95.45**	16.11
PHM (cm)	59.02	31.72	20.50
NB	3.99	0.81*	0.45
NPP	2589.4	341.7*	156.1
PW (g)	0.01	0.01	0.01
NSP^1	0.00	0.01**	0.00
NSP^2	10729.0	4895.0	4837.0
WHS (g)	1.62	2.85**	0.71
Yld(ton ha^{-1})	33.55	1.07*	0.75

Abbreviations: NDW(g) – Nodule dry weight; DF – Days to 50% flowering; PHF(cm) – Plant height at flowering; DM – Days to maturity; PHM(cm) – Plant height at maturity; NB – Number of branches; NPP – Number of pods per plant; PW(g) – Pod weight; NSP^1 – Number of seeds / pod; NSP^2 – Number of seeds / plant; WHS(g) – Weight of 100 seeds; Yld(ton ha^{-1}) – Yield in tons per Ha.

Results

The analysis of variance showed that, the genotypes were statistical different for all the traits studied exception of plant height at maturity, pod weight and number of seeds per plant - Table 3. Mean yield and agronomic performance of seed yield and its component characters in soybean evaluated at Yandev is presented in Table 4. From this Table, the genotypes that have highest yields are NCRI SOY 5 (3.24 t/ha), TGX 1904 – 6F (2.93 t/ha) and TGX 1984 – 22F (2.88 t/ha). The genotypes that served as check viz. TGX 1440 – 1E, TGX 1448 – 2E, TGX 1485 – 1D, TGX 1835 – 10E and TGX 923 – 2E yielded 1.36 t/ha, 1.66 t/ha, 1.95 t/ha, 1.62 t/ha and 1.4 t/ha respectively. Therefore, genotypes like NCRI SOY5 (3.24 t/ha), TGX 1904 - 6F (2.93 t/ha), TGX 1984 – 1F (2.48 t/ha) and TGX 1984 – 22F (2.88 t/ha) yielded more than the checkers.

Table 4. Mean performance of seed yield and its components in Soybean evaluated at Yandev during the 2010 Season.

Entries	NDW (g)	DM	PHM (cm)	NB	NPP	PW (g)	NSP^1	NSP^2	WHS (g)	Yld (ton h^{-1})
NCRI SOY 16	0.807	111.33	33.47	3.467	54.5	0.333	2.067	125.5	10.91	1.91
NCRI SOY 5	0.663	113.00	39.07	4.333	42.5	0.387	2.067	75.5	11.77	3.24
SAM SOY 2	0.700	114.33	37.90	4.467	52.5	0.330	2.000	73.7	11.05	1.21
TGX 1440-1E (check)	0.540	110.33	31.07	3.867	36.3	0.333	2.000	63.3	10.42	1.36
TGX 1448-2E (check)	0.503	112.00	28.73	3.933	43.2	0.277	2.000	93.3	10.50	1.66
TGX 1485-1D (check)	0.723	110.33	28.73	3.000	39.9	0.377	2.133	58.5	9.49	1.95
TGX 1835-10E (check)	0.843	96.67	31.80	3.800	32.2	0.387	2.067	63.9	10.87	1.62
TGX 1904-6F	0.313	106.67	32.73	3.400	62.3	0.277	2.000	133.7	10.46	2.93
TGX 1984-17F	0.367	106.33	34.40	4.267	47.6	0.417	2.133	186.5	8.81	1.68
TGX 1984-19F	0.360	103.00	37.73	3.067	36.9	0.347	2.000	46.6	9.56	1.65
TGX 1984-1F	0.323	112.67	27.87	3.333	55.1	0.443	2.000	117.5	10.18	2.48
TGX 1984-22F	0.873	108.00	32.33	4.333	71.3	0.347	2.000	139.9	9.56	2.88
TGX 1984-5F	0.483	103.00	31.67	3.733	48.5	0.390	2.000	60.5	9.56	1.77
TGX 1985-12F	0.747	107.00	31.13	4.533	43.0	0.390	2.000	60.7	9.17	1.23
TGX 1986-1F	0.983	108.33	35.60	4.000	53.0	0.387	2.000	80.6	10.64	1.76
TGX 1987-10F	0.440	100.33	35.73	2.600	27.6	0.443	2.000	49.8	11.17	1.11
TGX 1987-19F	0.727	114.00	33.00	3.80	52.2	0.387	2.000	101.5	9.27	1.91
TGX 1987-57F	0.993	105.33	34.47	4.133	46.9	0.360	2.133	56.9	9.63	1.60
TGX 1987-62F	1.007	103.67	38.40	3.467	61.3	0.387	2.000	53.6	8.81	1.40
TGX 923-2E (check)	0.753	121.33	34.07	3.867	43.7	0.207	2.000	157.3	7.80	1.40
Lsd (5%)	0.452	6.63	7.48	1.111	20.6	0.16	0.105	114.9	1.39	1.43
CV	41.6	3.7	13.5	17.8	26.3	26.9	3.1	77.3	8.5	47.2

