Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.7, No.3, 2017

Evaluation of Yield and Yield Related Agronomic Traits of Different Introduced Soybean (Glycine Max L. [Merrill] Varieties in Pawe District, Northern Ethiopia

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Abstract
A field experiment was carried out in 2014 and 2015 cropping season on nine soybean varieties with two checks of total eleven varieties in Randomized Complete Block design with the aim of evaluating the performance of yield and yield contributing characters of introduced soybean (*Glycine max L.)* varieties considering number of days to 50% flowering, nodule number plant$^{-1,}$ days to 95% maturity, plant height, pods plant^{-1}, number of seeds pod^{-1}, number of seeds plant^{-1}, branch number plant^{-1}, 100 seed weight, adjusted grain yield .The combined analysis showed that **Belessa-95** for days to flowering and some of other varieties for hundred seed weight showed a significant different at ($p<0.01$). Whereas, the parameters; plant height, grain yield per plot and adjusted were significantly different at ($P < 0.05$) (table 5). On the other hand, the rest of all other yield related traits did not show significant difference ($P < 0.05$) (table 5). Since no more varieties, except only **PB12-8** performed over the all varieties including both checks regarding grain yield, it is recommended that there should be further evaluation of the all varieties at different environment with in different environment.
Keywords: Agronomic traits; Soybean; Variety

1. Introduction

Cultivated soybean, G. max (L.)Merry. Is a diploidized tetraploid (2n=40), in the family Leguminosae, the subfamily Papilionoideae, the tribe Phaseoleae, the genus Glycine Wild. It is an erect, bushy herbaceous annual that can reach a height of 1.5 meters. Three types of growth habit can be found amongst soybean cultivars: determinate, semi-determinate and indeterminate [1]. Soybean (*Glycine max* (L) Merr.) is one of the most important crops in the world, accounting for 48% of the world market in oil crops, and is widely used for animal feed for oil and protein production [2]. In Vietnam, soybean is an important crop and is utilized as a good source of meal food and high-quality protein.

Soybean is the most important crop due to its good chemical composition. Soybean seed contains 36% protein, 19%oil, 35% carbohydrate, 5% minerals and several other components including vitamins [3]. It is an ideal crop for improved nutrition, food security, sustainable crop production and suitable in livestock irrigation systems [4]

The major world producers of soybeans are the USA, China, North and South Korea, Argentina and Brazil. Ontario is the major producer of soybean in Canada, accounting for 90% of the total production in 1995. From 1945 to 1995, production increased from 18,000 to approximately 820,000 hectares in Canada 5]. The current National Production of soybean in Ethiopia is estimated as 11, 261 hectare; with a total productivity of 1,582 tons per hectare [6]. Food insecurity and malnutrition are among the urgent challenges that developing countries face these days. The major staple food crop of most developing Sub-Saharan African Countries, maize, contains low protein (5.2-13.7 %) [7].

Despite the significance of soy bean to address food and nutrition insecurity problems prevailing in the country, little emphasis has been given to production, supply and export of this important commodity. High yielding soybean cultivars could be achieved by introducing well adapted varieties or through hybridization and selection for one or more of major yield components. Therefore, sufficient genetic information regarding the yield traits of soybean is essential and an important step to get progress in soybean breeding programs. **[8].**

Access to variable germplasm resource is what the country has been facing since only the oldest soybean materials are used for production and became a bottle neck problem resulted in lack of improved technologies. So, it is found to be necessary introduce best commercial varieties from abroad and test first for their adaptability. This study therefore is conducted to evaluate the performance of yield and yield related agronomic traits of soybean with the purpose of generating information that help to characterize and select morphologically vigor soybean genotypes that will be used as a stock containing desirable and good yield attribute or agronomic traits for further breeding program.

2. Materials and Methods

2.1 Description of the Study Area

The study area, Pawe Agricultural Research Center ($11^0 18' 49.6''$ N and $036^0 24' 29.1''$ E), is located about 570 km away from Addis Ababa, the capital city of Ethiopia. The altitude of the study area is ranges between 1000-1200 m above sea level. The specific soil type of the site is well drained Nitisoil with PH value ranging from 5.3-5.5. Besides, Pawe is known for its high and torrential rain fall with unimodal pattern that extends from May to October. The area receives an intensive annual rainfall amount of 1586mm. the min annual maximum and minimum temperatures are 32.6 and 16.5 ^{0}c, respectively [9]

2.2 Design and Materials Used

The experimented was conducted in 2014 and 2015 main cropping seasons at the experimental site of Pawe Agricultural Research Center of Ethiopian Institute of Agricultural Research (EIAR). A randomized complete block design with three replications was used. The plot size of 3m x 4m was used with a spacing of 0.6m and 0.05m between rows and plants, respectively. Spacing between plots and replications were 0.6m and 1.5m, respectively. All agronomic practices were done as per the recommendation for soybean bean. Nine commercial varieties were introduced from Brazil in 2012 and have been tested at quarantine and transferred to acclimatization or adaptation trials with two checks (one standard and one local check) were tested (table 1).

