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Screening of Soybean Genotypes at Highland Agroecology of Southwestern Ethiopia

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Abstract

Soybean is becoming an economically important oil crop in Ethiopia. The current production of soybean is lower than the demand in Ethiopia. The population of Ethiopia is highly concentrated in the highland areas and a relatively higher prevalence of under-nutrition are found in the highland areas of the country. Hence evaluating the adaptability of soybean genotypes at highland agroecology is an important option for nutrition security and horizontal production increment. The trial was conducted with 100 soybean genotypes in simple lattice design in the year 2019 main cropping season at Jimma zone, Dedo district, South Western parts of Ethiopia. The parameters collected include; days to flowering, days to maturity, number of pods per plant, number of seeds per plant, hundred seed weight and grain yield. The statistical analysis showed a significant difference at ($P<0.05$) among the genotypes for most of the parameters. Out of the tested 100 soybean genotypes, about 68 % of the soybean genotypes unable to set seed, only 32% set seed. Mean grain yield ranged from 0.24 t/ha to 1.26 t/ha. The yield performances of the tested soybean genotypes are lower than the national productivity of soybean at the tested location. Hence, in the future, it is good to introduce soybean genotypes adaptive to such high altitude areas from different sources. Furthermore, it is good to lunch a hybridization program to develop varieties for highland areas still, it is good to focus on yield and earliness.

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Keywords

Soybean, Evaluation, Frost, Performance.

Introduction

Soybean is a short-day plant, but the response to day length varies with variety and temperature. Day length influences the rate of development of the crop; in short-day types, increased day length may result in the delay of flowering and taller plants with more nodes. It is a medium-altitude crop and is well adapted to areas located at altitudes ranging from 1300 to 1800 m and receiving rainfall of 900 to 1300 mm (Hammer and Haraldson, 1975). Soybean is the world's most important legume in terms of production and trade due to its high content of protein (35-40 %) and oil (15-22 %). Soybean products are rich in essential amino acids, vitamins and minerals. Soybeans are used not only for food, but it also serves as a cure for various diseases and body ailments. Soybeans are included in medicines to improve the function of the heart, liver, kidneys, stomach and bowels. South Africa, Nigeria, and Zambia are the top three soybean producers on the African continent (Cornelius *et al.*, 2019). The demand for soybean in Ethiopia is increasing from time to time. However, the current production of soybean is lower than the demand. Currently, soybean grows below sea level to altitudes

close to 1800 m in Ethiopia, but there is an experience to grow soybean up to 2400 m.a.s.l in different countries like Kenya.

More than 1900 m.a.s.l in Brazil (Viana, 2013) with an average temperature between 20^{o}C and 30^{o}C. Hence, horizontal production increment through the development of suitable varieties under the highland area is one of the possible options. The present study aimed to evaluate the performance of soybean genotypes under the highland area.

Materials and Methods

The Study Area

The study was conducted at Jimma Zone Dedo district in Oromia regional state of Ethiopia. Dedo is located 377 km from Addis Ababa; the altitude lies between 880 and 2400 m.a.s.l, However, the trial site lies in 2300 m.a.s.l with mean annual rainfall ranges between 1200 and 2800 mm and temperature ranges from 20°C to 25°C.

Experimental Treatments and Design

A total of 100 early maturing lines and released soybean varieties in Ethiopia were evaluated in the simple lattice design. The experiment was planted in 2 rows plot of 4 m length.

The spacing used was 60 cm between rows and 5 cm between plants. 100kg DAP fertilizer was applied during planting and 3-4 hand weeding was practiced to control weeds. Harvesting and threshing was done manually.

Data Collection

The morpho-physiological observations were recorded at different stages of crop *viz*., days to flowering, days to maturity and hundred seed weight, disease severity and yield were collected on plot base.

Plant height, number of pods/plant and number of seeds/plant were collected on a plant basis on randomly selected five plants from the central rows and the averages of the five plants in each experimental plot were used for statistical analysis.

Data Analysis

The collected data were subjected to Analysis of variance using SAS Software after testing the ANOVA assumptions and treatment means were separated with the Least Significant Difference (LSD) at the 5 % probability level.

Results and Discussion

From this study, all of the studied soybean genotypes grow well to R1 (flowering). Soybean production at highland area depends on three independent and synergistic traits of flowering, viz: number of flowers produced on central racemes; capacity to retain central raceme flowers despite cold stress; and capacity to compensate a loss of central raceme flowers by rapid and sustained flower development on lateral racemes (Gass *et al.*,1996).

However, only 32 soybean genotypes set seeds and about 68 soybean genotypes were unsuccessful in setting seed and formed an abnormal pod (Image1). Hence, only 32 soybean genotypes were included in the static analysis.

The statistical analysis showed a significant difference for all of the parameters except the number pod per plant. From these studies, soybean genotypes T2-EL-LG-90-JM17-G8 was the earliest to flower (71 days), while genotype PI471904 showed the latest for flowering (129 days). Days to maturity ranged from 149 for the genotypes T1-EL-OS-JM17-E4and- 197 days for the genotypesPI471904 with a mean value of 182 days to maturity. The tested soybean varieties from this trial show high variability for days to maturity.

About 16 soybean genotypes show plant height below the mean value (57cm). The tallest plant height was recorded from PI471904 (98.7) and the shortest from PI417116 (33.5). The maximum number of pods per plant was observed on the varieties AFGAT (36.8) and the minimum from varieties PI423959 (7.8) with a mean value of 20.3.

