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Research Article

Performance Evaluation of Soybean (*Glycine max* L.) Varieties in Buno Bedele and Ilu Ababor Zones of South Western Oromia, Ethiopia

Garoma Firdisa*, Mohammed Tesiso, Gebeyehu Chala

Oromia Agricultural Research Institute (IQQO), Bedele Agricultural Research Center (BeARC), Bedele, Ethiopia

Abstract

Soybean is becoming economical important oil crop in Ethiopia. Evaluating the adaptability of released soybean varieties in diverse agro ecology is important for efficient use of nationally released varieties in their area of adaptation and thereby increases production and productivity of soybean in the country. The experiment was conducted to identify, select and recommend adaptable, high yielding, Insect pest and disease resistant released variety for Soybean producing areas of Buno Bedele and Ilu Ababor zones in south west Oromia. Seven Soybean varieties were evaluated in RCBD with three replication in Buno Bedele zone (Dabo Hana and Bedele districts) and Ilu Abba Bora zone (Darimu district) for two 2021 and 2022 main cropping seasons. Analysis of combined data revealed significant varietal differences (P< 0.05) in grain yield, days to 50% flowering, days to 95% maturity, plant height and pod per plant. However, no significant varietal differences were observed in number seed per pod. The replication effect was not significant (P< 0.05) for all characters. Katta (31.38qt/ha) and Didesa (29.46qt/ha) varieties were significantly yielder than the rest while Jalale (18.51qt/ha) variety is the lowest yielder,. In general, Katta and Didesa varieties were identified as the best varieties for yielding ability, stability and recommended in the area and with similar agro-ecologies.

Keywords

Soybean, Adaptability, Varieties

1. Introduction

Soybean (*Glycine max* (L.) Merrill) is one of the most important pulse crops and it belongs to the family (*Leguminosae*) and is a self-pollinated crop with a chromosome number of 2n=40 [1]. It was originated in Asia [2]. Soybean is cultivated all over the world, as a major source of oil (18%) and protein (40%). It used for cooking oil, soy milk, soy flour, and it is a good source of unsaturated fatty acids, minerals (Ca and P) and vitamins A, B, C and D [3]. Soybean is one of the fastest growing crops in the World and occupies an important position among grain legumes for its economic benefits [4]. Low and declining soil fertility has long been recognized as a major impediment to intensifying agriculture and biological nitrogen fixation in soybean economically and ecological beneficial in Africa, in addition, stimulating the local oil and food processing industries, the meal for livestock and poultry feed industries, and increased

*Corresponding author: garomafirdisa21@gmail.com (Garoma Firdisa)

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share of the international market (import substitution and export) [5].

Ethiopia is endowed with favorable climatic and soil conditions for production in South and Western Ethiopia. Soybean grows in altitudes ranging from 1250 to 2200 masl, but performs well between 1300 to 1800 masl [6]. The crop is grown over wider agro-ecologies with mean annual rainfall of 500 to 1500 mm. Nevertheless, critical moisture requirement stages are at germination and grain filling. Temperature ranging from 20 to 25°C, and prefers a soil pH of 5.5 [7].

Soybean is one of the most valuable crops in the world, due to its multiple uses as a source of livestock and aquaculture feed, protein and oil for the human diet and biofuel besides producing valuable grain, soybean fixes between 44 and 300kgNha^{-1} which makes a significant N contribution to intercropped and rotated cereal crops. For example, [8, 9] estimated the improvement of maize crop following soybean crop at between 0.5 and 3.5tons ha^{-1} or 30-350% relative to maize-maize sequences. Soya bean is also an important source of edible vegetable oil and protein for both humans and animals; and it improves soil fertility by fixing atmospheric nitrogen [10]. The introduction of soybean crop to Ethiopia dated back to 1950s with the objective of supplementing the diet of Ethiopians especially during long periods of partial fasting [11]. In the International trade market, soybean ranks number one among the major oil crops with an average protein contents of 40% on dry matter basis. It has the highest protein contents of all field crops and is second only to groundnut in terms of oil content (20%) among the food legumes. [12, 13] Reported that soybean is more protein rich than any of common vegetable or legume food sources in Africa.

