ASSET Series A (2006) 6 (1): 359-366

ASSET
An
International
Journal

GENETIC VARIABILITY STUDIES OF SOME TRAITS IN SOYBEAN (*GLYCINE MAX* (L) MERR) IN SAVANNA AND HUMID ENVIRONMENTS.

C. O. AREMU, O. J. ARIYO, AND D.K .OJO

** Dept. of Agronomy, Lautech, Ogbomosho*
***Dept of Plant Breeding And Seed Technology Unaab, Abeokuta*

ABSTRACT

Fifteen improved soybean genotypes were evaluated in two locations in four years. The result showed location (Loc.), year (Yr.), genotype (Gen.) effects to be significant. Also Loc x Yr and Gen x Yr interactions were significant for all the characters. Gen x Yr x Loc interaction effects were significant only with days to flower, number of branches per plant, number of pods per plant and seed yield. This indicated year and Gen x Yr interaction effects to be more important in soybean performance and that year and location effects could be exploited in soybean improvement. Gen x Loc interaction was not significant for all the characters except with number of seeds per plant. Genotypic coefficients of variation were higher for number of branches per plant, number of pods per plant and seed yield in Ogbomoso location than the phenotypic coefficient of variation.. All the characters correlated positively with seed yield in Ogbomoso a guinea savanna agro-ecology. Whereas, number of pods per plant did not show genotypic correlation with seed number and seed yield in Abeokuta a humid agro-ecology. Path coefficient analysis revealed that seed yield was affected by days to flower, number of branch per plant and number of seeds per pod in Ogbomoso location. Only days to flower directly affected seed yield in Abeokuta location. The high broadsense heritability estimates for branch number and number of seeds per pod ensures successful selection for these traits in Ogbomoso specific location for maximum yield performance. The results of this study revealed that soybean cultivation should be encouraged in Ogbomoso a guinea savanna agro-ecology where branch and pod number per plant exhibited high potential performance for high yield and reliable selection.

Keywords: character, variability, genotype, location, year, interactions, soybean, yield

* For all correspondence.

INTRODUCTION

The knowledge of genetic variability and the heritability estimates of characters is necessary in plant improvement programmes. Such knowledge helps to determine the nature and amount of heritable and non-heritable variations. This ensures effective breeding procedure. However, variety selection and subsequent recommendation for release are

ISSN 1595-9694 © UNAAB 2006

based on yield data analysis, and measurement of agronomic characters that contribute to grain yield (Araujo and Coulman, 2002).

The degree of phenotypic and genotypic variance is usually measured by the coefficient of variability. As such, the expected genetic response to selection is determined by heritability and the variability of the traits for which selection is to be made (Burton, 1989; Osiketa *et al.*, 2000).

Heritability which measures the genetic variation in a population relative to the total phenotypic variation of a trait is highly influenced by the genotypes method of determination and environment to which the genotypes are subjected (Saleh *et al.*, 1995).

Inter- character relationship is very important in plant breeding for character selection and to determine most effective breeding procedure. As the number of independent characters, affecting a dependent character increases, there is bound to be some amount of interdependency. Correlation may be purely genetic or environmental. Genetic correlations arise from linkages that have not reached equilibrium and from pleiotropy (Simmonds 1979) and therefore important in crop improvement. Singh and Ram (1986) reported high heritability estimates for days to flower, number of pods per plant and number of branch per plant in soybean. According to Karb *et al.* (1994), estimates of both heritability and genetic advance are more informative in genetic and breeding studies than only genetic advance. According to Ojo (2000), characters with high broadsense heritability estimates and low genetic advance are said to serve as good predictors of yield in tropical soybean. But Rao *et al.* (1997) reported the use of path coefficient analysis as most informative in identifying cause and effect relationship in grains. In crop improvement programmes, knowledge of seed yield is insufficient until relationships among various quantitative characters with seed yield are known. This knowledge enhances meaningful character selection in plant breeding. This present study evaluated the character variation, and relationship as well as heritability of six soybean traits in guinea and humid savanna agro-ecologies.

