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RESEARCH ARTICLE

Correlation, path coefficient and principal component analysis of seed yield in soybean genotypes

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Abstract

This study was aimed at determining grain yield selection criteria using principal component analysis, correlation and path coefficient analysis. The experiment was carried out using seventeen medium duration soybean genotypes laid in a randomized complete block designin 2009 at at Teaching, Research and Experimental Farm of University of Agriculture Makurdi and at AkperenOrshi College of Agriculture Yandev, Benue State Nigeria. Results revealed that their PCA implicated pods per plant, seed yield, plant height and first pod height for accounting for the most variability in the soybean genotypes. Correlation coefficient of seed yield was significant and positive with pods per plant. Increase in this trait will ultimately increase the seed yield. Correlation coefficient also revealed a strong negative association of seed yield with first pod height. Path coefficient analysis revealed that first pod height had the largest negative direct effect on seed yield. It seems that the lower the first pods on a plant, the higher the yield.

Introduction

Soybean is a legume that grows in tropical, subtropical and temperate climates. Soybean is an important source of high quality, inexpensive protein and oil. Soybean has the highest protein content (40 to 42%) of all other food crops and is second only to ground nut in terms of oil content (18 to 22%) comprising 85% unsaturated fatty acids and is free from cholesterol, among food legumes, so it highly desirable in the human diet (Antalina et al., 1999). It is however, characterized by low yield, partly because of low yield varieties, lodging and pod shattering, in addition to other production constrain.
Selection for seed yield, which is a polygenic trait, often leads to changes in other characters. Therefore, the knowledge of relationship between seed yield and other characters is desirable to be able to choose the appropriate selection programme during breeding. Correlation studies enable the breeder to the strength of relationship between various characters as well as the magnitude and direction of changes expected during selection. Path coefficient analysis measures the direct and indirect effect for one variable upon another and permits the separation of the correlation coefficient into components of direct and indirect (Dewey and Lu, 1959). Principal component analysis explains the contribution of the most important traits that account for the total genetic variability.
The objective of this study was to determine the component characters whose selection would lead to improvement in seed yield of soybean genotypes in two locations that have comparative advantage in growing soybean in Benue state, using principal component analysis, correlation coefficient and path coefficient analysis.

Material and Methods

Seventeen advanced soybean genotypes obtained from International Institute of Tropical Agriculture Ibadan (IITA), were planted in randomized complete block design with three replications during the 2009 cropping season at Teaching, Research and Experimental Farm of University of Agriculture Makurdi and at AkperenOrshi College of Agriculture Yandev. The experimental sites were all ploughed and harrowed twice. The planting dates were 7th and

14th of July, 2009 at Makurdi and Yandev respectively. The soil texture was sandy loam which is good for soybean production. Each plot consisted of four rows of 3m length with a row to row distance of 50cm maintaining 20 plants per meter in length. Recommended package of cultivation practices were followed and a good crop stand was achieved. Five plants were selected at random to take data on first pod height, plant height, number of pod per plant, number of branches per plant, nodulation scoring. Whereas days to 50% flowering, days to maturity, shattering score, lodging score, 300 seed weight and seed yield were taken on plot basis. Shattering: ten days to two weeks after maturity, plants in each plot were for shattering and scored on a 1- 5 scale: 1= non of the pod shattered, 2=less than 25% shattered, 3= 25 - 50% shattered,4=50 - 75% shattered and 5=more than 75% shattered. Simple linear correlation and principal component analysis were performed using SAS1977.Path coefficient analysis was performed using Amos graphics.

Result and Discussion

Principal component analysis.

