ASSET Series A (2003) 3 (4):127-136

ISSN 1595-9694 C
UNAAB 2003

SEASONAL VARIABILITY, CORRELATION, GENETIC DETERMINATION AND CONTRIBUTION OF NINE AGRONOMIC TRAITS TO SEED YIELD IN SELECTED TROPICAL SOYBEAN *(Glycine max (L)* Merr) GENOTYPES

D. K. OJO

Dept. of Plant Breeding andSeed Technology, University of Agriculture, Abeokuta, Nigeria.

ABSTRACT

Eighteen tropical soybean genotypes were sown in the teaching and research farm of the University of Agriculture, Abeokuta (7°29N, 330E), Nigeria in year 2000 and 2001 to examine the degree of genetic determination and contribution of nine traits to seed yield taking cognisance of changes in weather conditions between cropping seasons. Analysis of variance revealed highly significant effects of genotype (G), year (Y) and GxY interaction for almost all traits.

Increased number of pods per plant, reduced seed size, reduced chaff weight and significantly higher seed yield were observed in 2001. Observed estimates of genotypic variance, phenotypic variance as well as broad sense heritability (HB) were also higher in 2001 relative to year 2000. However, pod number per plant, plant height, 300-seed weight and number of branches per plant with overall high estimates of HB(64.1 - 89.9%) and genetic advance (GA) (35.2 - 55.5%) were identified as the most important yield-related traits with at least 92.0% contribution to seed yield over the two years.

It was, therefore, concluded that the identified traits could be good predictors of seed yield and that direct selection for these traits in the early segregating generations could result in substantial genetic improvement for seed yield among tropical soybean genotypes.

Keywords: Correlation, Genetic advance, Heritability, Humid tropics, Stepwise regression, Soybeans.

INTRODUCTION

Soybean *(Glycine max* L Merr) grows very well in any tropical soil where maize grows. However, grain yield in soybean has been reported to be influenced by date of planting, period of maturation and harvesting especially when the crop is sown under tropical field conditions (TeKrony *et al.,* 1979). In Nigeria, soybean is normally planted in the early rainy season (June - August) depending on the geographical location. Most of the available cultivars mature between 90 - 120 days after sowing. In the South Western part of Nigeria, planting is done in July through early August so that good quality soybean seeds could be harvested late in October or early November when the sky is relatively dry. This is because soybeans sown in the major rainy season in the bimodal region normally have higher grain but of very poor seed quality (Nangju, 1977).

I

Chang (1983) observed a reduction in the germination of soybean seeds by decreasing soil moisture content below 11 % and by increasing it to about 26% at 39% field capacity. High temperature during part or most of the seed-filling phase and maturation period may reduce soybean seed quality at harvest. A linear decline in germination, vigour and physical quality of harvested seeds has been reported when maturing soybean plants were exposed to increasing periods of high temperature during the seed-filling phase (Green *et al.,* 1965; Keigley and Mullen, 1986).

Although, seed production environment and weather conditions at harvest are good determinants of yield and subsequent maintenance of seed quality among tropical soybean cultivars (Ojo *et al.,* 2001), grain yield in crops is generally determined by a number of yield-related characters that are morphological in nature. Adequate knowledge of the relationship that exists between grain yield and yield-related characters is essential for the identification of selection criteria to be used for yield improvement in soybeans.

Malhorta *et al.* (1971) observed a strong positive correlation between number of pods and primary branches per plant and seed yield in soybeans. Gondane and Bhatia (1995) reported high genetic variability in pod yield and strong association between plant height, number of pods per plant, number of nodes per plant and pod yield in okra. Chandra *et al.* (1996) also observed high estimates of heritability and genetic advance for pod yield, plant height and number of seeds per pod in okra. Recently, Ojo and Amanze (2001) observed that days to flowering, days to maturity, number of pods per plant, number of branches per plant and pod weight had positive and significant correlation with yield in tropical soybeans. The last three traits were also reported to have high estimates of heritability and genetic advance to suggest that these traits could be used as good predictors of grain yield through simultaneous improvement and selection.

