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Evaluation of soybean (*Glycine max* L.) varieties for yield performance and adaptability over different growing seasons at Tselemti District, Northern Ethiopia

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A field experiment was carried out in 2015 and 2016 cropping season on ten soybean varieties using randomized complete block design. The aim is to evaluate soybean varieties for yield performance and adaptability considering number of days to 50% flowering, days to 95% maturity, plant height, pods per plant, plant height biomass and grain yield. Those varieties were superior overall the testing varieties such as Afgat and Gishama which produced 3010 and 2006 kgha^{-1} of grain yield respectively. Hence, on station trials revealed Afgat had higher yielding over other varieties which were also ranked the most preferred varieties. Therefore, improved variety of Afgat should be promoted for cultivation to farmers in northern western Tigray zone of districts and similar environments in Ethiopia.

Key words: Adaptation, soybean varieties, evaluation, yield performance.

INTRODUCTION

Soybean (Glycine max (L.) Merrill) - is one of the oldest annual agricultural plants known to mankind. It is a protein-oil plant with a high content of minerals and vitamins. According to its biological significance, it does not take place in the production it deserves. Because of all known characteristics of soybean, especially because of the grain richness of protein and oil, it represents a very important agricultural resource in the nutrition of humans and animals, but also for processing in various industries. The importance of soybean is rich and versatile. As a legume plant, it has great agro technical significance in crop rotation, because along with *Brady rhizobium japonicum* bacteria on its root, it enriches the land with nitrogen. Bacteria convert inorganic nitrogen N2 from the atmosphere into a form appropriate for the plant NH_2 (Vlahović et al., 2013).

Soybean is emerging as a very important food, market and oil crop in Ethiopia. In Ethiopia, pulses rank second as food crops after cereals, occupying 17.7% of the total cultivated area, and contribute 12% of the total crop production. The challenges are especially acute in Ethiopia and relatively more serious in the rural than urban areas, mainly because of a low level of understanding of a balanced diet and lack of capacity to purchase. Subsistence farmers in different parts of the country, who have been engaged in soybean production, are benefiting from the multiple uses of the crop. Thus, soybean is easily available, cheap, and a rich source of protein for poor farmers, who have less access to animal source protein due to their low purchasing capacity. Due

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Table 1. Mean value of yield and yield related traits of soybean varieties in 2015

Treatment	D flower (days)	D maturity (days)	PLHT (cm)	Podpp	BY (kg/ha)	Seed yield (kg/ha)
Wegayen	47.33[a]	139.0[e]	54.80	27.93	2574	1105.2[ab]
Gizo	55.00[ab]	132.[ab]	59.20	35.00	2759	775.8[ab]
Belessa	57.67[b]	132.0[ab]	58.53	35.93	3024	1354.4[a]
Awassa	48.67[a]	138.0[de]	48.50	11.40	2594	924.1[ab]
Gishama	52.00[ab]	136.0[cd]	52.20	22.87	2809	1379.8[a]
Afgat	58.00[b]	134.0bc	57.07	25.33	2293	817.6[ab]
Nyala	51.67[ab]	131.0[a]	43.67	17.67	1610	562.8[b]
Gozela	48.00[a]	138.0[de]	59.07	21.93	2769	1118.1[ab]
Jalele	47.33[a]	133.0[ab]	50.33	23.80	1843	864.6[ab]
Boshe	51.00[ab]	136.3[cde]	53.93	19.40	2444	807.9[ab]
Mean	51.67	135.00	53.7	24.1	2472.0	971.0
CV	8.2	1.1	28.9	56.3	33.0	34.8
LSD(0.05)	7.267	2.497	26.67	23.31	1398.37	579.31
F-test	*	**	ns	ns	ns	*

to its nutritional composition, it also helps to prevent human diseases, especially those arising from unbalanced diet (Abush, 2013).

In Northern Ethiopia, soybean is introduced in two zones namely northern western and northern zone, some special district and pocket areas of the region. Some research reported that soybean varieties produce significantly yields at different locations emphasizing to evaluate soybean varieties in various agro ecological zones for their adaptation, yield potential and disease reaction so as to select suitable varieties for cultivation.