MATERIALS AND METHODS

Fifteen soybean varieties obtained from the International Institute of Tropical Agriculture (IITA) Ibadan, were grown in two locations of Ogbomoso (Guinea savanna) and Abeokuta (Humid savanna) in the late seasons of 1999, 2000, 2001 and 2002. The trial locations are as described in Table 1.

Following land preparation, 7.5kg N, 7.5kg, P_2O_5 and 7.5kg K single phosphate as NPK 15:15:15 Compound fertilizer was applied into the soil. The varieties were grown in a randomized complete block design with three replications. Seed sowing was by drilling in four-row plot of 3m x 6m. On emergence seedling spacing was 75cm between rows and 5cm within rows to give a total of 242,000 plants per hectre. Immediately after planting a mixture of Galex (four litres) and Grammazone (1 litre) were sprayed per hectare to control weeds. This was followed by manual weeding as at when necessary.

Data from the two inner rows consisting of 242 plant stands were used and characters measured were days to flower, number of branches per plant, numbers of pods per plant, numbers of seeds per pod, 300-seed weight and seed yield. These characters were subjected to combined analysis of variance for locations and years to obtain the variance components. The mean square for a source of variation was equated to its expectation and the unknown solved for according to the method of Rasmusson and Lambert (1961) as follows:

$$6_X{}^2 = 6_g{}^2 + (6_g{}^2{}_l / l) + (6_g{}^2{}_y / y) + (6_{gliy}{}^2 / ly) + (6_e{}^2 / rly)$$

ISSN 1595-9694 © UNAAB 2006

where:
$б_g^2$ = genotypic variance
$б_{gl}^2$ = genotype x location variance
$б_{gy}^2$ = genotype x year variance
$б_{gly}^2$ = genotype x location x year variance
$б_e^2$ = error variance
Broadsense heritability estimates were calculated on the variances from the combined analysis of variance for the characters using the years and locations according to the procedure of Kempthorne (1957).
The genotypic and phenotypic coefficient of variation (GCV and PVC) respectively for each character in each location for the years combined were computed as reported by Falconer and Mackey (1996)

PVC = $(б_p^2/ x)$ 100
GCV= $(б_g^2/ x)$ 100
where
$Б_p^2$ = phenotypic variance
$б_g^2$ = genotypic variance
x = mean performance of the genotypes

Genotypic correlation analysis which detected the degree of association between each parameter and yield on one hand and pairs of parameters on the other was also computed as by Falconer and Mackay (1996). Path coefficients were calculated using the genotypic coefficients of correlations as outlined by Dewey and Lu (1959).

RESULTS

There were variations in the genotypes for the six characters studied (Table 2) except for 300- seed weight. The characters performed differently in the year and location environments. The character performance varied widely in the years than in the location environments (Table 3) even as the loc.x yr. and gen. x yr. interactions varied significantly for all the characters. However, only number of seeds per pod and seed yield showed significant variation with respect to gen. x loc. interaction. But under the second order interaction of gen. x yr. x loc., only number of seeds per pod and 300-seed weight did not show significant variation. The mean value, genotypic and phenotypic coefficient of variation and heritability estimates (broadsense) for the six characters for Ogbomoso and Abeokuta environments for the years are presented in Table 4. Seed yield was most variable as it recorded the highest PCV (29.83) and GCV (39.71) in Abeokuta and Ogbomoso, respectively. Ogbomoso environment recorded the highest genetic variation for number of branch per plant and followed by number of pods per plant (32.19) and (29.07), respectively, while Abeokuta location (for the four years combined) recorded high GCV for number of branches and number of seeds per pod.
The heritability estimate also varied from one character to the other. Number of pods per plant recorded the highest heritability estimate of 73.08% in Ogbomoso environment and followed by number of branches per plant with 59.30%. The heritability estimates were generally low for the remaining characters. Genotypic correlation coefficients among the five characters and seed yield for the years combined are presented in Table 5. Days to 50% flower correlated significantly with all the characters even as number of branches per plant, number of pods per plant and number of seeds per pod correlated significantly with all the characters in Ogbomoso location. In Abeokuta location, days to flower showed significant and positive correlation with all the characters. Number of branches per plant also correlated positively with all the characters except its correlation with 300-seed weight that was negative. Number of pods per plant correlated significantly but negatively with weight of 300 seeds even as the correlation of number of seeds per pod was

