Evaluation of early maturing soya bean genotypes for pod shatteringresistance and highyielder in Western Tigray, Ethiopia.

Abstract

Shattering in soybean occurs after the pods reached maturity which can cause considerable yield loss. The aims of this study were to evaluate the pod shattering resistance and the performance of the agronomic traits of several soybean genotypes. Field experiment was conducted at Humera district during 2018 cropping season using sixteen soya bean genotypes. Treatments were evaluated with RCBD and replicated three times. Pod shattering, number of branches, seed per pod, pod per plant, hundred seed weight and seed yield were showed a significant ($P<0.01$) variation among genotypes.While; days from planting to days of flowering and days of maturity weren.t significant variation among genotypes. The mean pod shattering was ranged from scale1.25 to 4 Maximum amount of pod shattering was measured in the genotypes PI423959 (4), PI506764 (3.75) and PI417085 (3.25). However, minimum amount of pod shattering was measured in the genotypes of PI417116 (1.25), Desha (1.75) and PI417132 (2). Highest yield was obtained from the genotypes PI714116 (19.29kg/ha) and PI417132 (16.54kg/ha). However, slowest yield was obtained from the genotypes Williams(check) (6.7kg/ha) followed by PI223963 (8.53 kg/ha) and Nova (check) (9.86 kg/ha).

Key word; Soya bean, yield, pod shattering, and correlation

Introduction

Soybeans in Ethiopia are mostly cultivated during the summer season (June/July-September/October). As a consequence, the seed maturing process and the period there after often occur in the peak of dry season, which poses a different production problem, such as pod shattering. The use of susceptible variety to pod shattering will aggravate the seed losses. Pre-harvest pod shattering can occur when pods weaken from adverse weather conditions or when harvest is delayed. Pod shattering is a serious production constraint that causes 34 to 99% seed losses in soybean (Tiwari and Bhatnagar 1991) depend on the susceptibility of the variety, environmental factors, and delayed harvesting.

Allot of finding was done to identify shattering resistance; in Ghana and Indonesia from 34 and 150 soya bean genotypes obtained six and eight moderately resistant and very resistant genotypes; respectively (Zhang L and Boahen L 2010, Bara N, Khare, et al. 2013. Various studies that have been carried out showed that there were several soybean genotypes that have resistant to very resistant in pod shattering. Other studies supported that pod shattering was genetically controlled (Adeyeye, et al, 2014, Sujata, et al, 2012). Nowadays, the problems during soybean cultivation in Ethiopia are climate change and the labor scarcity. Shortage of labor can delay harvesting, leading to yield losses. A significant yield loss was reported by Tiwari & Bhatnagar (1991) due to delayed harvesting at maturity, particularly in susceptible varieties to pod shattering. The availability of soybean resistant to pod shattering would reduce the yield losses and increase the farmers' income. A study by Tukamuhabwa et al. (2002) showed that resistant varieties did not shatter even when harvested after a delayed harvesting period of 21 days. Soybean resistance to pod shattering was varied between genotypes, as well as the limit of resistance to pod shattering. The research was aimed to evaluate the pod shattering resistance and the performance of the agronomic traits of several soybean genotypes.

Material and Methods

Study site;

The field experiment was conducted during 2018 in main crop growing season in western Tigray (Humera station). The site is located at 14^{o} 00' 85" North latitude and 36^{o} 34' 52" East longitude. The elevation of this station is about 600 meters above sea level. The mean annual temperature of the area is 29 ^{0}c and the rainy months extend from late June to the middle of September. The remaining 8-9 months are dry and hot. The experimental site is described as having hot to warm temperatures and high evaporation conditions. This specific environment is classified as a hot to warm semiarid lowland agro ecology. In such areas, the climate tends to be characterized by high temperatures and limited precipitation, leading to increased evaporation.