The yields of soybean in most parts of Africa can increase from 0.5 to 2.5tons ha^{-1} if the recommended steps are followed during their production. In most cases when soybean yields exceed 1.2ton ha^{-1}, farmers are likely to make profits but at less than 0.7tons/ ha farmers may not be able to recoup the cost of production. As soybean market value is good, application of little fertilizer like 20kgPha^{-1}, starter nitrogen and inoculant is often profitable even with conservative yield increment of 0.5tons ha^{-1}. Important measures for boosting soybean yields include; adoption of high yielding seed varieties, soil fertility management, pest/disease control, observing the most appropriate planting time. It is an ideal crop for improved nutrition, food security, sustainable crop production and suitable in livestock integration systems. Production and the usage of improved seeds is one of the most efficient ways of raising crop production. Even though, soya bean is very important oil crop in our country, its distribution through the country was limited to a certain areas. And also many improved soybean varieties were released from research institutions but not well reached to the farmers.

Therefore, the objective of this study was to evaluate improved soybean varieties that give best yield for the study area and similar agro ecology.

2. Materials and Methods

2.1. Description of Study Areas

The experiment was conducted at Dabo Hana (Dhaye subsite) and Bedele districts in Buno Bedele Zone and Darimu district in Ilu aba Bora Zone during 2021-2022 main cropping seasons.

Bedele District

The study was conducted in Bedele district of Buno Bedele Zone, Southwest Oromia Regional state during 2021 and 2022 main cropping seasons. It is bordered by the Sigmo woreda, Jimma Zone on the south western, Chora district in the northwest, Arjo woreda in the northern, and by the Gechi i in the east. It is found at 480 km to the Southwest of the capital city of Addis Ababa Ethiopia. It has a total area of 2,210.16 km^2 with 41 rural and 2 unban kebele total 43 kebeles.

The area receives mean annual rainfall of 1200-1800mm and it has an altitude between 1300 and 2200 meters above sea level [14]. Geographically, the woreda falls between 36° 0` 0`` up to 28° 80` 0``N latitude and 20°79`E longitude. The woreda has 45% arable land or cultivable land (57% was under annual crops), 4.7% pasture land, 35%, and 12% is considered swampy and degraded or otherwise unusable land respectively.

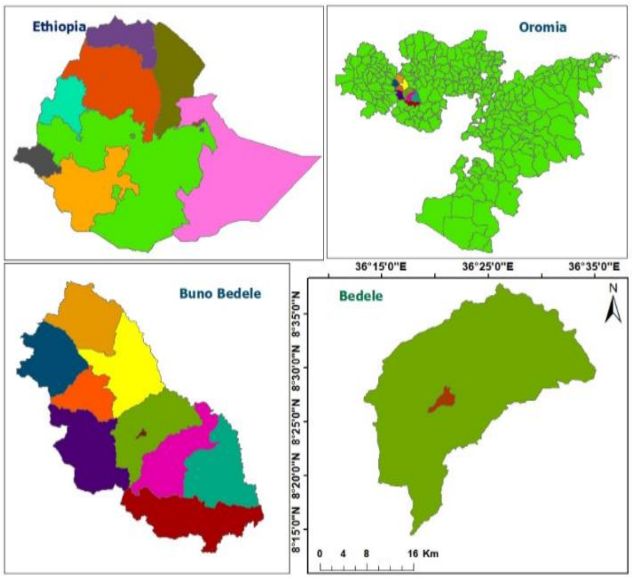

Figure 1. *Map of Bedele district.*

Dabo Hana District

Geographically, the study area (Dabo Hana district) is located in Oromia National Regional State, western Ethiopia, in 08°30’28.7” to 08°41’34.6”N and 036°26’19.2” to 036°30’41.1” E with altitude ranging from 1791 to 1990 masl. The long-term weather information at nearby study area (Ethiopian Metrology Agency Bedele District Branch) indicated that a uni-modal rainfall pattern with average annual rain fall of 1945 mm. The rainy season covers April to October and the maximum rainfall is received in the months of June, July and August. The minimum and maximum annual air temperatures are 12.9 and 25.8°C, respectively, the predominant soil type in Southwest and Western Ethiopia in general and the study area in particular, is Nitisols according to the soil classification system [15].