The data revealed that the 3 principal components having greater than one eigenvalues contributed 69.77% of the total variation among the 17 genotypes of soybean (Table 2). It was found that PC1 contributed 35.8%, whereas PC2 and PC3 contributed 22.4 and 18.2% respectively of the total variation. The traits which contributed more to PC1 were seed yield, pods per plant, branches and first pod height.PC2 was dominated by plant height, while the PC3 was dominated by days to 50% flowering, days 90% maturity and 300 seed weight. The first 3 PCs explained 76.4% of the total variation in the seven variable data set. The PC1, PC2 and PC3 showed relatively large variation (eigenvalues 2.87, 1.79 and 1.46 respectively I Table 2). These eigenvalues were greater than one and represented exact linear dependency, but the rest had small or modest variances (eigenvalues less than 0.7). Ghafoor et al., (2003) evaluated chickpea accessions by using multivariate techniques. The first three PCs with eigenvalues greater than one contributed 83.3% of the variability amongst genotypes.Ghafoor et al., (2001) studied genetic diversity in blackgramgermplasm accessions; quantitative traits were analyzed for cluster and principal component analysis. The first four PCA with eigenvalues greater than one contributed 79.5% of that total variability among accessions. Iqbal et al., (2008) evaluated soybean genotypes by using multivariate techniques. The first 3 PCs with eigenvalues greater than one contributed 69.77% of the total variability among the soybean genotypes. He observed that PC1 were implicated by number of filled pods, grain yield per plant, biological yield per plant and harvest index (%).

Correlation Studies.

Knowledge of the relationship among plant characters is useful while selecting traits for yield improvement. Estimation of simple correlation was made among 8 important yield components with seed yield of seventeen genotypes of soybean (Table 3). Correlation coefficient revealed that seed yield was highly significant and positively correlated with pods per plant.The positive and strong association of pods per plant with seed yield revealed the importance of this trait in determining seed yield. This indicates that high mean values for this trait can increase the seed yield. Positive association of seed yield with plant height, 300 seed weight and branches were observed. Vange*et al* (1995) reported positive and significant association of seed yield with number of pods per plant. Rajput et al., (1986) and Yao et al., (1987) also reported similar results of correlation between pods per plant and grain yield. Iqbal et al., (2003) reports positively and highly significant correlation of grain yield with plant height, pods per plant and 100 seed weight. Seed yield had a negative correlation with days to 50% flowering and days to maturity. Ramteke et al., (2010) reported that grain yield was negatively associated with both days to flowering and maturity. Similar results were obtained by Malik et al (2006).Arshad et al., (2006) reported negative association of grain yield with days to flowering and maturity. The negative associations of characters like days to flowering and maturity will become problem in combining these important traits in a single genotypic for high grain yield. Some suitable recombination might be obtained through bi-parental mating, mutation breeding or diallel selective mating by breaking undesirable linkage as suggested by Ghafoor et al., (1990).

Path coefficient analysis is presented in Table 4 and Figure 1. Path analysis revealed that seed yield was positive and directly affected by plant height, 300 seed weight and branches. Whereas, first pod height, pods per plant, days to 50% flowering and days to maturity had negative direct effects on seed yield. This suggested that selection on the basis of these traits might lead to the loss in terms of seed yield. Similar findings were reported by Malik et al., (2006) that direct effect of first pod height, days to 50% flowering, days to maturity, plant height on seed yield was negative. Yared (2011) reported negative direct effect of days to 50% flowering, plant height and pods per plant on seed yield in Brassica carinata. The negative direct effect of pods per plant could be attributed to the negative indirect effect of days to 50% flowering on pods.

PCA revealed that the most implicated traits were seed yield, pods per plant, first pod Height and branches. Correlation revealed positive and strong association of seed yield with pods per plant. A strong negative correlation of seed yield with first pod height was observed. Path coefficient revealed a strong negative direct effect of first pod height on seed yield. Therefore, first pod height selection may be effective in improving the seed yield.

First pod height had a negative and significant correlation with grain yield, pods per plant, branches per plant and plant height. Since pods are born on the stem, and branches, It seems that the higher the first pods on a plant, the lower the yield and vice versa. Copur et al., (2009) reported negative and significant correlation of grain yield with first pod height.

