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SCREENING SOYBEAN (Glycine Max (L.) Merrill) GENOTYPES FOR RESISTANCE TO POD SHATTERING IN ZARIA, NIGERIA

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ABSTRACT
Eighteen soybean genotypes were evaluated for resistance to pod shattering and other important agronomic traits in 2016 dry season at the screen house of Institute for Agriculture Research Samaru, Ahmadu Bello University, Zaria Nigeria. Four genotypes with glabrous leaf were susceptible to pod shattering. In the same vein, three genotypes with leaf glabrous were moderately resistant. All genotypes with leaf pubescence were either highly resistance or resistance to pod shattering. The mean square from the analysis of variance for the nine traits measured indicated that seven traits showed highly significant differences (P<0.01) among the genotypes, while significant difference was observed for pod length (P<0.05), however number of seed per pod showed no significant difference among all genotypes. The correlation analysis indicated that there was positive correlation between pod shattering and days to maturity (r = 0.346*); however there was negative correlations between number of seeds per pod and shattering score (r = -0.527**). A negative correlation also, existed between number of pod per plant and pod shattering (r=-0.403*), while plant height and pod shattering showed a positive correlation (0.334*). In the same vein, plant height had negatively correlated with 100 seed weight (r = -0.488**), but positively correlated with days to flowering (r = 0.359*).

Keywords: Glabrous, pod shattering trait, pubescence, soybean genotypes

INTRODUCTION

Soybean (Glycine max (L.) Merrill] is a leguminous annual crop belonging to the family Fabaceae. It is an erect bushy plant with a well-defined main stem and branches, with numerous leaves. It production is rapidly increasing due to its high nutritional value as food for both humans and livestock and as an important industrial crop. It is an economically important crop with an average of 40 % protein and 20 % oil content (Context network and Sahel Capital, 2016).

Soybean ranks number one in term of total production among important oil seed crops after groundnut, followed by cotton, sunflower, canola and palm oil. Kaga et al. (2012) reported that soybean is grown on approximately 250 million hectares throughout the world and ranked the fourth after maize, wheat, and rice in terms of global production. The United States, Brazil and Argentina are the world leading countries which represent 35 %, 30 %, and 27 % of the global soybean production respectively (NAMC, 2011). Nigeria produces about 679,000 metric tons of soybean seeds mainly from the middle belt and Guinea savannah regions. The world total estimated soybean planted area in 2018 was 124.9 million Ha, with an average yield of 348.7 million tonnes, while average yield per ha was 2.8 tonnes (FAO, 2018). Soybean meal is rich in phosphorous, calcium and iron (Ogoke et al., 2003) making it a perfect supplement for animal feed. It also has the potential to fix atmospheric nitrogen through biological nitrogen fixation with the help of Bradyrhizobium spp thereby enhancing the productivity of crop grown in rotation. Similarly the residues of soybean crop are high quality feed for livestock (Ojiem et al., 2006).

Like many other economically important legume crops, Soybean production in tropical and sub-tropical ecology is hampered by pod shattering, a physiological trait that could reduce seed yield drastically (Krisnawati and Adie, (2017b). Pod shattering is the opening of mature pod along the dorsal or ventral sutures and followed by seed dispersal when the crop reaches maturity and during harvesting (Bara et al., 2013). The extent of yield loss that could result due to pod shattering in soybean may range from 34 to 100 % (Krisnawati and Adie (2017b).

Resistance to pod shattering is the most important factor for the improvement of soybean, especially in tropics. The Nigerian climate is characterized by abundant sunshine, which provides an ideal environment for soybeans production, hence will increase in pod shattering and resulting in significant yield losses in soybean.

Previous investigations have shown that different soybean genotypes may have different shattering potentials. Varietal differences in pod shattering resistance among parental genotype and between the parents and their F1 progenies have been established (Richard, 2018) for which selection can be made for desirable genotypes. The results showed ranges from highly resistant, to being highly susceptible Krisnawati and Adie (2017b) screened 68 soybean genotypes and reported a range of percentage shattering from 2.5 - 100%, using the oven method, and the degree of shattering ranged from 0 to 80% and further identified 23 highly resistant genotypes, with 31 resistant, and eight moderately resistant while six were highly susceptible to pod shattering. The authors furthermore observed the degree of pod shattering in the field varied from 1.3% to 42.3%.

