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Performance evaluation of Soybean (*Glycine max* l.) varieties in Buno Bedele and Ilu Ababor zones of South Western Oromia, Ethiopia

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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, 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 consecutive years (2021 and 2022 main cropping seasons). The combined analysis of variance revealed significant differences (P< 0.05) among varieties in grain yield, days to 50% flowering, days to 95% maturity, plant height and pod per plant. However, significant differences were not observed in number of seed per pod. Katta (3.14 tha^{-1}) and Didesa (2.95 ha^{-1}) varieties were high yielder than the rest while Jalale (1.85 ha^{-1}) 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.

KEY WORDS: *Soybean*; *Adaptability*; *varieties*; *Glycine max*

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 (Singh *et al*., 2007). It was originated in Asia (Hymowitz, 2004). 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 (Mekonnen and Kaleb, 2014). Soybean is one of the fastest growing crops in the World and occupies an important position among grain legumes for its economic benefits (Hungria and Mendes, 2015).

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. Beside, producing valuable grain, soybean fixes between 44 and 300 kg N ha^{-1} (Hung, 2014) which makes a significant N contribution to inter-cropped and rotated cereal crops. Crosswell *et al.* (1992) estimated the

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improvement of maize crop following soybean crop at between 0.5 and 3.5 tons 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 (Worku *et al*., 2011).

It has long been understood that low and declining soil fertility is an important barrier to intensifying agriculture and biological nitrogen fixation in soybeans is economically and ecologically beneficial in Africa. It also stimulates the local food and oil processing industries, the livestock and poultry feed industries, and increase the region's share of the global market through import substitution and export (Raimi *et al.*, 2017).

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 (Asfaw *et al.*, 2006). 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 (Zerihun *et al.*, 2015). 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 (Asrat, 1965). 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. (Dugje *et al.*, 2009) 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 2.5 tons ha^{-1} if the recommended packages are followed during their production. (Van *et al*., 2018). In most cases when soybean yields exceed 1.2 ton ha^{-1}, farmers are likely to make profits but at less than 0.7 tons/ ha farmers may not be able to recoup the cost of production. As soybean market value is good, application of little fertilizer like 20 kg P ha^{-1}, starter nitrogen and inoculants is often profitable even with conservative yield increment of 0.5 tons ha^{-1}. Important measures for boosting soybean yields include; adoption of high grain yielding varieties, soil fertility management, pest/disease control, observing the most appropriate planting time. It is an ideal crop for nutrition, food security, sustainable crop production and suitable in livestock integration systems (Herrero *et al*., 2010). 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 and recommend the best variety(ies) for the study area and similar agro ecology.

2. Material and Methods

2.1 Description of the study area

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

Bedele district of Buno Bedele Zone, South-west Oromia Regional state during 2021 and 2022 main cropping seasons. It is bordered by the Sigmo district, District of Jimma Zone on the south western, Chora district in the north-west, Jimma Arjo district. District in the northern, and by Gechi district in the east. It is found at 480 km away from the capital city, Addis Ababato the Southwest. The area receives mean annual rainfall of 1200-1800 mm and it has an altitude between 1300 and 2200 meters above sea level (Bbzahldo, 2018). Geographically, the district falls between 36º 0' 0" up to 28º 80' 0" N latitude and 20° 79' E longitude. The districthas 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 (Fig. 1, 2 and 3).

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 m.a.s.l, The district had 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 (FAO, 2001). Darimu district is one of the districts of Ilu Abba Bora Zone of south western Oromia Regional State, located 668 Km away from AA to the south western. The altitude ranges from 862 to 1874 m.a.s.l.. The study area has mean mininum and mean maximum temperature of 11.6 and 25.5°C, with annual rain fall of 2077 mm (NASA, 2023) Nitisol, Acrisol and Cambisol were dominant soil.