Borojevic (1990) defined heritability as the proportion of total phenotypic variation that is determined by the genotype of a plant. According to Graham and Welch (1996). estimation of heritability for a trait is more important than just knowing the number of genes that is involved in the expression of that trait because the latter is an important tool for measuring progress in crop improvement as heritability indicates how easy or difficult it will be to produce a change in a given trait by applying selection. However, John and Thangavelu (1997) observed that heritability estimates alone cannot provide sufficient information for genetic improvement that would result from selection of best individual crops suggesting the need for additional genetic information.

Large genotypic variability has been established among tropical soybeans. There is therefore, a need to know the degree of genetic determination and contribution of traits that have significant association with grain yield taking into consideration the variations that exist in weather conditions from one year to another. The objective of this study was to examine the association that exist between seed yield and related traits, their degree of genetic determination and contribution to seed yield in selected tropical soybean genotypes with reference to changes in weather conditions over cropping seasons.

MATERIALS AND METHODS

Eighteen tropical soybean genotypes obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria were sown in the teaching and research farm of the University of Agriculture, Abeokuta, Nigeria in August 2000 and 2001.

After land preparation that involved ploughing and harrowing, seeds of each soybean genotype were sown in

randomized complete block design with three replicates. Seeds were sown by drilling in four-row plots at 0.75m between rows. Upon emergence, seedlings were thinned down to a within-row spacing of 0.05m leaving a population of 480 plants per plot. As no pre-emergence herbicides were used, hand weeding was done some three weeks after planting followed by subsequent weeding as the need arose. From each plot, the following data were collected:

- Number of days to first flowering determined as the number of days from sowing to the date of appearance of first flowers.
- Days to maturing was the number of days it took plants in each plot to reach or attain their physiological maturity.
- Plant height at harvest was taken as the mean distance from soil surface to the tip of ten randomly selected plants from each plot.
- Number of pods per plant was the mean number of pods of ten plants selected at random from each plot.
- Number of branches per plant was taken as the mean number of branches from ten randomly selected plants in each plot.
- Pot length (cm) was determined as the mean of ten pods from ten randomly selected plants in a plot.
- Lodging at harvest was determined using a scale 1 - 5

1 = all plants were erect (no lodging)
3 = 50% of plants were erect.
5 = all plants lodged.

Weight of 300 seeds or 300-seed weight in gram was the weight of 300 well-dried. cleaned and randomly selected seeds of each genotype.

Chaff weight per plot (Kg) was the weight of all leftovers after threshing all plants from the net plot (two middling rows).

Seed yield per plot was the weight in Kg of all plants from the net plot after threshing cleaning and drying seeds to about 10% moisture content.

All means for each trait in each year and a combination of two years were subjected to analysis of variance to determine the significant effects of genotypes, year and genotype by year interaction. Simple correlation coefficients were obtained to determine the type of association that existed between all possible pairs of characters using the Pearson correlation analysis. Estimates of phenotypic and genotypic coefficients of variability, broadsence heritability (H_B) and genetic advance (GA) were determined using the methods (Allard, 1960; Borojevic, 1990).

Stepwise regression analysis (Weisberg. 1980) was also used to determine the percentage contribution of more important traits that had significant association with seed yield.

RESULTS

Mean seed yield - and agronomic performance of eighteen tropical soybean genotypes sown in Abeokuta over a two-year period is presented in Table 1. Mean seed yield of genotypes ranged from 438.1 to 2267.9 kg/ha. Large and significant variations \\ere also observed among

genotypes with respect to other agronomic traits indicating that the soybean genotypes evaluated were highly variable in their genotypic performance.