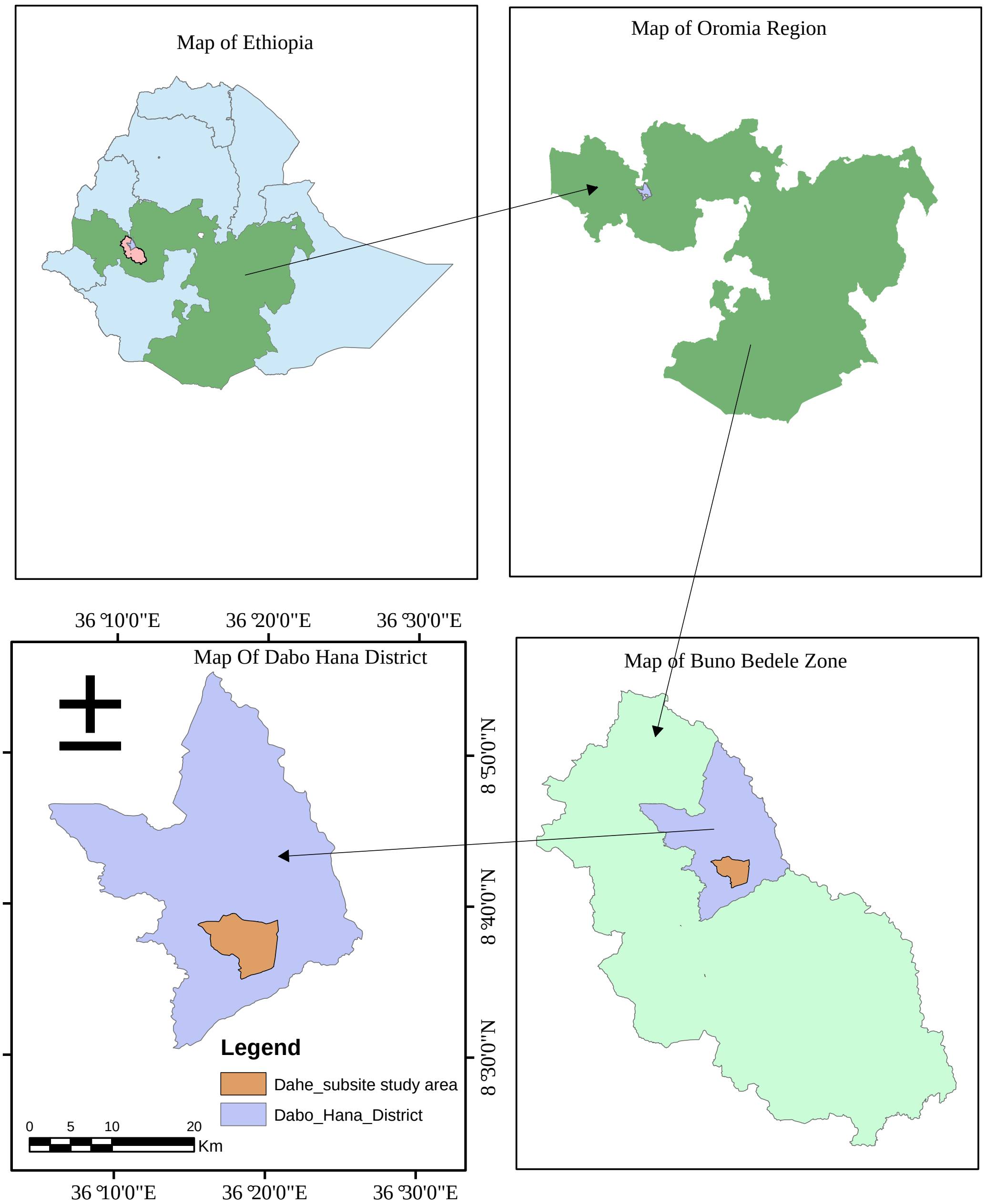

Figure 2*. Map of study Area (Dabo Hana district).*

Darimu District

Darimu district is one of the districts of Ilu Abba Bora Zone of south western Oromia Regional State, which is far Darimu district 668Km from AA. The attitude ranges from 862 to 1874. The study area has mean min and mean max temperature of 11.6 and 25.5°C, with annual RF of 2077mm (NASA, 14-Mar-2023 at 5:00PM) Nitisol, Acrisol and Cambisol were dominant soil type. [16].

2.2. Experimental Materials and Design

The study was composed of seven (7) improved soybean varieties (Table 1) organized in a randomized completed block design with three replications. The size of plots used for this experiment was 2.4m×3m (7.2m^2). The spacing between rows and plants was 40cm and 10cm, in the given order.