Plant material and field Management

A total of 17 different soya bean genotypes were used in a field experiment (Table 1). The genotypes were obtained from Federal research institute. The experiment was laid out in randomized complete block design (RCBD) with three replications. Each treatment were

randomly assigned into a plot area of $15m^2$ (5m row length and 3m width), which consisted of 5 rows of soya bean. The spacing between block and plot will be 2m and 1m, respectively. The spacing between plants and rows were 5 cm and 60 cm, respectively. Seeds are sown on June 2017 on three time's ploughed plots of land. Each experimental plot are received the same rate of NPS (100 kg/ha). The other management practices were applied equally and properly as per the recommendations.

Table 1. Description of early mature soya bean genotypes on this experiment.

S.No.	Genotypes	S.No.	Genotypes
1	PI200488	10	Desha
2	Nova(check1)	11	Delsoy 4710
3	PI423959	12	PI423962
4	PI417132	13	PI507005
5	Wiliams(che2)	14	PI506764
6	PI567059	15	KS3494
7	PI423963	16	PI417116
8	PI417085	17	PI416935
9	PI200456		

Data collection:

Pod shattering character

Pod shattering was measured on visual observation in the field. The number of shattered pods were counted and expressed as percentage. According to AVRDC [14] genotypes were classified into five categories based on their reaction to pod shattering as follows: very resistant (0%), resistant (1 to 10%), moderately resistant (>10 to 25%), moderately susceptible (>25 to 50%), and susceptible (>50%).

Agronomic data

Yield components including plant height, branches per plant, pod per plant, hundred seed weight, seed yield and shatteringwere determined. Plant height and branches per plant were measured from ten randomly selected plants in each plot. However, number of pods per plant was counted

from ten randomly selected plants. The weight of hundred counted seeds was recorded in gram for individual plots. Similarly, seed yield (kg/ha**)** was measured fromthreshed and cleaned plots separately using a sensitive balance and converted into kilogram per hectare.

Data analysis

Analysis of variance was done for yield and yield components (stand count at emergence, days to 50% flowering and maturity 90%, plant height, branches per plant, number of pods per plant, and thousand seed weight) from the field experiment, to know the main effects and their interactions using Genstat version 18 software. Least Significant Difference (LSD) values were used to separate differences among treatment means at 5% probability level.

Result and Discussion

Pre- harvest Pod shattering

This study revealed a wide range of resistance to pod shattering with significant differences among genotypes ($P<0.001$) (Table 2). The mean pod shattering was ranged from scale1.25 to 4 Maximum amount of pod shattering was measured in the genotypes PI423959 (4), PI506764 (3.75) and PI417085 (3.25); respectively. However, minimum amount of pod shattering was measured in the genotypes of PI417116 (1.25), Desha (1.75) and PI417132 (2). From the field observation pod position at lower part of the plant was more susceptible to pod shattering compared to those at middle as well as upper part. Harvest soybean fields as early as possible to reduce pod shattering during harvest, start harvesting somewhat earlier in the day when plant material is moist. The result is consistent with Kirsnawati, et al. 2020 Soybean genotype which showed consistently resistant to pod shattering, Anjasmoro variety (3.48 t/ha), categorized as resistant to pod shattering. Identification, development and utilization of varieties with resistance to pod shattering can reduce yield losses (Adeyeye et al., 2014). In addition according (Krisnawati A and Adie M M 2017) who reported that eight soya bean genotypes were showed very resistant to pod shattering. The current finding was similar with Tukamuhabwa et al. (2002) who reported that environmental factors such as drought stress during pod maturation has a significant impact on pod shattering. That might be the reason of an increase in pod shattering incidence observed particularly during the short rain season accompanied with dry weather conditions. Zhang and Boahen (2010) clarify that the rate of shattering was faster on non-

irrigated soybean than irrigated soybean. Furthermore, Zhang and Bellaloui (2012) stated that temperature and rainfall as essential factors affecting soybean seed shattering. The current finding agreed more with Bhor et al. (2014) who reported that genotypic characteristics play a major role in the overall expression of pod shattering suggesting that differences could be attributed to variation in genetic information of soybean genotypes and seasonal weather conditions during growth and development.