Key: NDW(g) – Nodule dry weight; DM – Days to maturity; PHM(cm) – Plant height at maturity; NB – Number of branches; NPP – Number of pods per plant; PW(g) – Pod weight; NSP^1 Number of seeds / pod; NSP^2 – Number of seed / plant; WHS(g) – Weight of 100 seeds; Yld (ton ha^{-1}) – Yield in tons per Ha.

The genotypic correlation coefficient analysis for seed yield and components of soybean evaluated is presented in Table 5. This table shows that number of branches per plant, number of pods per plant, number of seeds per plant and weight of one hundred seeds were significantly correlated with seed yields.

Table 5. Correlation coefficients of seed yield and its components in soybean evaluated at Yandev during the 2010 season

Variables	PHM	NB	NPP	PW (G)	NDW	NSP[1]	NSP[2]	WHS	YLD
PHM		0.361*	0.216	0.209	0.288*	0.022	0.154	0.209	0.162
NB			0.573**	-0.007	0.316*	-0.125	0.407**	0.058	0.323*
NPP				0.024	0.359*	-0.129	0.579**	0.089	0.471**
PW (g)					-0.004	0.190	0.059	0.161	0.149
NDW (g)						-0.081	0.106	0.007	0.059
NSP¹							-0.130	-0.186	0.058
NSP²								0.142	0.487**
WHS (g)									0.288*

* = significant at 5%, ** = significant 1%.
Key: PHM(cm) – Plant height at maturity; NB – Number of branches; NPP – Number of pods per plant; PW(g) – Pod weight; NDW(g) – Nodule dry weight; NSP[1] – Number of seeds / pod; NSP[2] – Number of seeds / plant; WHS(g) – Weight of 100 seeds; and Yld (ton ha^{-1}) – Yield in tons per hectare.

Path coefficient analysis for yield and yield component traits of soybean evaluated is presented in Table 6. Direct effects indicated in bold showed that number of seeds per plant had the highest direct effect (0.2872) with yield while number of pods per plant (0.0258) had the least direct effect with yield. Figure 1 revealed the path diagram for yield and yield components of soybean evaluated at Yandev during the 2010 season. The double-arrowed lines indicate the genotypic correlation between traits while the single- arrowed lines indicate the path coefficients (direct effect).

Table 6. Direct (bold) effect of seed yield and its component characters in soybean evaluated at Yandev during the 2010season.

Variables	NB	NPP	NSP2	WHS	YLD
NB	**0.0450**	0.1482	0.0116	0.0129	0.323
NPP	0.0258	**0.0258**	0.1664	0.0198	0.4708
NSP²	0.0184	0.1499	**0.2872**	0.0314	0.487
WHS	0.0026	0.0231	0.0407	**0.2210**	0.288

* = significant at 5%, **= significant 1%.
Key: NB – Number of branches; NPP – Number of pods per plant; NSP[2] – Number of seeds/ plant; WHS(g) – Weight of 100 seeds; YLD (ton ha^{-1}) – Yield in tons per hectare.

The stepwise regression analysis of the contribution of some agronomic characters to seed yield at Yandev is presented in Table 7. The regression of yield on number of pods per plant and weight (g) of one hundred seeds were significant while the regression of other yield components under study were not significant. The proportion of the variability that existed in the soybean when only number of pods per plant was involved in the yield equation was 48%. That of weight (g) of one hundred seeds was 6%.

Table 7. Regression of seed yield and its components in soybean evaluated at Yandev during the 2010 season.

Model	Variables	Coefficient of variation	R^2	R^2 change	Proportion due to regression	Cumulative regression	Significance
1	NPP	0.482[a]	0.232	0.219	48%	48%	0.05
2	WHS (g)	0.542[b]	0.293	0.269	6 %	54%	0.05

Where: Predictors: (Constant), NPP; Predictors: (Constant), NPP, WHS (g); Dependent variable: Yld (t/ha)

Discussions

The highly significant and significant variability exhibited in the twelve 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. These results agreed with the findings of GHATGE & KADU (1993) and RASAILY & al. (1986), SHAAHU & al. (2012, 2014) who obtained considerable genotypic variability for seed yield.