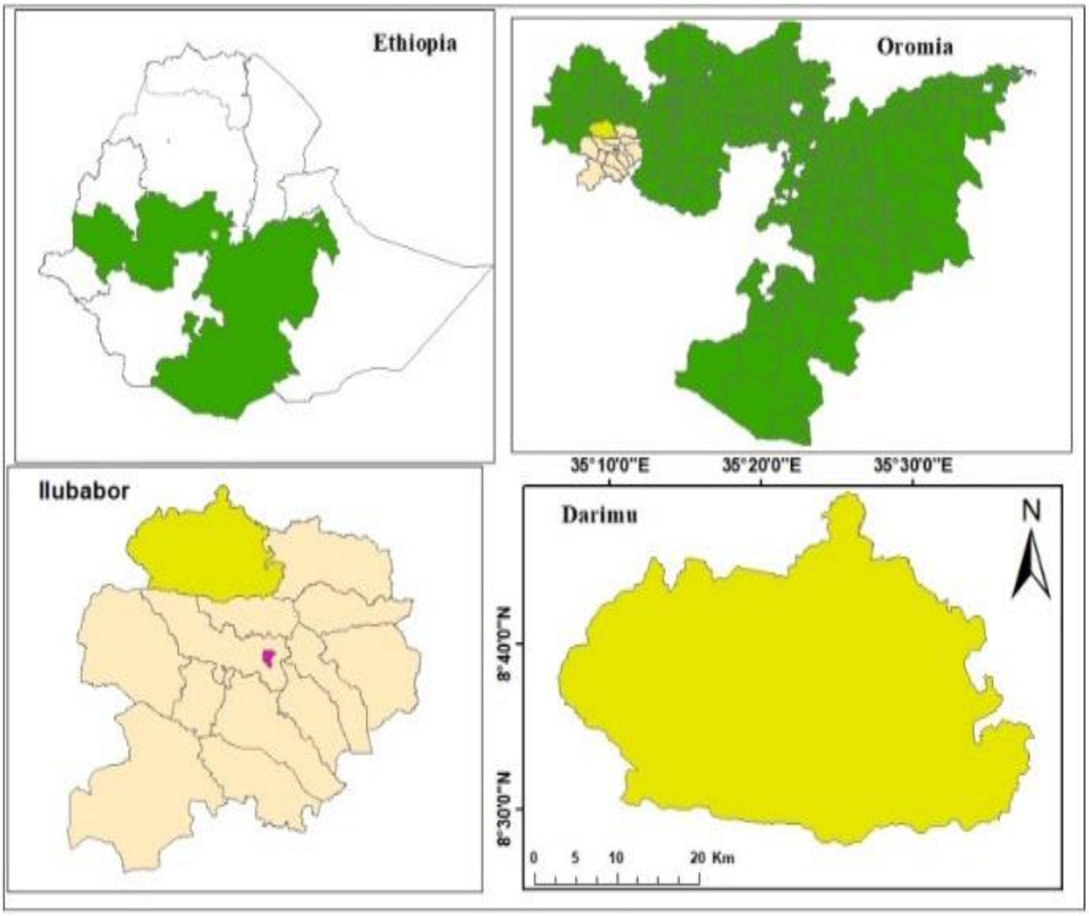

Figure 3. *Map of study Area (Dabo Hana district).*

Table 1. *List of genotypes used for the experiment with their characteristics.*

Varieties	Year of release	Altitude (masl)	Maturity group	Center of release
Boshe	2008	1200-1900	Medium	BARC
Cheri	2003	1300-1850	Medium	BARC
Clark 63k	1981	100-1700	Medium	BARC
Cocker-240	1981	700-1700	Medium	BARC
Didesa	2008	1200-1900	Medium	BARC
Jalale	2003	1300-1850	Medium	BARC
Katta	2011	1200-1900	Medium	BARC

Note: masl=meter above sea level, BARC = Bako Agricultural Research Center

Data Collection

Days to 50% seedling emergence: Days to emergence was recorded as number of days from planting to the time when 50% of the seedlings in plots emerged from the soil through visual observation.

Days to 50% flowering: this was determined by counting the number of days from planting to the time when first flowers appeared in 50% of the plants in a plot by counting the number of plants.

Days to physiological maturity: it was determined as the number of days from planting to the time when 90% of the plants started senescence of leaves (browning of the foliage) and pods started to turn black.

Plant height (cm): it was measured at physiological maturity from the base to the tip of a plant for randomly pre-tagged ten plants in harvestable rows using meter tape and averaged on a plant basis.

Number of pods per plant: it was recorded based on five pre-tagged plants in each net plot area at harvest and the average was taken as number of pods per plant.

Number of seeds per pod: the total number of seeds in the pods of five plants was counted and divided by the total number of pods to find the number of seeds per pod.

Grain yield (kg ha^{-1}): Plants harvested from the four central rows and for aboveground dry biomass were threshed to determine grain yield, and the grain yield was adjusted to the moisture content of 10%.

$$\text{Adjusted Grain Yield} = \frac{(100 - \text{MC}) \text{ X Unadjusted Yield}}{100 - 10}$$