ISSN 1595-9694 © UNAAB 2006

only significant with seed yield all in Abeokuta location. In all there were significant relationships between seed yield and the five characters in Ogbomoso environment than for the Abeokuta environment which is more humid than Ogbomoso. The direct and indirect effects of some characters on seed yield in each of the two locations are given in Table 6. Ogbomoso location had the largest direct effect with respect to number of branch per plant and a large indirect effect through reduction in weight of seeds. Number of days to flower also had large direct effect on seed yield with its large indirect effect via reduction in number of pods per plant. The large direct effect of number of seeds per pod has been nullified through reduction in weight of seeds. Though the direct effect of weight of seeds was negative, but it had a large indirect effect through increase in number of seeds per pod.

In Abeokuta location, the large negative direct effect of number of pods per plant was nullified indirectly through increase in number of days to flower. Similarly, the direct effect of weight of seeds was negative but it had a large indirect effect through increase in number of seeds per pod. Although number of branch per plant had a low direct effect but it had a large indirect effect via increase in number of seeds per pod.

DISCUSSION

Crop yield improvement is determined to a large extent by the effective functioning of the crop yield characters. Expression of these characters depends on the overall genetic and environmental factors (Berdahl and Barker, 1997).

The variations observed for the six characters can be attributed to both the diverse environments and genotypes used in the study. The significant difference in the first and second order (Loc. x yr., Gen. x yr and Gen x yr. x Loc.) interactions indicated the wide range of variability existing in the tested genotypes, year and location effects. This reveals the achievable result obtainable in any improvement programme especially in enhancing higher yield and genotype specific agro-ecology adaptation. That the year and genotype components of variance were significant in addition to loc. x yr, gen.x yr. interaction components for all the characters is an indication that specific location factors e.g. soil type, cultural practices etc. were as important as variable factors associated with years such as amount of rainfall and solar radiation. The high GCV and heritability estimates for number of branches per plant and number of pods per plant recorded in Ogbomoso location allows for genetic manipulation of these characters and still ensure effective yield improvement of soybean in the Guinea savannah agro-ecology. However, inter-character correlation and coefficient of variation fail to reveal the amount of interdependency via the direct and indirect causes of association in characters measured (Falconer and Mackay, 1996; Ariyo *et al.*, 1987). This therefore places path coefficient analysis a more reliable tool in identifying cause and effect relationship in characters. That days to flower, number of branch and number of seeds per pod had large direct effects suggest the importance and achievable success in selecting for these traits when breeding for Ogbomoso specific location. Moreover, the high heritability estimates and significant genotypic correlation coefficient allows for producing repeatable result in practical breeding methods for specific location adaptation. The success in selecting for these traits could be attributed to the more days of sunshine with less precipitation and relative humidity prevalent in the environment. This of course, allowed more flower formation and resulted in more pod formation and hence more seed accumulation in the pods. It therefore implied that seed yield improvement in soybean is enhanced by optimal rainfall with more days of sunshine than heavy rainfall with wet weather condition. That the negative effect of number of pods per plant was nullified by the positive indirect impact of number of branch per plant is suggestive of the fact that selecting genotypes with increased branch number would still increase seed yield in the given location of Abeokuta. The other characters which showed no significant genotypic correlation with seed yield in each of the two locations may not be of practical value in selection.

In conclusion, premium should be placed on days to flower, number of branches and number of seeds per pod in yield improvement breeding programme of soybean for Ogbomoso specific location. However, direct selection for number of pods per plant via number of branch would enhance yield improvement for Abeokuta specific location. In addition, it is advised that more characters be included as well as more agro-ecological locations so as to ensure reliable and effective selection procedure suitable for specific agro-ecologies.

Table 1. Location agro-ecology and weather co-ordinates in the growing environments of the soybean genotypes.