2.3 Data Collected and Analysis

Data on agronomic traits such as number of branch per plant, days to 95% maturity, pods per plant, number of seeds per pod, plant height, grain yield, and 100 seed weight were recorded. Data for number of pod per plant, number of seeds per pod and plant height were collected from the average value of randomly selected five plants per plot. Whereas data on seed yield, and hundred seed weight were collected on plot basis. Analysis of variance was performed using Statistical Analysis Software (9.0). Least Significant Difference (LSD) test at 5% probability level was used for mean comparison when the ANOVA showed significant difference. The data thus collected were analyzed statistically by the analysis of variance technique and treatment means were compared using LSD test at 5 %level of probability [10].

Table.2 List of soybean Introduced and Control varieties used for the Experiment

S.N	Variety	Source	Maintainer	Year of introduce
1	PB12-1	Brazil	Brazil	2012
2	PB12-2	Brazil	Brazil	2012
3	PB12-3	Brazil	Brazil	2012
4	PB12-4	Brazil	Brazil	2012
5	PB12-5	Brazil	Brazil	2012
6	PB12-6	Brazil	Brazil	2012
7	PB12-7	Brazil	Brazil	2012
8	PB12-8	Brazil	Brazil	2012
9	PB-12-9	Brazil	Brazil	2012
10	Belessa-95(local check)	Ethiopia	Awassa/Ethiopia	
11	Wegayen(St. check)	Ethiopia	Pawe/Ethiopia	

3. Result

Table 3 Mean value of Yield and Yield related Traits of Soybean varieties in (2014)

TRT	DF (50%)	NN	DM (95%)	PP^{-1}	PH(cm)	SP^{-1}	BRA	HSW(g)	$AdjYha^{-1}$(kg)
PB12-1	52.7b-d	10.1ab	96.7a	34.1ab	47.4c	2.4a	2.8a	8.4ef	1106.0bc
PB12-2	53.7bc	9.9ab	99.7a	29.4ab	49.5c	2.1a	3.3a	9.0ed	1391.3ac
PB12-3	53.3bc	12.6ab	967a	32.2ab	51.8bc	2.1a	3.2a	8.7ed	1815.0ba
PB12-4	51.3bc	11.3ab	97.0a	32.7ab	49.9c	1.9a	2.9a	9.4b-d	1715.0ac
PB12-5	54.0ab	10.1ab	98.7a	21.9b	66.8ab	2.2a	2.5a	10.2b	1506.7ac
PB12-6	53.7bc	12.3ab	96.7a	42.9a	46.7c	1.9a	3.1a	9.3cd	943.3c
PB12-7	53.7bc	7.0b	99.0a	33.0ab	57.5a-c	1.8a	2.8a	7.7f	1831.3ba
PB12-8	52.7b-d	11.7ab	99.3a	40.3ab	53.7a-c	2.0a	3.5a	8.4ef	2118.0a
PB12-9	52.0cd	8.8ab	94.7a	32.2ab	50.4c	2.5a	2.2a	8.8ed	2091.3a
Belessa-95	55.7a	9.7ab	96.3a	24.0b	69.4a	2.4a	2.6a	10.0bc	2170.3a
Wegayen	52.3b-d	14.3a	99.3a	31.6ab	51.3bc	1.8a	2.1a	11.3a	1687.0ac
Mean	**53.2**	**10.7**	**97.6**	**32.2**	**53.9**	**2.1**	**2.8**	**9.2**	**1670.5**
CV (%)	2.05	31.8	3.06	34.15	17.36	25.4	32.34	5.25	30.15
LSD	1.8	5.8	5.1	18.7	15.9	0.9	1.55	0.2	857.78
p value	0.009	0.45	0.56	0.55	0.09	0.8	0.6	0.0001	0.1

Table 4 Mean values of Yield and Yield related Traits of Soybean varieties (2015)