The reaction used in this series of evaluations provided a good basis for classifying genotypes into resistant, moderately resistant, moderately susceptible and susceptible categories. The two genotypes (PI417116 and Desha)were the most resistant and also, the five (Nova (check1), PI417085, PI423959, PI423963 and PI506764) were moderately susceptible. However, the rest ten genotypes were moderately resistance (Fig.1). This classification is a crucial in plant breeding and agricultural research to identify and develop crop varieties that exhibit resistance or tolerance to pod shattering. In general, pod shattering is affected by different environmental factors (dry climate, low humidity, high temperature, and rapid temperature changes) and irrigation systems (Agrawal,etal, 2002 and Zhang and S. Boahen, 2010).

Table 2. Pod shattering character of early mature soya bean genotypes

genotypes	Scale (pod shattering)	Pod shattering (%)	Reaction
Delsoy 4710	2.0abc	15.6	MR
Desha	1.75bc	9.9	R
KS3494	2.0abc	19.3	MR
Nova(check1)	3.125abc	26.2	MS
PI200456	2.75abc	22.7	MR
PI200488	2.5abc	20.2	MR
PI416935	2.75abc	22.7	MR
PI417085	3.25abc	27.6	MS
PI417116	1.25c	6.4	R
PI417132	2.0abc	11.4	MR
PI423959	4.0a	41.5	MS
PI423962	2.75abc	22.7	MR
PI423963	3.0abc	26.01	MS
PI506764	3.5ab	33.4	MS
PI507005	2.5abc	20.2	MR
PI567059	2.5abc	20.2	MR
Wiliams(che2)	2.75abc	22.7	MR

GM	**2.61**
Lsd (5%)	**1.827**
CV (%)	**49.3**

Note; R: Resistance, MR: Moderately Resistance, MS: Moderately susceptible, S: Susceptible

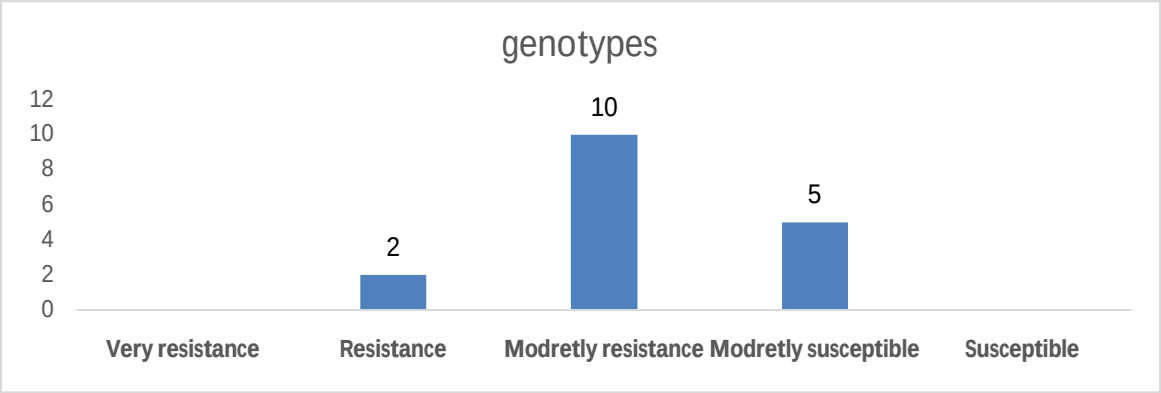

Fig. 1. Pod shattering reaction of early mature soya bean genotypes

Yield Components

Phenological traits (days of flowering and maturity)

Analysis of soya bean genotypes interims of flowering and maturity; it was observed that there wasn.t significant difference among the genotypes interims of the time taken for flowering and maturity. This lack of significance difference suggest that the different genotypes of soya bean tested exhibited similar pattern in their development stage particularly in relation to flowering and maturity. It could be due to genetic stability with in the tested genotypes.The current finding was agreed with Zhang and Bellaloui (2012) maturity dates of soybean varieties within the same maturity group can vary from 10 to 15 days depending on the time of planting and location (Table 3).