Mean squares from analysis of variance of sued yield and related traits for soybean genotypes tested in 2000 and 2001 in Abeokuta are presented in Table 2. The analysis revealed highly significant effects of genotype (G), year (Y) and GxY interaction for almost all traits evaluated confirming that the soybean genotypes performed differently over the two-year period. However, year and G x Y mean squares were not significant for lodging.

Table 3 presents the mean, range, genotypic and phenotypic variances and estimates of broadsense heritability (H_B) of seed yield and related traits on yearly basis. Increased number of pods, reduced chaff weight and consequently higher seed yield was obtained in 2001 compared with 2000 although, records for other traits remained entirely similar for the two years of the experiment. Except for 300-seed weight and chaff weight, however, estimates of H_{13} were higher for all characters in year 2001 relative to 2000.

Correlation matrix of seed yield and related traits among soybean genotypes evaluated in 2000 and 2001 is shown in Table 4. Highly significant positive correlation coefficients were observed between seed yield and plant height, pod number per plant, and also number of branches per plant. Significant negative association was also observed between lodging, chaff weight and seed yield. However, association between days to flowering, days to maturity. 300-seed weight and seed yield was negative and non-significant. Pod number per plant and number of branches

per plant were positively and significantly correlated with days to maturity and plant height.

Performance of soybean genotypes, genotypic and phenotypic coefficients of variation, estimates of H_B and genetic advance (GA) and percentage contribution of significant traits to seed yield averaged over two years of the experiment are presented in Table 5. Seed yield was observed to be highly heritable (H_{13} = 79.0%) with relatively high genotypic coefficient of variability (GCV) of 57.2%. Pod number per plant, plant height, 300seed weight, lodging and number of branches per plant had relatively high estimates of H_{13} (47.6% - 89.9%) and GA (35.2% - 55.5%). All five traits above contributed more than 92.0% to total seed yield. However, the five traits with the exception of lodging had low GCV of 30% or less. As expected, chaff weight, days to flowering and days to maturity that were negatively but not significantly correlated with seed yield did not contribute to seed yield either (Table 5). Although, pod length was positively correlated with seed yield, it did not also contribute to seed yield in any way.

DISCUSSION

It is clear from the current study that large variability exists among tropical soybean genotypes. Unpredictable changes in weather conditions experienced from one year to another necessitates the need to conduct soybean research in two or more years to be able to arrive at a logical conclusion with regards to crop genotype selection especially when experiments are conducted within the same geographical location or site. According to Funnah and

Table 1. Mean seed yield (Kg/ha) and agronomic performance of eighteen soybean genotypes sown in Abeokuta, Nigeria in years 2000 and 2001

a(I - 5): 1 = no lodging; 3 = 50% of plants lodged; 5 = **nearly all plants lodged.**

Genotype	Yield (.Kg/ha)	Days to flowering	Days to maturity	Plant height (cm)	Pod no/ plant	Pod length (cm)	Branch no / plant	1 Lodging (1-5)	300-seed wt.(g)	Chaff wt.' (Kg)
TGx 1831-32E	2267.9	41.0	83.7--	42.6	108.4	3.6	4.7	3.2	_	0.9
TGx 1830-20E	2187.3	38.7	84.7	34.7	101.5	3.7	3.4	1.0	32.6	'=0.7
TGx 1895-22F	2175.3	41.2	84.0	43.7	123.1	3.9	3.0	1.0	34.9	0.7
TGx 1895-4F	1857.6	3.9.3	84.7	445	121.8	4.0	2.2	1.8	37.1	0 7
TGx 1805-8F	1783.5	38.8	84.7	37.4	108.0	3.9	2.4	2.2	34.7	0.5
TGx 1485-1 D	1731.8	38.7	84.3	31.9	118.0	3.9	3.4	1.0	30.8	0.7
TGx 1895-49F	1658.6	42.5	84.3	45.4	108.0	4.1	2.6	1.2	36.2	0.8
TGx 1876-4E	1513.1	41.5	84.3	52.2	109.2	4 1	3.7		27.7	0.7
TGx 1871-12E	1508.6	43.2	84.0	43.3	116.7	4.4	3.6	1.0	23.4	0.7
TGx 1740-2F	1433.5	41.8	84.3	42.5	115.3	3.8	2.8	1.0	28.9	0.5
TGx 1835-10E	1120.6	42.5	84.3	37.1	114.1	4.0	2.9	1.7	32.7	0.6
TGx 1895-6F	1015.9	47.2	86.7	43.4	97.0	3.9	3.2	1.0	36.8	0 5
TGx 1897-17E	943.8		84.0	38.7		4.1	3.2		32.2	0.5
TGx 1892-10E	818.7		83.2	36.6		4.1	2.4		38.5	0.3
									33.0	0.6
								1.0	33.4	0.2
							2.8	1.0	35.6	0.2
TGx 1895-19F			82.5	32.0			2.8	11.0	42.9	0.2
	1365.0						31			0.56 1
	463.3					0.2	0.8			0.06

