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Research Note

Studies on relationship between seed yield and yield components in soybean *(Glycine max L. Merrill*)

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Abstract
A study was conducted on 56 genotypes of soybean to determine correlation and per cent contribution of variation by each trait on grain yield through principal component analysis. Mean Values for traits studied showed that TGx1987-64F had the highest yield of 2.09 t/ha, followed by TGx 1987-37-37F. Correlation coefficient for seed yield was positive with days to flowering and maturity, plant height and number of pods per plant. The principal component analysis identified the traits days to maturity, plant height and number of pods per plan as mostly responsible for variation among the genotypes. Highly weighted variables under the first principal component which explained 39.83% of the total variation include days to maturity, plant height and number of pods per plant. The second principal component explained an additional 20.52% of the total variation. These two components explained 60.36% of the total variation in all the variables. Therefore, genetic enhancement of these traits will ultimately increase the grain yield.

Key words
Soybean, correlation, principle component analysis, yield.

The world-wide importance of soybean (*Glycine max (L.) Merrill*) is well known. Nevertheless, in most developing countries, there is a wide gap between its supply and demand. Plant breeders have continuously sought to ameliorate the situation by developing improved varieties with higher seed yield. Meanwhile, using seed yield *per se* to develop high yielding varieties has been very expensive and time consuming., The use of correlated yield components with seed yield could be an advantage during early generation testing where lots of entries are involved., Indirect selection may be more efficient, especially if the secondary character is highly correlated with yield and is easily measurable. As per Grafius, 1964, improvement of traits like yield may be accomplished through component breeding. Subsequently, many workers (McNeal *et. al.*,1978, and Johnson *et al*, 1983) suggested that selection for component traits can help to increase productivity.

To test large populations in plant breeding programme, plant breeders must seek ways of improving evaluation efficiency in early generation testing for seed yield and other characteristics. Therefore, the objective of the study is to obtain pertinent information that could guide plant-breeders towards more judicious use of yield components as indirect selection criteria in soybean yield improvement.

On-Station field experiment was carried out during the cropping seasons of 2008 and 2009 at experimental farm of Akperan Orshi College of Agriculture, Yandev, Nigeria. The experiments were conducted during raining season (July – November) 0f each year. The soil texture was sandy loam which is good for soybean production. Fifty-six (56) soybean genotypes obtained from International Institute of Tropical Agriculture (ITTA) were laid in a randomized complete block design with 3 replications. Each plot consisted of 4 rows of 3m length with a row to row distance of 50cm maintaining 20 plants m^{-1} in length. Recommended package of cultivation practices were followed and a good crop stand was achieved. Characters evaluated were days to 50% flowering (DTF- Days to flowering: date to which approximately 50% of the plant in a plot had their first flower.), days to maturity (DTM- Days to maturity: days from sowing to the time when more than 90% of the pods were mature morphologically i.e. when pods turn from green to light brown or straw colour.), plant height at harvest (Ht), number of pods per plants (PPP), number of shattered pods per plot (Shat), taken on the two border rows two weeks after harvest, nodulation scoring (Nodu-Nodulation scores: nodulation was recorded 60 – 75days after planting on the of 5 plant selected at random, dug within one metre from both ends of a row. A guide was used to score visually on 1-5 scale.), 300-seed weight (Sdwt300), Lodging Score (Lodging was scored at the time of harvest as 1= all plant erect, 2= some plant leaning or lodging, 3= most plants leaning, some lodged, 4= most plants lodged, 5= all plant lodged) and Grain yield in tones per hectare (Ydtha).

Data collected were subjected to analysis of variance using general linear model (GLM) procedure of SAS (SAS, 1997). Genotypic and

phenotypic correlations was calculated based on the formulae of Mode and Robinson (1959).

The mean values for all the traits studied on 56 genotypes of soyabean are presented in Table 1. Yield (t/ha) of TGX 1987-64F (2.09 t/ha) was found to be higher than all the other genotypes evaluated, however this genotype is *on a par* with the yields of TGX 1987-37F (1.93 t/ha), TGX 1987 – 10F (1.85 t/ha), TGX 1985 – 4F (1.73 t/ha), and TGX 1984 – 5F (1.71 t/ha) and significantly higher than other entries. . With respect to seed weight, TGX 1987-38F had the highest significant 300 seed weight (49.02 g) followed by TGX 1985 – 10F (48.68 g), TGX 1987-15F (48.16 g), TGX 1987-58F (39.17 g) and TGX 1987 – 55F (47.87 g). These genotypes were significantly higher than TGX 1987 – 31F (36.38 g), TGX 1987-65F (35.28 g), TGX 1019-2EN (36.3 g) and TGX 1987 – 25F (33.98).