Branches per plant

There was a significant difference between the tested soya bean genotypes on braches per plant. Genotypes was varied in their ability to produce branches per plant. On average, the number of branches per plant ranged from one to three. Maximum number of branch per plant counted on the genotypes Delsoy 4710 (3) and K53494 (2.75). While the lowest number of branch per plant was counted from the genotypes of Williams (check) (1), PI423962 (1) and PI507005 (1.5)

(Table 3). The Finding was harmony with Kirsnawati and Adie (2020) number of branches were between 2.67 to 5.33 branches an average of 3.64 branches per plant.

Variability on Pod per plant and Seed per pod

Soyabean genotypes were showed significant difference at $p<0.01$ value on the productive pods per plant. Maximum amount of pod per plant was counted from the genotypes PI417116 (47.75), PI416935 (34) and PI200488 (41). Whereas, minimum amount of pods per plant were counted from the genotypes PI423963 (25), PI423959 (26) and Nova(check) (27.75) (Table 3).

In addition; seed per pod also shows there was a significant variation among the soya bean genotypes. Maximum seed per pod was counted from the genotypes PI417116 (3) and PI567059 (3). Minimum amount of seed per pod was counted from the genotypes of PI417085 (2) and Nova (check) (2) (Table 3). This study was indeed with Richard et al. (2019) reported that hundred seed weight ranged from 2.03g to 2.54g.

Variability on Hundred seed weight

Hundred seed weight shows there was a significant variation ($p<0.01$) among the soya bean genotypes. Seed weight was ranged from 14.75g to 9.5g with mean value. Heaviest seed weight was measured from PI200488 (14.75g) and Nova(check) (14.25g). While, the lowest seed weight was measured in the genotypes of PI416935 (9.75g) and PI417116 (10.0g) (Table 3). Seed weight is a critical factor in determine yield, as heavier seeds often translate to higher yields and better overall plant performance. The current study Harmony with Gilles et al. (2022) Who reported that hundred seed weight ranged from 12 (TGX1835-10E, TGX1835-10E, and TGX2009-1F) to 21 g (TGX2010-5F), with an average of 15 g. Hundred seed weight is an essential parameter and contributes to optimizing the yield. It is very important for soybean plant adaptation and influences the seed vigor (Morrison and Xue, 2007). In addition Kirsnawati and Adie (2020) hundred seed weight range from 13.55 g to 20.56 g.

Variability on Grain yield

The result shows that there was a significant difference ($p<0.01$) among genotypes. Grain yield was ranged from 19.29qt/ha to 6.7qt/ha with the mean value 11.64qt/ha. Highest yield was obtained from the genotypes PI417116 (19.29qt/ha) and PI417132 (16.54qt/ha). However,

slowest yield was obtained from the genotypes Williams(check) (6.7qt/ha) followed by PI223963 (8.53 qt/ha) and Nova (check) (9.86 qt/ha) (Table 3). The result in lined with Richard et al., (2019) who reported grain yield ranged from 665.93 kg ha-1(cultivar Hill) to 1981.5 kg ha-1 (line 931/5/34) with a mean of 1230.93 kg ha-1. And also the result supported by Gilles et al , (2020) who stated that introduced soybean genotypes such as TGX2013-2F, TGX1951-4F, TGX2023-1E, TGX2004-13F,and TGX1987-10F were the highest yielding (1.7–2 t/ha). According to Kirsnawati and Adie (2020) reported seed yield of soya bean genotypes ranged from 2.34 – 3.54 t/ha with an average of 2.97 t/ha. The result was lined with [Tariku et al., [2023] who reported that Cocker (27.9kg/ha) was among the high yielder released varieties. In addition; Similarly; the result was lined with Kirsnawati., et al. 2020 stated genotype ATgt-18-009 produce a high yield (3.17 t/ha).

Table 3. Yield and yield parameters of early mature soya bean genotypes.