Variety	FD (50%)	NN	MD (95%)	PP^{-1}	PH(cm)	SdP^{-1}	BRA	HSW(g)	$AdjYha^{-1}$(kg)
PB12-1	53.7b	7.3b	119.0a	27.0b	71.7ac	1.9a	2.0b	12.3cd	1706.4b
PB12-2	54.7ab	12.1ab	117.0ab	28.0b	65.0c	1.7a	1.8b	14.7ad	1830.8ab
PB12-3	54.0b	14.8a	113.3ab	29.1b	86.7ab	1.7a	2.1b	16.2a	2170.3ab
PB12-4	55.0ab	11.1ab	119.3a	32.4ab	69.1bc	1.6a	2.8b	14.3ad	1900.7ab
PB12-5	54.7ab	13.2ab	120.7a	38.5ab	67.1c	1.8a	3.2ab	15.3ac	2010.6ab
PB12-6	54.0b	10.ab	117.3ab	29.1b	78.7ac	1.7a	2.4b	15.5ab	2019.5ab
PB12-7	55.7ab	10.5ab	120.0a	36.6ab	71.4ac	1.9a	2.1b	14.0ad	2091.5ab
PB12-8	57.0ab	7.9b	119.7a	45.1a	86.5ab	1.8a	4.0a	12.2d	2320.9a
PB12-9	54.0b	11.5ab	118.7a	27.3b	68.8ac	1.9a	2.7b	12.7bd	1653.3b
Belessa-95	58.0a	12.2ab	116.7ab	27.5b	90.1a	2.01a	1.7b	13.5ad	1930.9ab
Wegayen	54.3b	9.5ab	117.0ab	31.5b	83.7ac	1.8a	2.8b	15.0ad	1789.0b
Mean	**55.0**	**10.9**	**118.1**	**32.0**	**76.2**	**1.81**	**2.6**	**14.2**	**1947.6**
CV (%)	3.87	35.20	2.43	23.2	14.70	13.67	33.77	12.80	15.8
LSD	3.62	6.58	4.90	12.7	19.10	0.42	1.47	3.08	524.6
P value	0.30	0.50	0.09	0.12	0.09	0.17	0.03	0.16	0.3

Table 5 Mean grain yield and agronomic characters of soybean varieties combined over two seasons (2014 and 2015)

TRT	DF (50%)	NOD	MD (95%)	PP^{-1}	PH(cm)	SdP^{-1}	BRA	HSW(g)	$AdjYha^{-1}$(kg)
PB12-1	53.27b	8.70b	107.83ab	30.57b	59.53bc	2.15a	2.40b	10.37bc	1406.19d
PB12-2	54.17b	11.00ab	108.33ab	28.70b	57.27c	1.91a	2.60b	11.83ab	1611.05b-d
PB12-3	53.67b	13.70a	105.00b	30.63b	69.30abc	1.89a	2.63b	12.45a	1992.67ab
PB12-4	53.17b	11.17ab	108.17ab	32.53ab	59.07bc	1.79a	2.87b	11.87ab	1807.84a-d
PB12-5	54.33b	11.63ab	109.67a	30.20	66.97bc	1.97a	2.87b	12.77a	1758.64a-d
PB12-6	53.83b	11.57ab	107.00ab	35.97ab	62.50bc	1.80a	2.77b	12.42a	1481.43cd
PB12-7	54.67b	8.93b	109.50a	34.80ab	64.47bc	1.89a	2.43b	10.87bc	1961.41abc
PB12-8	54.83b	9.77ab	109.50a	42.67a	70.13ab	1.93a	3.97a	10.28c	2219.05a
PB12-9	53.00b	10.17ab	106.67b	29.77b	59.63b	2.17a	2.47b	10.73bc	1872.34a-d
Belessa-95	56.83a	10.93ab	106.50ab	25.77b	79.77a	2.22a	2.17b	11.75abc	2050.62ab
Wegayen	53.33b	11.90ab	108.17ab	31.53b	67.53bc	1.81a	2.47b	13.17a	1738.02a-d
Mean	**54.09**	**10.86**	**107.85**	**32.10**	**65.11**	**1.96**	**2.69**	**11.68**	**1809.02**
CV(%)	3.09	33.49	2.73	28.86	15.89	20.88	32.99	11.21	23.02
LSD	1.95	4.2	3.4	10.7	12.1	0.47	1.03	1.53	485.33
P value	0.01^{**}	0.5^{ns}	0.18^{ns}	0.2^{ns}	0.02^{*}	0.5^{ns}	0.1^{ns}	0.002^{**}	0.047^{*}

N.B: **, * represents significance level at 1, 5 % respectively and **ns** is non-significance.

