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Determination of soybean (*Glycine max* L.) production yield and yield components under metekel pawe at lowland western Ethiopia

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Abstract
Soybean is an important an oil seed and pulse in Ethiopia. However, the yield of this crop is limited mainly due to shortage of improved varieties suited to specific area. This field experiment was conducted during 2019/2020 cropping season to evaluate soybean varieties for yield production at conducted on farm field experiment in Metekel Zone Westeren Ethiopia in Pawe and Mandura field site the experiment contains five varieties namely Pawe-1, Pawe-2, Belesa, GTX-2644-133 and Nyala. The experiment was conducted using randomized complete block design with three replications. Data were collected on days to maturity, plant height, branch number, pods per plant and grain yield and subjected to analysis of variance using SAS software program. The result of this study revealed that, there was significant difference (p>0.05 or p>0.01) among varieties in all traits. The highest (2248.0 kg ha^{-1}) and (2147.9 kg ha^{-1}) grain yield were recorded from Parwe-2 and Pawe-1 variety, respectively among tested treatments. Therefore, it can be concluded that variety Pawe-2 or Pawe-1 well performed and can be recommended for the growers in the study area and its vicinity.

Keywords: Soybean varieties, performance evaluation, grain yield

Introduction

Soybean (*Glycine max* L.) is a papilionoid legume crop that belongs to the family of *leguminosae* that has a fairly wide range of adaptation for climatic conditions (Seltene *et al.*, 2016) [8]. The plant is classed as an oil seed and pulse, fat free (defatted) soybean mail is a primary low-cost source of protein for animal feed and most prepackaged meals, soy-vegetable oil is another valuable product of the processing soybean can produce at least twice as much protein per acre than many other major vegetable or grain crops (Mahasi *et al*, 2010) [6]. 5-10 times more protein per acre than land set aside for grazing animals to make milk and up to 15 times more protein per acre than land set aside for meat product.

Soybean is mainly used for cooking oil, fodder and soil fertility regulation (dual-purpose crop) in the study area. Soybean is an internationally known important pulse crop it is used for different purposes. Since the oil content is high 23% and above) it is used for edible oil production. The by product is cheap and an important source of protein for both human consumption and animal feed. It can also be used as soy meat and soy milk (Dixit *et al*, 2011). In Ethiopia FAFA food processing plc company has imported and used soybean prepare balanced food for infants and adults. Recently the factory is trying to improve the food values of other food types by mixing with soybean flour, which indicates the importance of soybean and its increment on the market (MOANR, 2017) [7].

Soybean was grown on about 36,635.79 ha in Ethiopia from which about 81,234.659 tons are produced in the year 2017, with the average regional yield of 2.21 t ha-1. In the same year 209.28 ha was covered with soya bean in SNNP Region from which about 268.409 tones were produced, with the average zonal yields 1.28 t ha^{-1} (CSA, 2017). However, the regional grain yield is far less than the attainable yield (2 to 2.8 t ha^{-1}) under good management conditions (MOANR, 2017) [7]. Low yield soybean in SNNP Region is attributed to several production constraints which include shortage of improved varieties, poor crop management practices, moisture stresses, low soil fertility, diseases and insect pests (Kidane *et al.*, 1990) [5].

More than twenty-seven improved soybean varieties have been released at national and regional levels in Ethiopia (MOANR, 2017) [7].

Soybean is becoming a high potential crop in Benshanugel gumeze region in Metekel zone pawe area in particular. However, in so far no improved varieties were evaluated yet and recommended for the area. Therefore, to exploit potential area for soybean production evaluating and promoting high yielder soybean varieties are a paramount importance. Because of this information generated in this study is helpful to identify best high yielding soybean varieties for the area and small scale holder farmers to produce these crops in the future which will support in food security and income generation. Hence, the present study was to identify superior soybean variety/ies in terms grain yield and desirable agronomic traits from the tested varieties for study area.