Not much has been done on the varietal performance of soybean in the Northern Ethiopia. Therefore, there is the need to study the performance of some newly developed soybean varieties in the northern Ethiopia. The objective of the study was to determine the performance of ten soybean varieties in the northern Ethiopia.

MATERIALS AND METHODS

The study was carried out at Shire-Maytsebri Agricultural Research Center located in Tselemti District. Field experiment was conducted for two years 2015-2016 growing season. The research station lies at 13°59' North Latitude and 38°14' east Longitude and has an altitude of 1323 meter above sea level. Regarding the soil of the study site it is deep heavy black soil that cracks (shrink) when dry and swells when moistened it is a Vertisols soil type (Tesfahun et al., 2018).

Temperature ranges from 15.7 to 21.8°C in (November-January), while maximum temperature ranges from 36.4°C (February-May). The dry season occurs from November-March whereas rainy season occurs from June-September, following a unimodal rain fall pattern. The most dominant soil types of the district are Cambisols, Nitosols, and Vertisols (Girmay et al., 2016).

The field experiment was laid out as a randomized complete block design with three replications. The study involved testing of ten varieties for adaptation and yield performance. The trial was planted with plot size of 4 m x 2.4 m during the cropping season of 2015 and 2016. The crop was planted in late June at spacing of 60 cm x 5 cm.Hand weeding was used to control weeds as per recommendation.

Data analysis

Data collected includes: Days to 50% flowering, Days to 50% maturity, plant height(cm), number of pod per plant, number of branch per plant, above ground biomass yield(kg/ha), grain yield(kg/ha) and harvest index (%). Data collected were subjected to analysis of variance (ANOVA) as described by Gomez and Gomez (1984). Means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

As shown in the first trial year (2015) (Table 1), Gishama is superior in the parameters of plant of yield (1379 $kgha^{-1}$) followed by the variety Belessa which (1354 $kgha^{-1}$) yield is recorded. However, no significance difference for the parameters of plant height, and number of pod per plant and biomass yield. On the other hand, in the second year (Table 2) no significance difference was either ($p<0.05$ or $p<0.01$) observed in most parameters though some agronomic traits; short flowering dates (47.3, 48.67 days) were recorded by Jalele and Awassa. Regarding the earlier to mature 131 days were recorded from Nyala variety but the latest one was 139 from Wegayen (Table 2). In addition, no significance difference was revealed on parameters like plant height, number of pod per plant, biomass and grain yield.

Table 2. Mean value of yield and yield related traits of soybean varieties in 2016

Treatment	D flower (days)	D maturity (days)	PLHT (cm)	Podpp	BY (kg/ha)	Seed yield (kg/ha)
Wegayen	47.33^{a}	139.0^{e}	54.80	27.93	2574	1105.2
Gizo	55.00^{ab}	132.7^{ab}	59.20	35.00	2759	775.8
Belessa	57.67^{b}	132.0^{ab}	58.53	35.93	3024	1354.4
Awassa	48.67^{a}	138.0^{de}	48.50	11.40	2594	924.1
Gishama	52.00^{ab}	136.0^{cd}	52.20	22.87	2809	1379.8
Afgat	58.00 ^{b}	134.0^{bc}	57.07	25.33	2293	817.6
Nyala	51.67^{ab}	131.0^{a}	43.67	17.67	1610	562.8
Gozela	48.00^{a}	138.0^{de}	59.07	21.93	2769	1118.1
Jalele	47.33^{a}	133.0^{ab}	50.33	23.80	1843	864.6
Boshe	51.00^{ab}	136.3^{cde}	53.93	19.40	2444	807.9
Mean	51.67	135.00	53.7	24.1	2472.0	971.0
CV	8.2	1.1	28.9	56.3	33.0	34.8
LSD (0.05)	7.267	2.497	26.67	23.31	1398.37	579.31
F-test	**	***	ns	ns	ns	ns

Table 3. Performance of Ten Soybean varieties over two years (2015-2016)