Table 6 ANOVA for mean squares of seed yield and other agronomic characters of different soybean varieties over two years (combined analysis)

Source of variation	Degree of freedom	FD	NOD	MD	PP	PH	SdP^{-1}	BRA	HSW	$YldP^{-1}$(g)	$AdjYha^{-1}$
variety	10	7.3^{**}	12.25^{ns}	12.7^{ns}	119.77^{ns}	259.97^{*}	0.14^{ns}	1.34^{ns}	5.89^{**}	170345.32^{*}	362287.5^{*}
year	1	54.5**	0.97^{ns}	6882.9^{**}	0.7^{ns}	8176.3^{**}	1.35^{**}	1.12^{ns}	402.56^{**}	580265.64**	1266707.24^{**}
Varity*year	10	2.44^{ns}	13.47^{ns}	8.14^{ns}	89.74^{ns}	162.2^{ns}	0.06^{ns}	1.13^{ns}	2.56^{ns}	115870.21^{ns}	247508.38^{ns}
error	42	2.81	12.23	8.68	84.79	107	0.16	0.78	1.71	80607.32	173505.94

N.B **, * represents highly significance level at 1% and 5% respectively and ns non- significance

3. Discussion

As shown in the first trial year (2014) of (table 2), local control Belessa-95 is superior in the parameters of plant height and yield 69.4cm (2170.33$kgha^{-1}$) respectively, followed by the variety PB12-8 which (2118.00 $kgha^{-1}$) yield is recorded and candidate PB12-5 with the height of 66.8cm. Whereas highest hundred seed weight was recorded by standard Wegayen (11.33 g).

On the other hand, in the second year (2015) no significance difference either ($p<0.05$) or ($p<0.01$) observed in any parameters though the candidate varieties showed best performance than both checks. Some agronomic traits; short flowering dates 53.67, 54.00 recorded by PB12-1 and PB12-9 and PB12-3. Highest yield 2320.09 $kgha^{-1}$, 2170.34$kgha^{-1}$, 2019.52 $kgha^{-1}$ was recorded by candidate PB12-8, PB12-3, PB12-6, respectively.

The combined analysis for days to flowering , number of nodule per plant, days to maturity, number of pods per plant, plant height, number of seeds per pod, branch number per plant, hundred seed weight per plot and adjusted grain yield for two years (2014 and 2015) at Pawe are presented (table 5).

Combined analysis of variance over two years revealed highly significant difference ($p<0.01$) among the varieties for the parameters days to flowering and hundred seed weight, whereas, plant height, plot grain

yield and adjusted grain yield recorded revealing that the varieties tested were significantly variable($p<0.05$). Days to flowering and hundred seed weight were showed non consistence performance for both seasons.

The presence of non-significance interaction for most of the traits studied indicates only the consistence performance weather not as expected of the varieties over two years. Short days of flowering (53, 53.17, and 53.33) were recorded by Treatment PB12-9, PB1212-1 and PB12-4, and PB12 the check Wegayen respectively. Highest Plant height (79.77cm) recorded by Belessa-95 (local check). Best yield performance was observed by the variety PB12-8 (221905 $kgha^{-1}$) than checks' record 1399.17$kgha^{-1}$ and 1182.83 $kgha^{-1}$ by Belessa-95 and Wegayen. The candidate variety PB12-8, therefore, showed consistent best yield performance during both trial seasons with regardless of agronomic traits.

4. Conclusion

In order to develop best materials and improving the productivity of soybean in the study area, it is better to consider the characters of the best variety having high yield advantage by resisting different biotic and abiotic stresses. According to this study, varieties differ significantly in their agronomic traits of days to flowering, plant height, hundred seed weight and yield performances recorded. This variation among the tested varieties for each trait enhances selection and advancement to the next trial stage. The average means performance of the study area across the seasons did not reveal a significant difference at 5 % probability level. As evidence of this experiment, new materials from outside their growing origin could not be effective with in two testing seasons. They need, therefore, additional testing at wider agro ecology and can be more advisable estimating the overall performance of the varieties since the genetic and environmental factors can cause a different level of variation of soybean characteristics. Even the combined analysis showed that only one variety (PB12-9) performed over the all varieties including both checks regarding seed yield, the all varieties should be tested further at different environment with in different years.

Acknowledgement

We would like to thank Ethiopian Institute of Agricultural Research, Pawe Agricultural Research Center (PARC) for the funds and facilities to conduct this research activity and Soybean research team. Lastly, we would like to express my gratitude thanks to Mr. Zigiju Mesenbet for his motivation and advise who advised me for full write up of the full write up of this paper.

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