Materials and Methods

Description of the Study Area

Two experiments were conducted during 2019/2020 cropping season at in Metekel Zone Westeren Ethiopia in Pawe and Mandura field site with altitude of 1165 above sea level. The rainfall distribution of the area is bimodal, with a primary rainy season between March to May and secondary small rain between Septembers to December. The monthly average minimum and maximum temperatures of 30 and 40 °C, respectively. Mandura also located in Metekl zone Westeren Ethiopia with in North latitude & 36°38’ and 37°07’ East longitude with altitude of 588 meter above sea level. The rainfall distribution of the area is bimodal with main rainy season extends from January to May and the second cropping season, from July to October. It receives annual average rainfall of 876.3 mm and the monthly average minimum and maximum temperatures of 18.2 and 37.3 °C, respectively. All the metrological data a given above for the two location are long term averages.

Experimental Design and Treatments

Four soybean varieties namely: Pawe-1, Pawe-2, Belesa, Nyala, and TGX-2644-133, were used for current study. This experiment was laid out using randomized complete block design (RCBD) with two replications at two locations in Pawe and Mandura in metekel zone field site

Experimental Procedure and Management

The land was ploughed twice, disked and harrowed once and ridged with 0.5m by tractor, after which corrected by labour. Two seeds per hole were sown on ridges by hand at 0.1m intra-row and 0.5m furrow spacing. Thinning was done two weeks after emergence to maintain the target intra-row spacing. The plot size was 25m2 (5mx5m) and which accommodated ten furrow per plot. The spacing between replications and pots was meter. Plots were furrow irrigated every 5-7 days from planting up to flowering and then every 8-10 days up to physiological maturity at Pawe location while at Mandura location, 6-10 days from planting up to flowering and then every 11-15 days up to physiological maturity according weather condition. No any fertilizer and agro-chemicals were applied during growing period. The first, second and third weeding and hoeing were performed 20, 40 and 60 days after emergence, respectively. The net harvestable row was 6 (six) excluding the border two rows.

Data Collected

Growth parameters

Plant height was measured at the time of physiological maturity from central rows as the mean height of five randomly taken plants from the ground level to the apex of each plant. Number of primary branches per plant was determined by counting primary branches of the main stem from randomly taken five plants in the central rows and average value was considered.

Yield and yield components

Number of capsules per plant was determined from five randomly sampled plants at central row and the average value was considered**.** The harvesting central rows per plot were harvested, sun dried to constant weight and shattered. The seed yield of each net plot was then weighed using an electronic balance.

Statistical analysis

The various data collected were subjected to analysis of variance in randomized complete block design (RCBD) using SAS software version 9.2 (SAS, 2008) with a generalized linear model (GLM) procedure. Means were separated using least significant differences (LSD) test at 5% level of significance.

Results and Discussion

Analysis of variance

The analysis of variance for the individual location was carried out first and significant differences ($P \leq 0.05$ or $P \leq 0.01$) among varieties were obtained for days to 90% of maturity, plant height (cm), primary branch, and pods per plant and grain yield at both locations (Table 1).

Prior to the combined analysis of variance, homogeneity of error variances was tested and all of the traits showed homogeneous error variances (table 1). Having this confirmation, the data were pooled across locations and combined analysis of variance were performed and presented in Table 1. The mean squares obtained in combined analysis of variance were used to separate genotypic effects, location and their interactions. The mean squares from the combined analysis of variance over the two locations showed statistically significant ($P \leq 0.05$ or $P \leq 0.01$) difference between locations for all the traits studied. The combined analysis of variance over the two locations revealed significant differences ($P \leq 0.05$ or $P \leq 0.01$) among varieties for most of the studied traits.

The presence of significant differences among the tested varieties might be due to the existence dissimilarity in genetic composition among them, for that fact characters may be differ in their genetic properties. Besides, environmental influences might be the possible causes of their significant differences or both. The highly significant differences observed among varieties for some of the studied characters revealed the presence of substantial variability among varieties. Similar results have been reported by Deresse and Gezahegn (2018) [2], who observed significant variation among soybean varieties for most of the characters they measured at different location.