The result is comparable to the one reported by Shankar (2014), who reported that pod per plant ranged from 19.20 to 53.93 with a general mean of 28.82 pods per plant. Similarly AFGAT showed the largest number of seed per plant (55.8), while varieties PI423959 showed the lowest number of seed per plant (10). With the mean value of 29.9, about 17 soybean genotypes recorded more than the mean value in a hundred seed weight (18.9g). The maximum hundred seed weight was recorded from the variety PI200456 (28.6g), while the minimum from the varieties PI567104B (9.7g). The mean yield ranges from 0.24 - 1.26 t/ha at dedo.

Table.1 Mean square value of yield and other parameters of soybean genotypes tested at Dedo highland in the year 2019

Source of variation		
Traits	**Mean square (Df = 31)**	**Error (Df=31)**
DF	**531.7****	**54**
DM	**237.4****	**87.5**
PH	**470.9****	**131.9**
NP	**79.76ns**	**39.3**
NS	**249.9***	**79.9**
HSW	**34.03****	**7.5**
Yield	**15.4****	**2.2**

Table.2 Mean yield and other parameters of soybean genotypes adaptation trial at Dedo high land(Jimma)

Genotypes	DF	DM	PH (cm)	NP	NS	HSW	Yield t /ha)
Pawe -2	111.5	196	64.1	33.7	51.5	24.7	1.26
SCS-1	115.5	187	56.8	21.2	26.4	21.6	1.13
PI417129B	106	187.5	59.9	20.9	34.9	19.8	1.05
PI567054C	125.5	197.5	79.9	26.3	44.7	10.9	1.01
JM-HAR/G99-15-SD-2	85	181.5	48.1	20	30.6	20.4	0.97
PR-143-(14)	113	187	52.1	24.6	40.9	19.9	0.96
JM-PR142/G99-15-SB	99.5	176.5	58.5	16.2	24.9	24.5	0.94
PI416810	109.5	171	67	20.4	32.1	16.8	0.93
PI417085	112.5	186	67.2	31.7	49.6	21.5	0.88
Nyala	98	186.5	51.6	19.3	26.1	16.5	0.87
PI423963	89	182	51.3	18.7	25.5	15.6	0.8
PI471904	129.5	197	98.7	26.7	42.2	12.3	0.79
PI200456	106.5	186	65.9	14.6	19.9	28.6	0.77
PI594760B	118.5	172.5	84	23.7	34.6	14.2	0.64
T2-EL-LG-90-JM17-B6	88.5	187.5	59.8	15.2	24.4	17.1	0.62
T2-EL-LG-90-JM17-G8	71	185.5	43.8	15.6	25.9	18.2	0.62
Coker 240	94.5	190	56.6	15.4	21	20.2	0.56
PI200488	93	183	45.7	24.4	33.6	20.6	0.53
Clark 63K	106.5	192	41.9	15.2	22.4	19	0.53
AFGAT	80	187	52.5	36.8	55.8	16.6	0.52
PI423959	94.5	185	41.4	7.8	10	24.3	0.52
PI567104B	119	154	88.1	24.7	42.7	9.7	0.51
PI200466	97.5	168.5	58.4	19.5	28.8	20.3	0.49
PI417089A	84	185.5	68.9	15.1	20	22	0.46
T1-EL-OS-JM17-E4	85	149	70.1	20.5	10.4	20.2	0.43
JM-HAR/PR142-15-SB	85	167	50.5	21.5	29.1	17.6	0.42
Harber	76.5	185.5	36	23.3	38.1	17	0.36
T3-EL-LG-63-JM17-A28	92	190.5	49.7	13.7	20.3	15.9	0.34
PI594172A	86	185.5	47.8	17.6	24.6	18.2	0.32
KS4895	79	186	40.1	11	17.5	16.8	0.31
PI417116	93.5	183	33.5	17.3	25.4	23.2	0.26
PI506764	86.5	185	41	16	23.8	23.4	0.24
Mean	98.5	182.6	57.2	20.3	29.9	18.9	0.66
Max	129	197.5	98.7	36.8	55.8	28.6	1.26
Min	71	149	33.5	7.8	10	9.7	0.24
CV (%)	7.5	5.1	20.07	30.9	29.8	14.4	22.4
LSD(0.05)	15	19	23	12.7	18.2	5.58	3

Photo.1 Performance of some soybean genotypes in the highland area, Dedo (a-c). Good performance (d). Unable to set seed due to chilling problem

The recently released soybean variety called Pawe2 gives the highest yield as compared to the other, which gives 1.26 t/ha and the lowest yielding variety was PI506764(0.24 t/ha). The yield performance of testing soybean genotypes was lower as compared to national productivity, which is 2.27 t/ha (CSA, 2017).

Recommendation

Among the tested 100 soybean genotypes at Dedo highland, 32 genotypes set seeds, while the rest 68 soybean genotypes were unable to set seed. Mean grain yield ranged from 0.24 t/ha to 1.26 t/ha.

The yield performances of the tested soybean genotypes are lower than the national productivity of soybean. Even though it is possible to harvest soybean yield in the highland area however, the yield performance is low as compared to the productivity potential of the soybean as well as the national productivity of the country. Based on this result, it is not feasible to advance the tested soybean genotypes for further tests. In the future, it will be good to introduce soybean genotypes adaptive to such high altitude areas from different sources. Furthermore, it is good to lunch a hybridization program to develop varieties for highland areas once when developed adaptable lines from introductions.

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