Genotypes	DF (50%)	DM (90%)	BPP	PPP	SPP	HSW (g)	GY(qt/ha)
Delsoy 4710	27.25	69.25	3a	32.25bcd	2.75ab	11.75ab	11.87cd
Desha	26.75	67.5	2.25abc	35.0a-d	2.5ab	11.88ab	13.21c
KS3494	26	67.75	2.25abc	36.5a-d	2.25ab	10.5ab	11.5cd
Nova(che1)	26	67	2.5abc	27.75cd	2.0b	14.25ab	9.86de
PI200456	25.75	67.25	2.75ab	35.0a-d	2.25ab	12.45ab	11.81cd
PI200488	27	69.5	2.25abc	41.0abc	2.5ab	14.75a	11.78cd
PI416935	28	66.25	1.5cd	44.0ab	2.25ab	9.75b	11.57cd
PI417085	25.5	67.5	2a-d	37.5abc	2.0b	12.5ab	10.21cde
PI417116	26.75	65.5	1d	47.75a	3.0a	10.0b	19.29a
PI417132	26	68	1.75bcd	37.0a-d	2.5ab	13.25ab	16.54b
PI423959	27.25	67.25	2.25abc	26.0d	2.75ab	13.93ab	9.86de
PI423962	26.75	69.5	1.75bcd	29.0cd	2.75ab	11.75ab	11.01cde
PI423963	27	65	1.5cd	25.0d	2.75ab	12.75ab	8.53ef
PI506764	25.5	69.75	1.5cd	36.75a-d	2.75ab	11.38ab	12.42cd
PI507005	26.5	68.5	1.5cd	40.75abc	2.75ab	11.5ab	10.27cde
PI567059	25.25	69.25	1.75bcd	37.25a-d	3.0a	12.88ab	11.46cd
Wiliams(che2)	27	70.25	1d	34.25bcd	2.25ab	13.25ab	6.71f

GM	**26.49**	**57.94**	**1.91**	**15.46**	**2.53**	**12.26**	**11.64**
Lsd (5%)	**2.485**	**5.692**	**0.994**	**11.296**	**0.64**	**3.89**	**2.54**
CV (%)	**6.6**	**6.9**	**36.6**	**31.3**	**17.9**	**22.4**	**15.4**

Note: DF: Date flowering, DM: Date of maturity, BPP: Branches per plant, PPP: Pod per plant, SPP: Seed per pod, HSW: Hundred seed weight, g: Gram, SY: Seed yield, qt/ha: quintal per hectare.

Correlation between pod shattering and agronomic traits

The correlation between pod shattering and yield, as well as pod shattering and pods per plant, was found to be highly significant and negative. This means that as the amount of pod shattering increases, both yield and the number of pods per plant tend to decrease. Specifically, the correlation coefficients were calculated to be r=-0.64 for yield and r=-0.53 for pods per plant. And also, there is a significant and negative correlation between pod per plant and hundred seed weight, with a correlation coefficient of -0.51 (Table 4). This means that as the number of pods per plant increases, the weight of a hundred seeds decreases. The result was agreed with the Krisnawati, et al.(2020) higher number of pod per plant increase the chance of obtaining the smaller seed size (100 seed size). In addition the result supported by Shete, etal, (2023) and Mahbub and Kumar et al. (2020) traits such as number of pods per plant, 100 seed weight and number of primary branches per plant showed a significant and positive correlation with seed yield per plant.

Table 4. Correlation coefficients between pod shattering and selected agronomic traits on early mature soybean genotypes.

	PPP	SPP	HSW	GY(qt/ha)
PPP				
SPP	0.07			
HSW	-0.51**	-0.18		
GY(qt/ha)	0.58**	0.35*	0.39**	
Pod shattering (%)	-0.53**	-0.15	0.35*	-0.64**

Conclusion

Soybean crop plays a crucial role in Ethiopia's agriculture sector and contributes significantly to food security and nutrition. It is well adapted from lowland to mid altitude agro-ecologies of the country. For a summary, the opportunity to obtain soybean pod shattering resistance is considerably higher due to the large genetic variability of soybean resistance to pod shattering. Based on the present study,considering mean high yield, highest productive pod per plant, and resistant to pod shattering; PI714116 was the best early maturing soybean genotype that fit in the study area. Further research is needed the future to cover a wide range of environment and genotypes to screen resistance and high yielder.

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