Table 2. Mean squares from analysis of variance for seed yield and related traits in eighteen tropical soybean genotypes sown in Abeokuta, Nigeria in two years (2001 and 2002)

Source	f	Seed yield (x1000)	Days to flowering	Days to-T maturity	Plant height	Pod no. per plant	Pod length	Branch no. per plant	Lodginga (1 -5)	300-seed weight	Chaff weight
Replication		1732.93**	0.01	7.00	142.21 **	541.35-	0.13	2.20	0.13	20.07**	0.04
Genotype (G)	7	1993.63*	81.66**	40.69**	303.35**	106.90*	0.23**	3,12**	2.01**	113 00**	0.26*
Year ( )		1681.18	0.75	37 93	666.14**	932.50*	59.84**	29.36**	0.4	224 33	5.55**
G x Y	17	857.82**	20.85**	3.85	140.71**	136.55**	0.15	1.51*	0.58	35.50**	0.07*
Error	70	161.89	0.76	2.75	37.94	47.33	0.04	0.49	0.54	4.10	0.02

P<0.01, P< 0.05

No. = number of pods & branches per plant.

a : 1 = no lodging; 3 = 50% of plants lodged; 5 = almost all plants lodged.

Table 3. Yearly mean, range, genotypic and phenotypic variances and estimates of broadsense heritability (HB) of seed yield and related traits observed in 2000(Y1) and 2001 (Y2) in Abeokuta, Nigeria

Trait		Mean	Range	Genotypic variance	Phenotypic variance	Heritability HB%
Seed yield (Kg/ha)'	Y1 ;	12-40.7	438.1 -2268.0	233603.60		79.9
	Y2	1490.0	241.4 - 2841.0	664738.50		80.0
Days to flowering(d)	Y1	40.9	36.0- 50.8	9.20	10.11	90.9
	Y2	41.0	340- 57.1	24.48	25.06	97.7
Days of maturity(d)	Y1	84.1	82.5- 94.5	4.32	9.44	45.8
	Y2	-.0	82.0- 96.2	3.62	3.83	94.5
Plant height (cm)	Y1	46.1	30.2- 56.4			57.9
	Y2	34.0	21.5- 54.3			69.5
Pod no. per plant	Y1	97.6	68.9- 121.5	340.38	471.44	
- - -~	Y2	105.4	71.5- 141.5	320.03	383.73	83.4
Pod length (cm)	Y1	3.7	3.6- 4.4	0.05	0.13	38.5
	Y2	3.2	2.9- 3.7	0.05	0.06	83.3
Branch no. per plant	Y1	3.6	2.1- 4.7	0.91	1.64	55.5
	Y2	2.6	1.8- 4.1	0.33	0.50	66.0
Lodging (1 -	Y1	1.3	10- 3.2	0.05	0.66	7.6
*	Y2	1.3	1.3- 3.7	0.52	0.88	59.1
300-seed wt.	Y1	38.1	23.4- 42.9			
	Y2	29.1	19.8- 36.0			
Chaff wt. (Kg/plot)	Y1	0.8	0.2- 0.9			
	Y2	0.3	0.1- 0.7			

Mak (1980), no valid comparisons could be made regarding the relative performance of crop genotypes over all environments in the presence of genotype by environment interaction.