The results of the correlation coefficient analysis revealed that seed yield had highly significant positive correlation with number of pods per plant and number of seeds per plant. Similarly, seed yield had significant positive correlation with number of branches per plant and weight of one hundred seeds. Number of branches per plant had positive and highly significant correlation with the number of pods per plant and number of seeds per plant. Many researchers: NAKAWUKA & al. (1999), IQBAL & al. (2003) and MALIK & ADIPALA (2006) also found highly significant genotypic correlation coefficient of seed yield with number of pods per plant. MALIK & al. (2007), TAYYAR (2007), COPUR & al. (2009) and SHAAHU& al. (2012, 2014) showed that the seed yield was positively and significantly correlated with pod number, fruit branch and 1000-seed weight. These results are in agreement with other reports by AKTHER & SNELLER (1996) and BOARD & al. (1997) who found strong positive correlations between seed yield with pods per plant and seeds per plant.

The results of the path analysis indicated that the direct effect of number of branches per plant, number of pods per plant, number of seeds per plant and weight (g) of one hundred seeds. This confirms the results of KHAN & al. (2000); SINGH & YADAVA (2000) who reported that 100-seed weight, branches per plant, number of pods per plant and number of seeds per plant had direct effects on seed yield in soybean. This shows that selecting for these characters may lead to increase in seed yield.

The coefficient of determination (R^2) explains the amount of variability in yield due to number of pods per plant and weight of one hundred seeds. The F-test revealed a highly significant regression value for all levels of combination of the yield components as well as their combination have significant effects on yield. The F-test showed that only number of pods per plant and weight of one hundred seeds are statistically significant (regression coefficient of 0.48 and 0.06 respectively). This seems to indicate that only number of pods per plant and weight of one hundred seeds currently influence yield. The proportion due to regression for number of pods per plant on seed yield was 48% and that of weight of one hundred seeds was 6%.

The results of the experiment seem to suggest that, in breeding, the traits to consider for when breeding pods per plant, seeds per plant and weight of one hundred

seeds. Moreover, it may be recommended that more research should be conducted using the population in this experiment so as to get a more stable results over location and year.
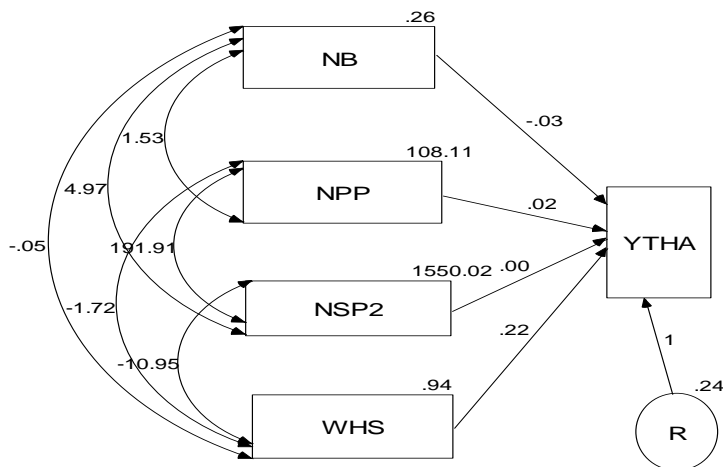
Figure 1. Path diagram for yield and yield components of soybean evaluated at Yandev during the 2010 season. [**Key**: Double-arrowed lines indicate the genotypic correlation between traits. Single-arrowed lines indicate the path coefficients (direct effect). NB – number of branches per plant; NPP – Number of pods per plant; NSP2 – Number of seeds per plant; WHS – Weight of one hundred seeds; YTHA – Yield in tons per hectare; and R – Error].

Conclusions

The analysis of variance showed significant in difference in nodule dry weight; days to 50% flowering; days to maturity; plant height at maturity; number of branches; number of pods per plant; number of seeds/ plant; and weight of 100 seeds among the genotypes studied. The result of this experiment conducted showed that there were highly significant correlation on number of pods per plant, number of seeds per plant, and significant correlation of one hundred seed with seed yield. The results of the path coefficient analysis also showed that number of pods per plant exerted the highest direct effect on seed yield. Weight (g) of one hundred seeds showed the least direct effect among the traits evaluated. The regression on seed yield and its component character also showed that number of pods per plant had the highest contribution to seed yield with the proportion due to regression being 48%. The relative contribution of number of branches per plant to seed yield was 2%.

Notes on contributors

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