Location	Year	Agro-ecology	Longitude	Latitude	Mean Rainfall (mm)	Mean temp. (^{0}C)
Ogbomoso	1999-2002	Guinea Savanna	04^0 10E	08^0 10N	1058.5	31.4
Abeokuta	1999-2002	Humid Savanna	03^0 24E	07^0 ^{0}N	1124.3	29.6

Table 2. Mean squares in the analysis of variance of six soybean characters.

Source of variation	Df	Days to 50% flower	No of branch per plant	No of pods per plant	No of seeds per pod	300-seed weight	Seed yield (g/plant)
Blocks	2	0.24	6.51	1.06	4.33	2.75	3.17
Genotypes	14	2.72*	30.46**	10.79**	9.07*	0.55	4.22**
Year	3	5.21*	9.42*	4.22*	22.41**	3.41*	81.32**
Location	1	16,17**	60.01**	43.28**	61.87**	82.11**	208.01**

* ** =significant at 5% and 1% levels of probability

Table 3. Combined analysis of variance of six characters of soybean

Source of variation	Df	Days to 50% flower	No of branch/ plant	No of pods /plant	No of seeds per pod	300-seed weight	Seed yield (g/plant)
Location (Loc.)	1	781.43	2936.52**	1153.79**	746.52	924.31	4911.92**
Year (Yr.)	3	1236.07*	3157.41*	2398.61**	1011.27*	1206.25*	3629.23**
Loc.xYr	3	1357.12**	1526.16*	2581.23*	1272.36*	2459.12*	5410.24**
(YrxLo).	16	831.44	3047.11**	3317.41**	972.31	908.17	1633.22*
Genotype (Gen.)	14	1590.31*	3721.16**	1931.40*	1706.33*	2531.53*	2426.11**
GenxLoc.	14	605.31	982.22	741.19	1058.17*	726.10	1806.10*
Gen.xYr	28	1581.09*	1963.15*	2001.71**	2895.1**	1763.10*	1975.06**
GenxYr x Loc	28	1251.17*	2610.22**	1316.71*	843.51	995.07	4953.46**
Pooled error	168	451.24	573.17	690.24	341.21	564.49	560.35

* ** =significant at 5% and 1% levels of probability

Table 4. Phenotypic and genotypic coefficient of variation and broad sense heritability estimates of six soybean characters in the years combined for the locations.

Character	Location	Mean	PCV	GCV	H_B
Days to 50%	1	41.83	13.42	12.22	29.36
Flower	2	49.24	10.37	10.98	31.71
No of	1	3.62	19.31	32.19	59.30
brch/plt	2	1.57	24.20	27.23	51.22
No of	1	2.06	20.07	29.07	73.08
pods/plt	2	1.47	18.21	13.42	37.41
No of	1	5.27	16.44	11.26	40.25
seeds/pod	2	3.45	14.71	23.41	41.73
300-seed	1	17.03	13.53	14.33	31.54
wt.(g)	2	25.28	21.62	10.19	35.26
Seed yield	1	1081.22	20.71	39.71	47.58
(g/plt)	2	912.93	29.83	30.16	38.22

1= Ogbomoso location
2 = Abeokuta location

Table 5. Genotypic correlation coefficients among six soybean characters for the years combined in the two locations.

Character	Location	No of brch/plt	No of pod/plt	No of seed/pod	300-seed wt (g)	Seed yield (g/plt)
Days to	1	0.86**	0.51*	0.47*	-0.31*	0.63**
flwr	2	0.42*	0.28*	0.31*	-0.46*	0.23*
No of	1		0.60**	0.49*	0.25*	0.50**
brch/plt	2		0.22*	0.27*	-0.58**	0.31*
No of	1			0.35*	0.41*	0.52**
pods/plt	2			-0.18	0.43*	0.17
No of	1				-0.60**	0.79**
seeds/pod	2				-0.11	0.43*
300-seed	1					-0.17
wt (g)	2					0.21

* ** =significant at 5% and 1% levels of probability
1= Ogbomoso location
2= Abeokuta location