Classifying varietal difference for pod shattering and other morphological traits of the new soybean germplasm collected alongside with some known varieties for resistance to pod shattering will provide information for selection of suitable parents. Therefore, this study was designed and conducted to characterize and classify soybean genotypes for their variability in pod shattering and to determine interrelationships of pod shattering with other agronomic traits.

MATERIALS AND METHODS

Three varieties of soybeans were collected from IAR, Samaru and fifteen other genotypes were sourced from the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria.

The experiment was conducted during the dry season, from March to June 2016 in the screen house of Institute for Agriculture Research (IAR) Samaru, Ahmadu Bello University, Zaria, (Latitude 11 11 N and 7 38 E, 600m above sea level), located in the Northern Guinea Savannah with mean annual rainfall of about 1045 mm. The 18 genotypes were screened using randomised complete block design (RCBD) with three replications. Each experimental unit consisted of a pot of 25.5 cm x 24.5 cm diameter by height. Two seeds were sown per pot. All recommended agronomic practices like weeding, fertilizer application of 30 kg P2O5/ha in form of single super phosphate (SSP) and a single spray of insecticide Cypermethrin + Dimethoate at the rate of 100 ml in 1.5 litres of water for any infestation from pre-flowering through post-flowering phases were carried out.

The level of resistance to pod shattering was evaluated using the oven method modified according to Jiang et al. (1991) and Krisnawati, and Adie (2019a) on all the genotypes tested. Ten fully matured dried pods from each genotype collected across the three replications were placed in brown envelopes for ten days at room temperature to maintain homogenous seed moisture content. The ten pods were later subjected to oven drying at a level of temperature of 80°C and time regime of 5hrs according to Tukamuhabwa et al. (2002). The percentage pod shattering was determined on a scale of 1:5 according to Asian Vegetable Research and Development Centre (AVRDC , 1979) in which, 1 = 0% shattering, 2 = 1–10%, 3 = 11–25%, 4 = 26–50% and 5 ≥ 50%. The shattering score was classified as follows 1= highly resistant; 2 = resistant; 3 = moderately resistant; 4 = susceptible and 5 = highly susceptible (AVRDC, 1979).

Data were collected on number of days to flowering, number of branches per plant, number of pods per plant, plant height at maturity, number of seeds per pod, 100 seed weight, pod shattering, days to maturity and pod length. Data collected were subjected to analysis of variance (ANOVA) using PROC GLM of SAS 9.3 (2012). In addition Pearson correlation coefficient was computed using PROG CORR of SAS 9.3 (2012).

RESULTS AND DISCUSSION

The mean square from the analysis of variance for the nine traits measured revealed that the genotype effects were highly significant (P<0.01) for all measured traits except number of seed per pod (Table 1), indicating genetic variability for all measured traits. The implication of this result is that progress could be made through identification of desirable soybean genotypes in breeding program. This result agrees with the findings of Nassar (2013).

Table1: Mean square for pod shattering and other agronomic traits

Source	DF	Days to 50% flowering	No. of branches/ plant	Plant height (cm)	No. of pods/plant	No. of seeds/pod	Pod Length (cm)	Days to maturity	Hundred seed Weight (g)	Pod shattering score
Genotypes	17	44.57**	5.58**	302.47**	1061.34**	0.35ns	0.44*	111.36**	6.58**	4.27**
Rep	2	2.46	3.13	21.73	158.72	0.67	0.29	0.13	0.06	0.06
Error	34	0.33	1.84	83.03	141.19	0.24	0.22	0.84	0.17	0.08

ns: non-significant difference; *: significant difference observed among the mean (P<0.05); **: highly significant difference observed among mean (P<0.01)

The result of Table 2 showed that genotypes with leaf pubescence were either highly resistant or resistant while genotypes with glabrous leaf are susceptible to pod shattering except for genotypes NG/SA/OA/10/11/046, TGX1740-1F, NG/AA/SEP/09/166, NG/AA/SEP/09/167 and NG/SA/07/100 which are classified as moderately resistant. This result suggested that resistance to pod shattering might be related to leaf hairiness.