Days to flowering and maturity negatively correlated with grain yield, 300 seed weight and branches per plant in medium duration genotypes of soybean studied. This means within the medium maturity group, as the mean values of days to flowering and maturity tends to increase, grain yield is affected

Generally, the highly correlated variables (e.g pods per plant, branches per plant and plant height) contributed greater variation in yield traits as shown by the first principal analysis. A total of 60.84% of the variation was contributed by these traits. Hence selection for yield using the traits is effective.

Table 1: Mean Yield and Agronomic Performance of medium maturity soybean lines evaluated in 2009.

Gen	DTF	DTM	Ht	Shat	Sdwt300	PPP	Bch	HtFP	YTHA
TGX1985-4F	42.67	97.50	63.73	1.5	41.29	64.43	2.47	10.97	2.76
TGX1985-8F	42.33	100.50	51.50	1.3	41.07	54.60	3.18	9.70	1.71
TGX1985-10F	43.00	94.00	51.80	2.3	43.32	65.80	1.55	12.62	1.65
TGX1985-11F	43.00	99.00	59.77	1.2	41.45	63.10	2.70	9.10	2.51
TGX1985-12F	42.33	97.67	53.87	1.3	40.39	47.20	2.23	12.53	1.67
TGX1986-1F	42.00	98.67	55.87	2.0	43.53	49.43	1.97	12.03	1.77
TGX1986-2F	42.00	96.33	55.40	1.0	42.67	46.23	1.98	10.93	2.66
TGX1986-3F	42.50	99.50	55.85	1.1	43.36	56.50	2.53	11.17	2.02
TGX1987-3F	45.50	99.83	57.73	1.0	42.34	61.13	2.10	8.47	2.09
TGX1987-14F	45.33	98.33	73.12	1.7	37.98	48.70	1.87	14.20	1.29
TGX1987-15F	44.33	98.00	65.40	1.5	41.67	47.63	1.93	12.00	1.900
TGX1987-19F	44.17	97.50	64.83	1.2	41.59	51.27	1.93	14.83	1.95
TGX1987-35F	44.83	97.83	62.60	1.5	43.61	50.23	2.13	16.07	1.86
TGX1987-37F	43.83	96.50	48.93	16	39.85	44.73	1.50	13.20	2.08
TGX1987-38F	44.17	97.33	76.67	1.3	43.01	80.33	2.03	10.15	2.67
TGX1987-40F	42.50	97.33	66.53	1.3	39.85	39.00	1.73	15.50	1.58
TGX1740-2F	43.00	99.83	47.30	1.2	39.72	31.87	1.43	13.97	1.23
Lsd	2.269	0.469	10.63	0.7	2.58	15.94	0.63	1.74	0.45

DTF=days to 50% flowering, DTM=days to maturity, HT= plant height (cm), SHAT= shattering scores, SDWT= 300 seed weight (g), PPP= pods per plant, BCH= branch per plant, HTFP= first pod height (cm), YTHA= seed yield (t/ha).

Table2. Results of principal component analysis (PC) among growth traits of soybean genotypes grown in 2009 cropping season.

Eigenvalue	2.867	1.788	1.456
Proportion	0.358	0.224	0.182
Cumulative	0.358	0.582	0.764
Variables	PC1	PC2	PC3
DTF	-0.071	-0.458	**0.494**
DTM	0.064	0.458	**0.584**
HT	0.110	**-0.531**	0.400
SWT	0.354	-0.082	**-0.369**
PPP	**0.494**	-0.297	0.027
BCH	**0.398**	0.356	0.283
HFP	**-0.480**	-0.224	-0.084
YTHA	**0.470**	-0.165	-0.175

DTF=days to 50% flowering, DTM=days to maturity, HT= plant height (cm), SWT= 300 seed weight (g), PPP= pods per plant, BCH= branch per plant, HFP= first pod height (cm), YTHA= seed yield (t/ha).