Varieties	D flower (days)	D maturity (days)	PLHT (cm)	Podpp	BY (kg/ha)	Seed yield (kg/ha)
Wegayen	50.83^{abcd}	125.7^{bc}	62.33^{bc}	39.90^{bcd}	3286^{bc}	1391^{cd}
Gizo	55.29^{cdef}	126.0^{bc}	60.02^{bcd}	47.09^{b}	3380^{abc}	1478^{bcd}
Belessa	58.67^{f}	126.0^{bc}	64.87^{bc}	40.50^{bcd}	3099^{bc}	1417^{bcd}
Awassa	49.67^{ab}	122.8^{b}	53.52^{cd}	34.77^{bcd}	3203^{bc}	1382^{cd}
Gishama	55.50d^{ef}	128.0^{c}	65.62^{bc}	40.00^{bcd}	4510^{ab}	2006^{b}
Afgat	56.67^{cdef}	113.3^{a}	87.20^{a}	75.27^{a}	5031^{a}	3010^{a}
Nyala	50.67^{abc}	122.2^{b}	43.53^{d}	22.43^{d}	2383^{c}	1005^{d}
Gozela	53.1b^{cde}	128.3^{c}	73.20^{ab}	44.80^{bc}	3780^{abc}	1688^{bc}
Jalele	47.67^{a}	121.5^{b}	50.63^{cd}	32.10^{bcd}	2576^{c}	1344^{cd}
Boshe	49.3^{ab}	121.7^{b}	57.27^{bcd}	26.51^{cd}	3114^{c}	1454^{bcd}
Mean	52.72	124.52	60.3	37.5	32951	1507.4
CV	7.1	3.0	20.9	30	30	30.8
LSD (0.05)	6.150	6.169	20.86	23.57	1789.00	768.22
F-test	**	**	**	**	*	**

Combined ANOVA for soybean seed yield and agronomic traits across the two years (2015 and 2016) btained from this study are presented in Table 3. Almost all traits showed significant interactions between varieties × year except for plant height, number of pod per plant, biomass and seed yield and 100-seed weight. One of the yield components measured was the mean number of pod per plant. The number of pod per plant was influenced significantly (P<0.01) and different varieties of soybean varied markedly for their pod per plant. The number of pod per plant was highest (75) in variety Afagt, followed by varieties Gizo (47) and Gozela (44) with average number of pod per plant respectively whereas the lowest was obtained from Boshe (31).

In addition, the mean values of the traits across were: plant height (30.0 cm) days to 50% flowering (47), days to 90% maturity (113) and seed yield (3010 kg/ha). Hence, the compared mean of the traits over two years revealed that all traits of the varieties responded differently and this signified Afgat performance (Table 4).

Apparently, the mean square of analysis of variance showed significant difference at P=0.05 among the varieties and varieties for all traits except for plant height, number of pod per plant, biomass and seed yield over the

Table 4. Mean square values of combined analysis of variance of ten varieties over two years (2015-2016).

Source of variation	DF	D flower (days)	Dmaturity (days)	PLHT (cm)	Podpp	BY (kg/ha)	SY (kg/ha)
Varieties (V)	9	75.76**	99.82**	610.8**	805.7**	3096521*	1181234**
Year(Y)	1	99.11*	5901.00**	1728.7*	8441.7**	32008234**	12241242**
V*Y	9	30.17*	53.05*	168.3^{ns}	328.7^{ns}	1108669^{ns}	283255^{ns}
Error	38	13.85	13.93	159.2	203.4	1171446	216007

two years (Table 4). The varieties and year interaction clearly demonstrated that variety and environment interaction across the environment clearly play a significant role in breeding adaptable variety to the wide environment. This interaction was validated by the significant difference at (P=0.05) for days to 50% flowering and days to 90% maturity.

Conclusion

In order to develop best materials and improve 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. This study evaluated the yield performance and adaptability of soybean varieties at Tselemti District for yield and yield components. The results show that Afgat differed significantly (P<0.05) in their performance when compared to the other varieties especially Williams that had the lowest values for most parameters assessed. Afgat had the highest yields over the others on station trials. Observing the yield, it can be concluded that Afgats are the best soybean variety which can improve the soybean production and therefore should be promoted for cultivation to farmers in Northern western Tigray zone of districts and similar environments in Ethiopia.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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