Phenology and Growth parameters Days to physiological maturity

The combined analysis of variance as shown in table 1 indicates the main effects of varieties and location had significantly ($p<0.05$) effects on days to physiological maturity, while their interactions no significantly effects. The highest days (104.7 and 104.5) maturity were recorded in Pawe-2 and TGX-2644-133 varieties respectively while the lowest days (81.2) to maturity was recorded in Nyala variety (Table 2). Pawe-2 and TGX-2644-133 varieties were late matured while Nyala was early matured varieties. Nyala variety matured 23.5 and 23.2 days earlier than pawe-2 and TGX-2644-133 varieties respectively. The highly significant effect of variety on days to physiological maturity might be due to different maturity group of varieties with early maturing variety Nyala having earliest days to maturity. This result was in agreement with the report of Deresse and Gezahegn (2018) [2] who reported that, days to maturity were significantly affected by soybean varieties. Moreover, this finding was in agreement with Habit and Adugna (2018) who founded that, days to maturity were significantly affected by soybean varieties.

Plant height at maturity

In this study, combined analysis of variance as shown in table 1 indicates the main effects of varieties and location had significantly (p<0.05) effects while their interactions no significantly effects on plant height. The tallest plant height (77.9cm) was observed for variety Belesa followed by TGX-2644-133 variety (77.5cm), while the shortest (28.2cm) plant height was recorded from variety Nyala (Table 2). This variation ascribed to the differences in the growing environment climatic conditions and genetic make-up of the varieties This result is in line with Simon *et al*. (2020) who indicated that plant height significantly difference among soybean genotypes. Similarly, Kibiru (2018) [4] who conducted experiment on soybean varieties he observed significantly difference in plant height.

Number of primary branches

Primary branches was highly significantly (p<0.05) affected by the main effects of variety and location. However, their interaction effect did not show significant effect. The highest and statistically similar mean number of branches 7.1, 6.7 and 6.5 per plant were recorded from variety TGX-133, Pawe-2 and Pawe-1, respectively. The lowest number of primary branches per plant (4.0) was recorded from varieties 'Nyala'. The difference in number of primary branches among the varieties could be most probably due to the existence dissimilarity in genetic composition among them, for that fact characters may be differ in their genetic properties to response formation of branch. This result was in conformity with the study by Deresse and Gezahegn (2018) [2], who reported that the number of branches per plant was significantly difference among they used varieties.

Table 1: Mean square for yield and yield components of soybean varieties tested at two locations (pawe and mandura and homogeneity test (F-max test) in 2019/20

Source	Degree of freedom	Plant height	Days 90% maturity	Primary branches per plant	Pods per pant	Grain Yield
Replication	2	1.748 ns	0.58*	0.0384*	513.2*	22276ns
Varieties	4	5.521*	2756.9*	8.9636*	13221.0**	855998**
Locations	1	597.9*	766.86*	11.6076*	3683.6*	3013*
Varieties x locations	4	3.389ns	187.8ns	2.6627ns	1207.8ns	10441ns
Error	17	0.343	13.90	2.6627	449.2	3427
CV (%)		1.2	10.29	11.18	16.30	3.85
		Mean Square of Error (MSE)				
Omorate	-	0.383	42.09	0.311	418.20	4957
Weyito	-	0.433	24.31	0.578	358.47	6140
F max	-	1.13ns	1.73 ns	1.86 ns	1.67 ns	1.24 ns

Ns= non-significant, *=significant, **= highly significant, ***= very highly significant at p<0.05CV=Coefficient of variance

Table 2: Means values of phenology and growth of soybean varieties tested at two locations in 2019/2020

Varieties	Days to 90% maturity			Plant height (cm)			Primary branch numbers		
	Pawe	Mandura	Combined	Pawe	Mandura	Combined	Pawe	Mandura	Combined
Pawe-01	101.00b	101.67b	101.33c	52.00b	42.4b	47.22b	6.8bc	6.30a	6.53a
Pawe -02	105.00a	104.33a	104.67a	53.93b	44.6b	49.28b	7.2b	6.23a	6.72a
Belesa	105.33a	102.00b	103.67b	85.40a	70.47a	77.93a	6.0c	5.00ab	5.50b
TGX-2644-133	104.67a	104.33a	104.50a	82.26a	72.73a	77.50a	8.87a	5.23a	7.05a
Nyala	81.33c	81.00c	81.17d	31.53c	24.9c	28.23c	4.3c	3.80b	4.03c
LSD(0.05)	1.16	1.24	0.824	12.22	9.28	7.57	1.05	1.43	0.78

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significant; LSD (0.05) = Least Significant Difference at 5% level.