Increased number of pods per plant, reduced chaff weight and higher seed yield obtained in the second year (2001) over and above the first year (2000) in the current experiment might have resulted from better crop management and adequate soil moisture (Tekrony *et al.,* 1980; Dadson, 1982), reduced soil temperature and optimum daily precipitation especially during pod-filling phase (Keigley and Mullen 1986; Ojo, 2000). Consequently, there was better genotypic expression of reduced chaff weight, increased number of pods per plant and subsequent increased seed yield in 2001 suggesting that environment was more friendly in 2001 compared with 2000. According to Van

Euwijk and Elgersma (1993), between year differences and within year similarities in

·p<&«
M P EG,

Table 4. Correlation coefficients ¥seed yield and related traits among eighteen tropical

Nigeria in mm and k@

	Seed yield	Days to flowering	Days to maturity	Plant height	Pod no./ plant	Pod length	Branch no. / plant	Lodging	300-seed wt.
Seed yield	1 .000								
Days %F wring	-0.024	1.000							
Days to Maturity	-0.155	0.827**	1.000						
Plant height	$q9`	E49	0.//	1.000					
Pod no g!	0.788	0.259	0.553	$«^`	1 000				
Pod length	0.289	-0.352	0.365	0.466	0.066	1.000			
			0.005	$53`	0.9e	0.004	1.000		r
Lodging				0.92	0.413	0.461	025	1.000	
300-seed wt.			-0.083	-0.300	0.534*	E28	-0.384	0.002	1.000

-p < &«
M P EG,

Ca	0.307*	0.403	-0.212	0.005	-0.337	0129	0.9n	0.447	-0.458

crop performance necessitates the need to incorporate meteorological information in the classification of genotype by trial interaction.

It has been suggested by Murtadha *et al.* (2000) that a trait with low GCV and high estimates of HB and GA will be a good predictor of yield in crops. Averagely high estimates of HB (47.6%) and high GA (76.2%) observed for lodging was an advantage because most of the soybean genotypes used in the current study were determinate and highly resistant to lodging with an average rating of 1.3. however, lodging may not necessarily be a good predictor of seed yield in tropical soybean judging from the high GCV (53.8%) obtained, the high HB and GA estimates for lodging notwithstanding. This is because non-allelic gene interaction could have resulted in an upward bias of the HB and GA estimates for lodging according to Ketata *et al.* (1976).

However, large variations between and within estimates of GCV, PCV, HB and GA as obtained for various traits in each year of the experiment has been ascribed to weather and soil factors that were not within the control of the experimenter. My observations and results are in conformity with similar reports in Okra (Chandra *et al.*, 1996; Murtadha *et al.*, 2000).

Current observations have also confirmed a recent report (Ojo and Amanze, 2001) that pod number per plant, plant height, seed weight and number of branches per plant are good predictors of seed yield in tropical soybeans because the four traits were associated with high estimates of HB and GA and low GCV. Linkage of these four important traits with resistance to lodging is also suspected. There is therefore a potential for large genetic determination for seed size, optimum plant height, increased number of pods and branches per plant among the soybean genotypes evaluated. Consequently, direct selection for these traits in addition to indirect selection for lodging resistance in the early segregating generations will be effective and can thus, be exploited for genetic improvement of seed yield among tropical soybean genotypes.

ACKNOWLEDGEMENTS

I am grateful to Dr. Baffour Asafo-Adjei of IITA, Ibadan Nigeria for the breeding materials and Mr. Tayo Oyelakin for computer analysis.