The TGX 1485-1D with 62 pods per plant was significantly higher than all the other genotypes. TGx 1984 -1F and TGX 923-2E had the highest days to maturity of 98 days. These were significantly higher than TGX 1987 -15F with 93 days to maturity and genotypes with same or earlier days to maturity. Genotypes with days to maturity later than 94 were however not significantly different from TGX 1984-1F and TGX 923-15F.

Correlation coefficient analysis: Knowledge of the relationship among plant characters is useful while selecting traits for yield improvement. Estimation of simple correlation coefficient was made among seven important yield components with yield of 56 genotypes of soybean (Table 2). Correlation coefficient revealed that yield was positively correlated with days to maturity, height, 300 seed weight and pods per plant. This indicates that that higher mean values for these traits can increase the seed yield. Positive correlation of seed yield with days to maturity showed that delay in maturity tends to increase the seed yield. Whereas increase in days to flowering and lodging may lead to decrease in seed yield due to negative correlation of seed yield with these traits. The results are supported by Malik *et.al.,(2006)* and Malik *et al*.,(2007).

There was significant positive correlation of days to maturity with pods per plant, plant height and 300 seed weight. This revealed that late maturity increased pods per plant, plant height, and 300-seed weight. Chand (1999) also reported that days to maturity positively correlated with pods per plant. Plant height was positive and significantly associated with pods per plant and 300-seed weight. Taller plants are likely to produce greater number of pods. Chand (1999) and Malik *et. al*.,(2007) observed similar results.

The results of the genotypic and phenotypic correlations revealed that generally the genotypic estimates were slightly higher than phenotypic (Table 3). This indicates greater contribution of genetic factors in the development of the associations. Iqbal *et al* (2003) reported similar findings. Chand (1999) performed experiments on different varieties of soybean and revealed that the genotypic coefficients for the characters studied were higher than the phenotypic and environmental correlation coefficients. According to Malik *et al* (2007), the genotypic correlations were higher than the phenotypic and environmental ones for most of the characters exhibiting high degrees of genetic association among traits under consideration. Days to 50% flowering as presented in Table 3 showed positive and highly significant association with days to maturity and 300 seed weight at both genotypic and phenotypic level. Days to 50% flowering also showed negative and highly significant association with nodulation scoring, shattered scoring and seed yield (t/ha) at both genotypic and phenotypic level. The significant negative correlation of days to flowering and seed yield has been corroborated by studies by Malik *et.al.,(2006)* and Arshad *et al., (*2006). These results are however in contradiction to findings of Sharma et al. (1983), who reported that days to maturity and days to flowering contributed most to seed yield. We suspect that environmental factors may have been the cause of the contradiction in the results reported. 300 seed weight was found to be positive and highly significantly correlated with days to flowering, days to maturity and plant height at both genotypic and phenotypic level. 300 seed weight was found to be highly significantly negative correlation with shattered scoring at both genotypic and phenotypic level. The association of 300 seed weight with seed yield was found to be non significant both at genotypic and phenotypic level. These results confirmed the findings of Isler and Caliskan (1998), Singh *et al* (2000), Khanghah and Sohani (1999), Singh and Yadava (2000). Iqbal et al (2003) reported the association of 100 seed weight with yield per plant to be non-significant at both genotypic and phenotypic level. Yield (t/ha) showed a negative and significant association with days to 50% flowering, lodging scoring, and pods per plant at the genotypic level whereas at the phenotypic level it showed a negative and significant association with days to flowering. Similar findings were reported by Malik et al (2007).

Principal Component Analysis among Growth Traits**:** The first principal component explained 39.83% of the total variation and dominated by highly positive days to maturity (0.50), plant height (0.48) and pods per plant (0.48) (Table 4). The second principal component explained an additional 20.52% of the total variation dominated

by highly positive seed weight (0.52). The first two components explained 60.36% of the total variation in the seven-variable data set. The first and second principal components showed relatively large variation (eigenvalues 2.79 and 1.44 respectively in Table (4). These eigenvalues were greater than zero and represented exact linear dependency, but the rest had small or modest variances (eigenvalues less than 0.95).

Generally, the highly correlated variables (e.g days to maturity, plant height, and pods per plant) contributed greater variation to the total variance in yield traits as shown by the first principal component analysis (Table 4).

Conclusion**:** The study indicated that selection for component traits viz., days to maturity, Plant height, pod weight, and seed weight will result to higher yield in soybean. A total of 60.30% of the total variation was contributed by these traits. Hence selection for yield using these traits will be effective.