The response of genotype to pod shattering varied from 1 = highly resistant for NG/SA/07/150, NG/AD/11/08/023, NG/AA/SEP/09/165, NGBOO129, TGX1448-2E and TGX1955-10E to 4 = susceptible for NS/SA/07/033, NGBOO/08 and TGX1440-1E (Table 3).

Plant height ranged from 33 for NG/AA/SEP/09/167 to 60 cm for NG/SA/07/100 (Table 3). The range of values for plant height obtained in the present study is similar to the findings of Singh et al. (1996) who reported a range of 30 to 57 cm, while Wanderi (2012) found a mean of mean of 33.3 cm among parental genotypes as compared with their progenies (31.2 cm). The lowest days to flowering (33 days) was observed in TGX1955-10E TGX1835-10E and TGX1448-2E while the highest of 46 was observed in TGX1440-IE. Hundred seed weight ranged from 12.4 g to 7.0g in NG/AA/SEP/09/165, and TGX1440-IE respectively. Similarly, number of pods per plant showed statistical variability among genotypes. It ranged from 24 to 90 in NG/AA/SEP/09/167 and TGX1448-2E, respectively. Days to maturity showed significant differences among genotypes and ranged from 102 days for TGX1835-10E, TGX1448-2E, NG/AD/11/08/023 and NG/SA/07/055 to 118 days NG/MR/11/11/060. The average number of branches per plant ranged from 3.3 in NG/AA/SEP/09/166 and TGX1448-2E to 7.3 in NG/AA/SEP/09/167 and TGX1440-1E. NGBOO129 is most variable in terms of grain height while the least was recorded for NG/AA/SEP/09/166.

Table 2: Pod shattering status of eighteen soybean genotypes evaluated using oven dry method

S/No	Genotype	Leaf blade	Shattering score	Pod shattering status
1	NG/SA07/150	Pubescent	1	Highly resistant
2	NG/AA/SEP/09/166	Glabrous	3	Mod. Resistant
3	NG/SA/JAN/09/147	Pubescent	2	Resistant
4	NG/SA/07/100	Glabrous	3	Mod. Resistant
5	NG/MR/11/11/060	Glaborous	4	Susceptible
6	NG/AD/11/08/023	Pubescent	1	Highly resistant
7	NS/SA/07/033	Glabrous	4	Susceptible
8	NGBOO/08	Glabrous	4	Susceptible
9	NG/AA/SEP/09/165	Pubescent	1	Highly resistant
10	NG/AA/SEP/09/167	Glabrous	3	Mod. Resistant
11	NG/SA/07/055	Pubescent	2	Resistant
12	NGBOO129	Pubescent	1	Highly resistant
13	TGX1440-1E	Glabrous	4	Susceptible
14	NG/SA/OA/10/11/046	Glabrous	3	Mod. Resistant
15	TGX1740-1F	Glabrous	3	Mod. Resistant
16	TGX1448-2E	Pubescent	1	Highly resistant
17	TGX1835-10E	Pubescent	2	Resistant
18	TGX1955-10E	Pubescent	1	Highly resistant

The correlation analysis between traits has been described as an important critarium in determining the most efficient way for selection of superior agronomic traits in crops (Adebisi et al., 2004). Pearson's correlation coefficients showed interrelationships between the variables measured. There was positive correlation (r = 0.346*) between pod shattering and days to maturity (Table 4) this means that shattering may occur in late maturing susceptible genotypes than in early maturing susceptible genotypes. However the highly (r = -0.527**) negative correlations between number of seeds per pod and pod shattering indicated the possibility of pod with high number of seeds per pod to shatter compared to pods of genotypes with fewer seeds.