Where MC- is the moisture content of Soybean seeds at the time of measurement and 10 is the standard moisture content of Soybean in percent. Finally, yield per plot was converted to per hectare basis and the average yield was reported in qt ha^{-1}.

3. Results and Discussion

Analysis of Variance

The combined analysis of variance for all varieties at different environmental conditions for grain yield was presented in Table 2. The combined analysis of variance exhibited highly significant difference at 0.1% probability level in Soybean varieties for grain yield. This indicated the presence of considerable variation in the genetic materials for yield and there is a possibility to improve the investigated Soybean varieties with simple selection.

However, the interactions; (Var*Loc) and (Year*Loc*Var) showed non-significant differences indicating consistent performance of varieties across locations and similarly the interaction (Year*Var) had non-significant effect on the studied and indicate that season was not affected the response of varieties on the studied parameters like grain yield.

Table 2. *ANOVA of seven soybean varieties for grain yield in in 2021-2022 cropping season.*

SOV	DF	SS	MSS	F-Value	Pr (<F)
Var	6	2069.0	344.84	7.0140	3.933e-06***
Loc	2	928.5	464.25	9.4428	0.000191***
Year	1	223.0	223.02	4.5362	0.035946*
Var*Loc	12	756.8	63.06	1.2827	0.242844
Year*Loc	2	193.5	193.49	3.9355	0.050357
Year*Var	6	291.9	48.65	0.9896	0.437318
Year*Loc*Var	12	486.1	81.01	1.6477	0.143387
Residuals	89	4375.6	49.16		

Note: SOV=source of variation, Var=variety, Loc=Location, **=significant at 0.01 probability level, ***=significant at 0.001probability level

The mean value of the Soybean Varieties for two years and locations

The combined mean value of the grain yield and yield-related characters of the seven soybean varieties is presented below in Table 3. The highest plant height was observed in Cheri (86.72 cm) whereas the lowest plant height was recorded from Clark 63k (56.59cm). The pods per plant were ranged from 49.46 to 73.94. The highest number of pods per plant was gotten from Katta (73.94) followed by Didesa (71.44), while the lowest number of pods per plant was obtained from Cocker-240 (49.46).