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Table 1. Mean yield and agronomic performance of soybean lines evaluated in Gboko in 2008 and 2009 cropping seasons

Variety	Days to flowering (DTF)	Days to maturity (DTM)	Plant height at harvest (cm) (Ht)	Nodulation (score)	Number of shattered pods per plot (Shat)	Lodging score (Lodg)	Number of pods per plant (PPP)	300-seed weight (g) (Sewt300)	Grain yield (t/ha) (Ydtha)
TGX1019-2EN	37	91	42.47	1.700	11.33	1.500	28.93	36.30	1.349
TGX1448-2E	48	97	42.00	1.067	1.50	1.333	37.90	45.60	1.310
TGX1485-1D	37	90	36.33	1.200	0.67	1.500	62.42	39.53	1.106
TGX1740-2F	38	94	46.37	1.383	0.50	1.333	24.83	47.41	1.488
TGX1984-10F	48	96	39.02	1.000	1.33	1.500	25.97	42.86	1.188
TGX1984-11F	48	95	43.03	1.033	0.83	1.833	27.33	44.49	1.129
TGX1984-17F	48	96	41.37	1.100	2.00	1.667	31.73	45.56	0.984
TGX1984-19F	48	94	44.97	1.067	0.67	1.677	30.20	41.79	1.024
TGX1984-1F	48	98	41.82	1.000	2.17	1.333	34.87	43.50	1.348
TGX1984-22F	48	93	42.53	1.267	0.83	1.500	23.57	44.34	0.962
TGX1984-23F	48	96	44.78	1.233	0.50	1.833	30.37	44.25	1.362
TGX1984-24F	48	95	39.72	1.300	1.00	1.333	22.10	42.56	0.793
TGX1984-5F	48	96	39.57	1.000	0.50	1.500	28.30	45.56	1.707
TGX1985-10F	43	93	43.60	1.167	1.67	1.333	30.60	48.68	1.255
TGX1985-11F	43	94	49.17	1.067	1.33	1.333	29.10	44.50	1.342
TGX1985-12F	42	93	45.97	1.333	1.33	1.167	28.30	46.30	1.167
TGX1985-4F	43	94	44.00	1.267	2.17	1.167	32.90	43.28	1.732
TGX1985-8F	42	95	43.87	1.267	2.50	1.500	35.67	43.81	1.383
TGX1986-1F	41	94	47.17	1.100	4.67	1.000	23.67	42.49	1.445
TGX1986-2F	40	91	41.20	1.133	0.50	1.333	28.23	43.82	1.520
TGX1986-3F	41	95	39.08	0.867	0.83	1.333	39.40	46.64	1.299
TGX1987-10F	39	93	42.40	1.433	0.67	1.333	28.93	43.82	1.849
TGX1987-11F	38	92	43.17	1.267	1.00	1.833	23.27	45.38	1.501
TGX1987-14F	46	93	54.27	1.200	2.17	1.833	27.57	43.67	1.182
TGX1987-15F	46	93	58.88	1.033	0.67	2.000	31.33	48.16	1.557
TGX1987-17F	39	84	42.63	1.100	5.83	1.833	27.20	37.51	1.126
TGX1987-18F	38	93	43.53	1.767	0.83	1.667	25.40	44.04	1.276
TGX1987-19F	46	94	52.67	1.067	0.83	1.167	25.77	44.76	1.368
TGX1987-20F	39	84	40.07	1.733	3.33	1.667	25.97	40.73	1.652
TGX1987-23F	38	91	38.37	1.933	1.33	2.000	26.70	42.83	1.462
TGX1987-25F	39	86	43.67	1.500	3.33	1.500	28.70	33.98	1.329
TGX1987-28F	38	89	39.90	1.033	5.17	1.667	28.10	37.62	1.529
TGX1987-31F	37	88	36.77	1.333	0.50	1.833	29.37	36.38	1.272
TGX1987-32F	37	84	43.03	1.415	6.50	1.333	28.97	40.33	1.349
TGX1987-34F	38	87	40.97	1.300	8.83	1.833	23.17	37.39	1.349
TGX1987-35F	46	93	46.93	1.067	3.17	1.500	27.33	46.23	1.485
TGX1987-37F	45	94	39.17	1.033	2.50	1.000	24.37	45.46	1.932
TGX1987-38F	44	95	48.90	1.033	1.33	1.500	31.17	49.02	1.615
TGX1987-3F	46	93	50.03	1.433	0.50	1.833	30.00	46.46	1.049
TGX1987-40F	42	96	51.27	1.200	0.50	1.000	24.03	43.93	1.432
TGX1987-43F	50	97	45.73	1.167	1.17	1.500	30.43	45.42	1.029
TGX198745F	50	97	44.73	1.067	1.00	1.500	33.10	46.38	1.015
TGX1987-47F	53	95	38.57	1.167	0.67	1.167	25.03	44.74	1.334
TGX1987-49F	53	97	42.33	1.400	1.17	1.333	31.87	42.67	1.389
TGX1987-51F	51	94	45.37	1.167	1.67	1.667	33.07	44.37	1.071
TGX1987-55F	50	95	46.83	1.267	1.33	1.167	27.90	47.86	1.162

Table 1. Contd..