Table 3: Means values of yield and yield components of soybean varieties tested at two locations in 2019/2020

Varieties	Pods per plant			Grain yield (kg/ha)		
	Pawe	Mandura	Combined	pawe	Mandura	Combined
Pawe-01	126.7b	149.80a	138.27b	2222.7a	2073.0ab	2147.9ab
Pawe -02	185.2a	145.30a	165.25a	2176.7a	2319.3a	2248.0a
Belesa	172.3a	123.83a	148.10ab	1884.0c	1884.3c	1884.2c
GTX-2644-133	165.6a	122.57a	144.08ab	1958.0c	1953.7bc	1955.8bc
Nyala	47.9c	44.40b	46.17c	1230.0d	1187.5d	1208.8d
LSD(0.05)	38.50	35.56	23.49	132.57	147.53	120.32

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significant; LSD (0.05) = Least Significant Difference at 5% level.

Yield and yield components

Number of pods per plant

The combined analysis of variance as shown in table 1 indicates the main effects of varieties had high significantly (p<0.01) effects while location had significantly (p<0.05) effects and their interactions no significantly effects on number of pods per plant. The highest mean number of pods per plant (165.25) was recorded for variety Pawe-2 and the lowest number of pods per plant (46.17) was recorded for variety Nyala (Table 3). The difference on number of pods per plant might be due the fact that the number of pods per plant regulated by the genotypes of soybean. This result was in line with Simon *et al*. (2020) who reported that significant difference of pods per plant among soybean varieties.

Grain yield (kg ha^{-1})

The combined analysis of variance of the current study showed the main effects of variety high significant (p<0.01) effect and location had significantly (p<0.05) effect while their interactions no significantly effects on number of grain yield. The highest grain yield (2248.0 kg ha^{-1}) and (2147.9 kg ha-1) were recorded for varieties Pawe-2 and Pawe-1, respectively and the lowest grain yield (1208.8 kg ha^{-1}) was recorded for variety Nyala. These two higher yielder varieties are relatively recent released varieties when it compared with the other tested varieties. Therefore, the possible reason for the observed the higher yielder varieties might be due to recent released variety gave higher yield than earlier released varieties. In addition, existence dissimilarity in genetic composition among them, for that fact characters may be differ in their genetic properties. Moreover, environmental influences might be the possible causes of their significant differences or both. On other hand, Nyala variety gave low yield compared to tested varieties. This might be due to heavy rain fall at maturity time. The result of this study is in agreement with the research finding of Simon *et al*. (2020) who observed a significantly difference among soybean varieties. Similarly, Deresse and Gezahegn (2018) [2] who studied on evaluate of soybean varieties found that, a significantly difference at plant in soybean varieties.

Conclusion and Recommendation

Soybean is an important an oil seed and pulse in Ethiopia. However, the yield of this crop is limited mainly due to shortage of improved varieties suited to specific area. This field experiment was conducted to evaluate soybean varieties for grain yield production at Pawe and Mandura in bmetekel zone westeren ethiopia Ethiopia. The experiment contains five varieties namely Pawe-1, Pawe-2, Belesa, GTX-2644-133 and Nyala. The experiment was conducted using randomized complete block design with three replications. Data were collected on days to physiological maturity, plant height, primary branch, and pods per plant and grain yield and subjected to analysis of variance using SAS software program. The result of this study revealed that, there was significant difference among varieties in these parameters at both location in pawe and mandura field experimental site.

From the combined results of this study the highest grain yield (2248.0 kg ha^{-1}) and (2147.9 kg ha^{-1}) were produced from Pawe-2 and Pawe-1 varieties, respectively. Therefore, it can be concluded that variety Pawe-2 or Pawe-1 well performed and can be recommended for the growers in the study area and its vicinity. Moreover, it can recommend from these findings that further investigation on different varieties along with other agronomic practice can be a step forward to identify more realistic effect of different.

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