Table 6. Direct and indirect effects of six soybean traits

Character	Location	Direct	Days to flower	No of branch/plant	No of pods/plt	No of seeds/pod	300-seed wt. (g)
Days to	1	0.63		0.38	-0.51	0.40	0.36
flower	2	0.41		0.62	0.43	0.22	0.21
No of	1	0.79	0.36		0.22	0.33	-0.53
branch/plt	2	0.30	-0.52		0.10	0.70	0.34
No of	1	0.47	0.31	0.18		0.63	0.55
pods/plt	2	-0.56	0.41	0.52		-0.40	-0.33
No of	1	0.50	0.28	0.13	0.32		-0.65
seeds/pod	2	0.39	-0.63	0.20	0.48		-0.82
300-seed	1	-0.31	0.44	0.24	0.25	0.51	
wt. (g)	2	-0.54	0.34	0.17	-0.16	0.63	

1= Ogbomoso location
2 =Abeokuta location

REFERENCES

Araujo, M. R. A., B. E Coulman 2002. Genetic Variation heritability and progeny testing in Meadow bromegrass. *Plant Breed,* 121, 417-424.

Ariyo, O. J., M. E. Aken'ova, C. A. Fatokun 1987. Plant character correlation and path analysis of pod yield in okra *Abelmoschus Esculentus. Euphytica,* 36, 677-686

Ariyo, O. J. 1995. Genetic variability, correlations and path coefficient analysis of components of seed yield in cowpea (*Vigna unguiculata*) *Pertanika J. Trop. Agric. Sci.* 18 (1) 63-69

Burton, G. W. 1989. *Progress and benefits to humanity from breeding warm-season forage grasses.* In: D.A. Sleper, K. H. Assay and J. F. Pedersen (eds.) CSSA *Special Publication No.15, 21-29 Crop Science Soc. of America, Inc., Madison.*

Berdahl, J. D., Baker, R.E. 1997. Clonal and open pollinated progeny testing in an intermediate wheat grass population. *Crop Sci.* 37, 1751-1754.

Deweu, D. R., F. H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat grain seed production. *Agronomy journal 51: 575-578.*

Falconer, D. S., Mackey, T.F. 1996 *Introduction to quantitative Genetics,* 4th edition Longman group Ltd. Harlow.

Karb R.P., Lather, B.S., Deswal, D.P. 1994. Prediction of field emergence through heritability and genetic advance of vigour parameters. *Seed science and Technology 22, 461-466.*

Kempthorne, O. 1973. *An introduction to Genetic statistics.* Ames, Iowa State University Press.

Ojo D.K. 2000. Genotype x environment analyses and selection for yield stability and adaptability in tropical soybean. *Nig. Jour. Ecology 2: 49-51.*

Osiketa, O. S., A.J. Ariyo, O.B. Kehinde 2000. Variation and Inter-character Association in the segregating F_3 populations Arising from Two Crosses of okra. *Moor journal of Agric. Research* 1:32-36.

Rao, S.A., Khan, M.A., McNeilly, T., Khan, A.A. 1997. Cause and effect relationships of yield and yield components in rice (*Oryza sativa* L.) J. Genet. & Breed. 51: 1-5.

Rasmusson, D. C., Lambert, J. W. 1961. Variety x environment interactions in barley variety tests. *Crop Sci.* 1 261-262.

Saleh, G. B. Sojiprihati, S.S., Yap. T. C. 1995. *Development and Performance of maize hybrids in Malaysia.* In proceedings of the second Asian crop science Conference, Aug., 21-23, 1995 Fukui, Japan: Asian Crop Science Society.

Simmonds, N.W. 1979: *Principles of crop improvement* Longman, London.

Singh R.K., Ram, H.H. 1986. Inheritance study of soybean seed storability using an accelerated ageing test. *Field crop research 13. 89-98*

Tenebe, V.A. Yusuf, Y., Kaiagama, B. K., I. E. O. Asenime 1995: The effects of sources and levels of phosphorus on the growth and yield of cowpea (*Vigna inquiculata* (L) Walp) Varieties. *Tropical Science* 35, 223-228.