Variety	Days to flowering (DTF)	Days to maturity (DTM)	Plant height at harvest (cm) (Ht)	Nodulation (score)	Number of shattered pods per plot (Shat)	Lodging score (Lodg)	Number of pods per plant (PPP)	300-seed weight (g) (Sewt300)	Grain yield (t/ha) (Ydtha)
TGX1987-56F	50	96	43.47	1.300	0.67	1.667	24.20	44.15	0.979
TGX1987-57F	49	95	40.57	1.033	0.67	1.500	31.10	43.14	1.522
TGX1987-58F	49	95	40.43	1.000	0.50	1.667	38.27	39.17	0.922
TGX1987-62F	39	90	39.07	1.467	0.67	1.833	26.60	44.56	1.477
TGX1987-64F	38	93	47.17	1.100	0.67	1.500	25.83	42.74	2.094
TGX1987-65F	38	93	40.43	1.017	1.33	1.500	25.00	35.28	1.469
TGX1987-6F	38	91	47.32	1.167	1.33	1.833	32.40	41.42	1.390
TGX1987-8F	39	96	44.00	1.500	2.50	1.333	33.40	41.94	1.443
TGX1987-9F	39	94	46.37	1.400	0.50	1.500	29.17	45.36	1.618
TGX923-2E	49	98	38.67	1.133	1.17	1.167	33.25	41.79	1.262
LSD	1.42	4.29	8.26	0.40	4.14	0.75	11.90	11.17	0.41

Table 2. Simple correlation coefficient between yield and yield contributing characters of 56 soybean genotypes

Characters	Days to maturity (DTM)	Plant height at harvest (cm) (Ht)	Lodging score (Lodg)	300-seed weight (g) (Sewt300)	Number of pods per plant (PPP)	Grain yield (t/ha) (Ydtha)
Days to flowering (DTF)	0.35**	0.059	-0.054	0.332**	0.015	-0.198**
Days to maturity (DTM)		0.56**	-0.479**	0.276**	0.56**	0.226**
Plant height at harvest (cm) (Ht)			-0.401**	0.132*	0.614**	0.349***
Lodging score (Lodg)				-0.022	-0.448**	-0.169**
300-seed weight (g) (Sewt300)					0.043	0.107*
Number of pods per plant (PPP)						0.36**

*, ** Correlation is significant at 5 and 1% level of probability respectively

Table 3. Genotypic and phenotypic correlation coefficient between yield and yield contributing characters of 56 soybean genotypes

Trait	Days to maturity (DTM)	Plant height at harvest (cm) (Ht)	Lodging score (Lodg)	Number of shattered pods per plot (Shat)	300-seed weight (g) (Sewt300)	Number of pods per plant (PPP)	Grain yield (t/ha) (Ydtha)
Days to Flowering	0.680*	0.106	-0.155	-0.336*	0.426*	0.018	-0.440*
(DTF)	(0.708)*	(0.114)	(-0.179)	(-0.392)*	(0.430)*	(0.020)	(-0.508)*
Days to maturity		0.182	-0.387*	-0.449*	0.573*	0.084	-0.151
(DTM)		(0.204)	(-0.440)*	(-0.474)*	(0.603)*	(0.077)	(-0.193)
Height			0.027	-0.084	0.404*	-0.185	0.055
(Ht)			(0.018)	(-0.076)	(0.462)*	(-0.252)	(0.064)
Lodging				0.056	-0.197	0.006	-0.189
(Lodg)				(0.108)	(-0.229)	(0.022)	(-0.350)
Shattering					-0.505*	-0.140	0.052
(Shat)					(-0.589)*	(-0.150)	(0.093)
300 Seed weight						-0.041	0.041
(Sdwt)						(-0.058)	(0.040)
Pods per plant							-0.173
(PPP)							(-0.286)*

Genotypic correlation in parenthesis

Table 4. Results of principal component analysis among growth traits of soybean genotypes

	Principal Component Analysis			
Characters	1st	2nd	3rd	4th
Eigenvalue	2.79	1.44	0.95	0.6
Contribution(%)	39.83	20.52	13.6	8.63
Cumulative Cont.(%)	39.83	60.36	73.95	82.58
Eigenvector				
Days to flowering (DTF)	0.13	0.7	-0.16	0.28
Days to maturity (DTM)	0.5	0.22	-0.12	0.08
Plant height at harvest (cm) (Ht)	0.48	-0.11	0.02	0.34
Lodging score (Lodg)	-0.4	0.09	0.43	0.76
300-seed weight (g) (Sewt300)	0.17	0.52	0.5	-0.39
Number of pods per plant (PPP)	0.48	-0.19	-0.09	0.28
Grain yield (t/ha) (Ydtha)	0.29	-0.36	0.64	-0.03