REFERENCES

Allard, R. W. 1960. *Principles of plant breeding.* John Wiley & Sons. London, 440pp.

Borojevic, S. 1990. *Principles and Methods of plant breeding. Pg* 154-160. Slavko Borojevic (ed.). Development in crop science Vol. 17, Elsevier Publishers Amsterdam.

Chandra, D. E., Singh, K.P., Panda, P.K. and Deo, C. 1996. Genetic variability and path analysis in Okra. *Environment and Ecology.* 14(2): 313-319.

Chang, H. H. 1983. Effect of drought on seed germination and yield of soybean. *Journal of the Agricultural Association of China,* 124: 53-62. Dept. of Agronomy, National Taiwan University, Taipei.

Funnah, S. M. and Mak, C. 1980. Yield stability studies in soybeans. *'experimental Agriculture,* 16: 387-390.

Gondane, S. U. and Bhatia, G. L. 1995. Response of okra genotypes to different environments. *PRV REV Journal,* 19(2): 143-146.

Graham, R.D. and Welch, R.M. 1996. Genetic control of characteristics pg 76-78 In: Breeding for

staple food crops with high micronutrient density. International Food Policy Research Institute. Washington D.C.

Green. D. E., Pinnell, E. I., Cavannah, L.E. and Williams. L.F. 1965. Effect of planting date and maturity date on soybean seed quality. *Agronomy Journal,* 57: 5-16.

Keigley, P. J. and Mullen, R. E. 1986. Changes in soybean seed quality from high temperature during seed fill and maturation. *Crop Science, 26:* 12121216.

Ketata, H., Edwards, L.H. and Smith, E. L. 1976. Inheritance of eight agronomic characters in a wheat cross. *Crop Science,* 16: 19-22.

John, J. A. and Thangavelu, S. 1997. Variability, heritability and genetic advance in sesame. *Madras Agric. Journal, 84(3):* 156-158.

Malhorta, R. S., Singh, K. B. and Dhaliwal, H. S. 1971. Correlation and path coefficient analysis in soybean. *Indian J. Of Agric. Science,* 42: 26-29.

Murtadha, S., Kehinde, O.B. and Ayo-Vaughan, M.A. 2000. Seasonal variability in okra. *Nigerian Journal of Ecology,* 2: 6-12.

Naugju, D. 1977. Effects of date of harvest on seed quality and viability of soybeans. *Journal Of Agricultural Science,* 89: 107-112.

Ojo, D. K. and Amanze, C.O. 2001. Prediction of grain yield through heritability and genetic advance of yield parameters in soybeans. *Nigerian Journal of Ecology, 3:* 10-13.

Ojo, D. K., Ellis, R. H. and Ajala, M.O. 2001. Effect of time of harvest on seed germination and capacity for seedling emergence in tropical soyabean genotypes. *Moor J. Agric. Research, 2: 8*14.

Ojo, D. K. 2000. Studies on soyabean seed quality and longevity improvement in the humid tropics. Ph.D. thesis, Dept. of Plant Breeding & Seed Technology, University of Agriculture, Abeokuta, Nigeria. 101 pp.

TeKrony, D. M., Egli, D. B., Balles, J., Pfeiffer, T. and Fellows, R.J. 1979. Physiological maturity in soybeans. *Agronomy Journal,* 71: 771-775.

TeKrony, D. M., Egli, D.B. and Philips, A. D. 1980. Effect of field weathering on the viability and vigour of soybean seed. *Agronomy Journal, 72:* 749-753.

Van Eeuwijk, F. A. and Elgersma, A. 1993. Incorporating environmental information in an analysis of GxE interaction for seed yield in perennial ryegrass. *Heredity,* 70: 447-457.

Weisberg, S. 1980. *Applied linear regression.* John Wiley, New York.