The highest days to maturity was obtained from Katta (139.4) and Cheri (131.2) while the lowest was obtained from Cheri (116.8), which means that early maturing than the others. In the case of days to flowering, the days to flowering weight was gained from Katta (86.33) whereas the lowest seed weight was gained from Boshe variety (76.39). Based on the combined data over the two year wide ranges of mean values between the minimum (18.51 qt/ha) for Jalale and maximum (31.18 qt/ha) for Katta were observed (Table 3). Katta and Didesa had the highest grain yield of (31.18 qt/ha) and (29.46qt/ha), respectively, while Jalale (18.51 qt/ha) had the lowest grain yield. This finding disagrees with the finding of [17, 18] who reported mean grain yield ranged from 14.26qt/ha to 29.73 qt/ha.

Table 3. Combined mean value of seven Soybean varieties for yield and yield related traits at Buno Bedele Zone (Dabo Hana & Bedele dstricts) and Ilu Aba Bora Zone (Darimu district).

Varieties	DTF (days)	DTM (days)	PLH (cm)	NP/PL	NS/P	GY (qt/ha)
Boshe	76.39^{d}	122.7^{bc}	60.81^{b}	51.57^{c}	2.67	22.65^{cd}
Cheri	85.33^{ab}	131.2^{ab}	86.72^{a}	71.36^{ab}	2.61	25.40^{bc}
Clark 63k	77.67^{cd}	116.8^{c}	56.59^{b}	55.43^{c}	2.54	22.93^{cd}
Cocker-240	78.17^{bcd}	126.4^{bc}	59.56^{b}	49.46^{c}	2.61	23.42^{cd}
Didessa	84.17^{abc}	120.8^{bc}	76.02^{a}	71.44^{ab}	2.67	29.46^{ab}
Jalale	76.67^{d}	125.9^{bc}	60.26^{b}	59.81^{bc}	2.59	18.51^{d}
Katta	86.33^{a}	139.4^{a}	85.54^{a}	73.94^{a}	2.67	31.38^{a}
GM	81	126.2	69.39	61.86	2.62	24.82
LSD (0.05)	7.45	12.71	14.39	13.36	0.36	5.20
CV%	14.0	15.3	31.4	29.72	20.7	31.7
P-value	*	*	*	**	NS	**

Note: DTF= Days to Flowering, DTF= Days to Maturity, PLH= Plant height (cm), NP/PL= Number of pod per Plant, NS/P= Number of seed per Pod, GM= Grand mean, LSD= Least significant different, CV= Coefficient of variation, NS= Non-significant, *=significant at P<0.05 level, **=highly significant.

4. Conclusion and Recommendation

In the last 2 decades or more clark 63K were the dominant soybean variety grown in Jimma, Buno Bedele and Illu Aba Bora zones of South western Ethiopia. In the study made for two year with released varieties, Katta (31.38qt/ha) and Didesa (29.46qt/ha) were found the two high yielding varieties based on 2 years mean.

Therefore, the two varieties Katta and Didesa were recommended for further demonstration and promotion for the study area and areas with similar agro-ecology in the Buno Bedele and Ilu Abba Bor zone of southwestern Oromia. Further research will be done using more soybean varieties/genotypes, over more locations and years to come up with better highly adapted and stable genotypes.

Abbreviations

BeARc Bedele Agricultural Research Center

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Conflicts of Interest

The authors declare no conflicts of interests.

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