Table 3: Correlation coefficient between pairs of agronomic traits of soybean grown in 2009.

	DTF	DTM	HT	SWT	PPP	BCH	HFP
DTM	0.064						
HT	0.477	-0.072					
SWT	-0.140	-0.158	-0.056				
PPP	0.168	-0.165	0.395	0.500			
BCH	-0.244	0.530*	0.029	0.190	0.383		
HFP	0.141	-0.310	0.112	-0.294	-0.593*	-0.566*	
YTHA	-0.124	-0.192	0.238	0.435	0.610**	0.340	-0.548*

*** Correlation significant at the 0.01 probability level; * Correlation significant at the 0.05 probability level.*

DTF=days to 50% flowering, DTM=days to maturity, HT= plant height (cm), SWT= 300 seed weight (g), PPP= pods per plant, BCH= branch per plant, HFP= first pod height (cm), YTHA= seed yield (t/ha).

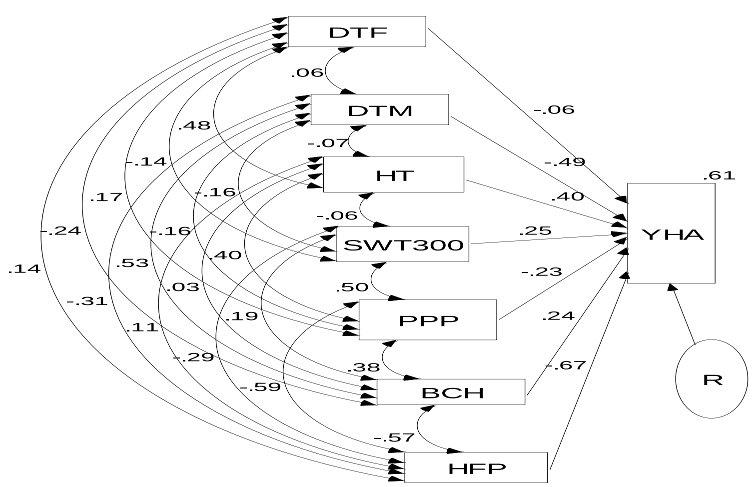
Table 4.Direct effect (bold), indirect effect and genotypic correlation of yield-related traits with yield of soybean genotypes grown in 2009.

	DTF	DTM	Ht	SWT	PPP	BCH	HFP	Correlation
DTF	**-0.06**	-0.029	0.192	-0.035	-0.039	-0.58	-0.094	-0.123
DTM	-0.004	**-0.490**	-0.028	-0.040	0.037	0.127	0.208	-0.189
HT	-0.029	-0.028	**0.400**	-0.015	-0.092	0.007	-0.074	0.169
SWT	-0008	0.078	-0.024	**0.250**	-0.115	0.046	0.194	0.438
PPP	-0.010	0.078	0.160	0.125	**-0.230**	0.091	0.395	0.609
BCH	0.014	-0.259	0.012	0.048	-0.087	**0.240**	0.382	0.349
HFP	-0.008	0.152	0.044	-0.073	0.136	0.137	**-0.670**	-0.556

**values bold are the direct effect to yield (path coefficients)*
**other values are indirect effects via different pathways except the genotypic correlation with yield.*

DTF=days to 50% flowering, DTM=days to maturity, HT= plant height (cm), SWT= 300 seed weight (g), PPP= pods per plant, BCH= branch per plant, HFP= first pod height (cm), YTHA= seed yield (t/ha).

Fig. 1 Diagram of the direct and indirect relationships of seed yield with its components, using path coefficient analysis
Single- arrowed lines indicate the path coefficients (direct effect)
Double-arrowed lines indicate the genotypic correlation between traits



DTF=days to 50% flowering, DTM=days to maturity, HT= plant height (cm), SWT= 300 seed weight (g), PPP= pods per plant, BCH= branch per plant, HFP= first pod height (cm), YTHA= seed yield (t/ha)

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