The negative correlation (r = -0.403*) between number of pod per plant and pod shattering tends to explain that shattering has negative effect on grain yield in soybean by reducing the number of pods per plant. Furthermore the positive correlation (r = 0.334*) between plant height and pod shattering tends to express that tall plants may tend to shatter more than shorter or intermediate plants due to the exposure to environmental factors. This is in agreement with the findings of Haruna (2010). Plant height was highly and negatively correlated (r = -0.488**) with seed weight and positively correlated (r = 0.340*) with days to flowering. This result is in disagreement with the findings of Rajkumar et al. (2010) who reported that seed weight was negatively correlated with days to flowering and plant height. Results of this study demonstrated the importance of breeding for resistance to pod shattering along with improvement for grain yield in soybean

Table 3: Mean performance of eighteen soybean genotypes evaluated for Resistant to Pod Shattering and other important agronomic traits under Screen House condition

Genotypes	Days to flowering	Shattering score	No. of branches	Plant height (cm)	No. of pods/Plant	No. of seeds pod	Pod length (cm)	Days to maturity	Hundred seed weight (g)
NG/AA/SEP/09/165	36	1	5	42.5	40	3	3.9	110	12.4
NG/AA/SEP/09/166	42	3	3	45.8	44	2	3.8	112	12.0
NG/AA/SEP/09/167	42	3	7	33.5	24	2.3	2.8	115	8.2
NG/AD/11/08/023	42	1	4	51.1	44	2.7	3.4	103	9.4
NG/MR/11/11/060	41.3	4	5	60.8	44	2.3	3.7	119	9.0
NG/SA/07/055	41	2	4	34.6	73	2	3.4	103	9.9
NG/SA/07/100	41.7	3	7	64.8	60	2	3.5	118	8
NG/SA/07/150	36.3	1.3	6	36.3	44	2	3.5	108	11.7
NG/SA/JAN/09/147	35.7	1.3	7	40.0	58	2	3.1	120	9.9
NG/SA/OA/10/11/046	40.7	3	5	38	39	2	3.9	106	10.6
NGBOO/08	36	4	5	53.2	53	2	3.4	107	9.5
NGBOO129	41	1	5	51.6	83	2.7	3.9	103	10.2
NS/SA/07/033	41.3	4	6.7	56.3	26	2	3.2	116	9.1
TGX1440-1E	46.3	4	7.3	51.9	58.7	1.7	3.0	112	7.0
TGX1448-2E	33	1	3.3	51.9	90	2	3.1	102	10.5
TGX1740-1F	40.7	3	4	36.8	65.7	2.3	3.7	105	10.6
TGX1835-10E	33.3	1.7	5.3	34.4	76	2.3	3.4	102	12.2
TGX1955-10E	33	1	6.7	34.2	72.3	2.7	4.4	107	10.6
Mean	39.1	2.2	5.5	45.4	55.3	2.2	3.5	109	10
LSD	0.9	0.5	2.2	15.1	19.7	0.8	0.7	1.5	0.9
CV (%)	1.5	12.3	24.6	20.1	21.5	21.8	13.3	0.8	4.1

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Table 4: Phenotypic correlation coefficient among 11 traits of soybean genotypes evaluated for resistance to pod shattering

Variables	Days to Flowering	No. of branches/plant	Plant Height (cm)	Number of pods/plant	Number of seeds/pod	Pod length (cm)	Pod Shattering Score	Days to maturity	Hundred seed weight (g)
Days to flowering	**1**								
No. of branches/plant	0.112	**1**							
Plant height	0.340*	0.009	**1**						
No. of pods/plant	-0.400**	-0.288	-0.045	**1**					
No. seeds/pod	-0.265	-0.205	-0.173	0.020	**1**				
Pod length	-0.253	-0.318	-0.128	0.171	0.546**	**1**			
Shattering score	0.499**	0.046	0.334*	-0.403*	-0.527**	-0.191	**1**		
Days to maturity	0.290*	0.605**	0.359*	-0.549	-0.252	-0.267	0.346*	**1**	
Hundred seed weight	-0.605	-0.54	-0.488**	0.165	0.391	0.528**	-0.396	-0.448	**1**

CONCLUSION

The degree of pod shattering varied among genotypes with shattering score ranging from 1 = highly resistant to 4 = susceptible. In addition, Pod shattering had negative association with number of pods/ plant, number of seeds/pod while, plant height and days to maturity had positive association with pod shattering soybeans.

RECOMMENDATIONS

1. Based on the results of the studies, resistance to pod shattering and leaf pubescence were found to exhibit positive relationship. It is therefore recommended that the two qualitative traits be investigated at molecular level in order to ascertain this relationship.
2. Breeding for short or intermediate and early maturing varieties should be encouraged to reduce pod shattering in susceptible varieties for sustainable yield.

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