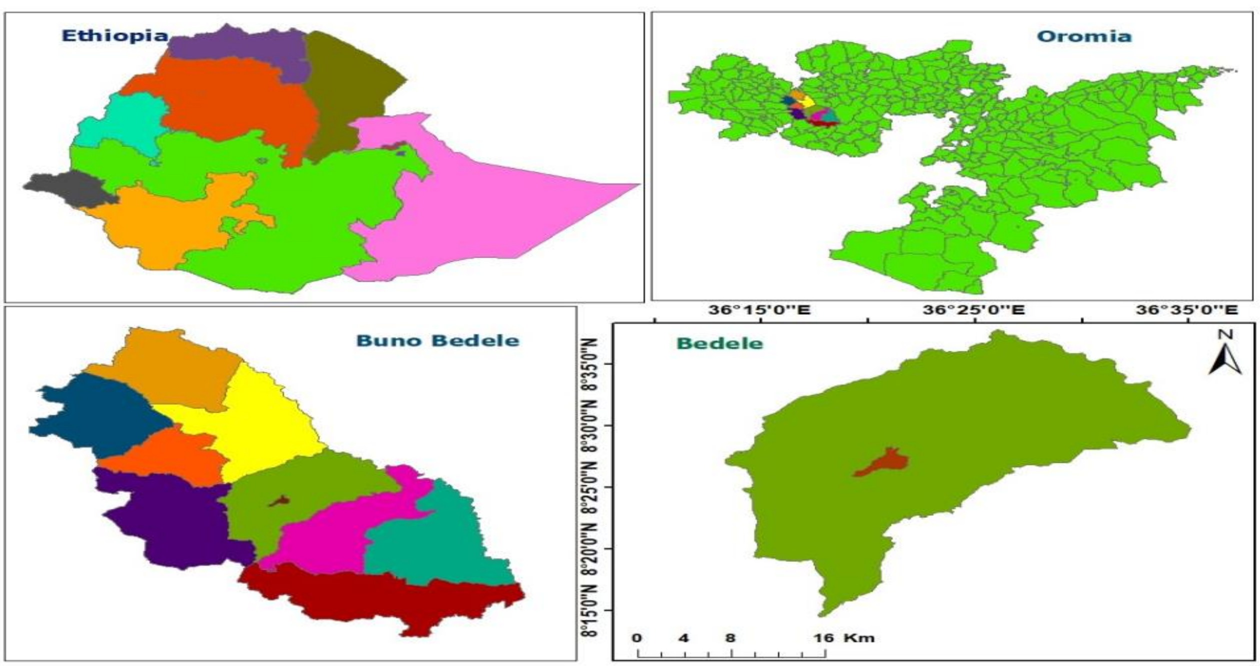

Fig. 1: Map of study area Bedele district

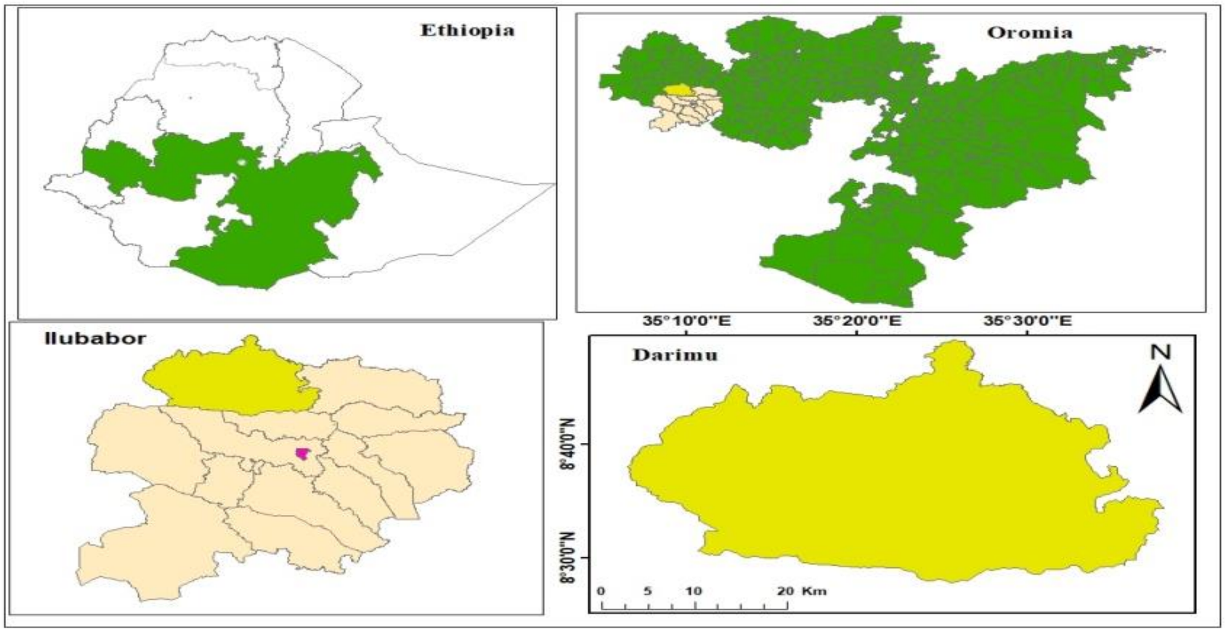

Fig. 2: Map of study Area (Darimu district)

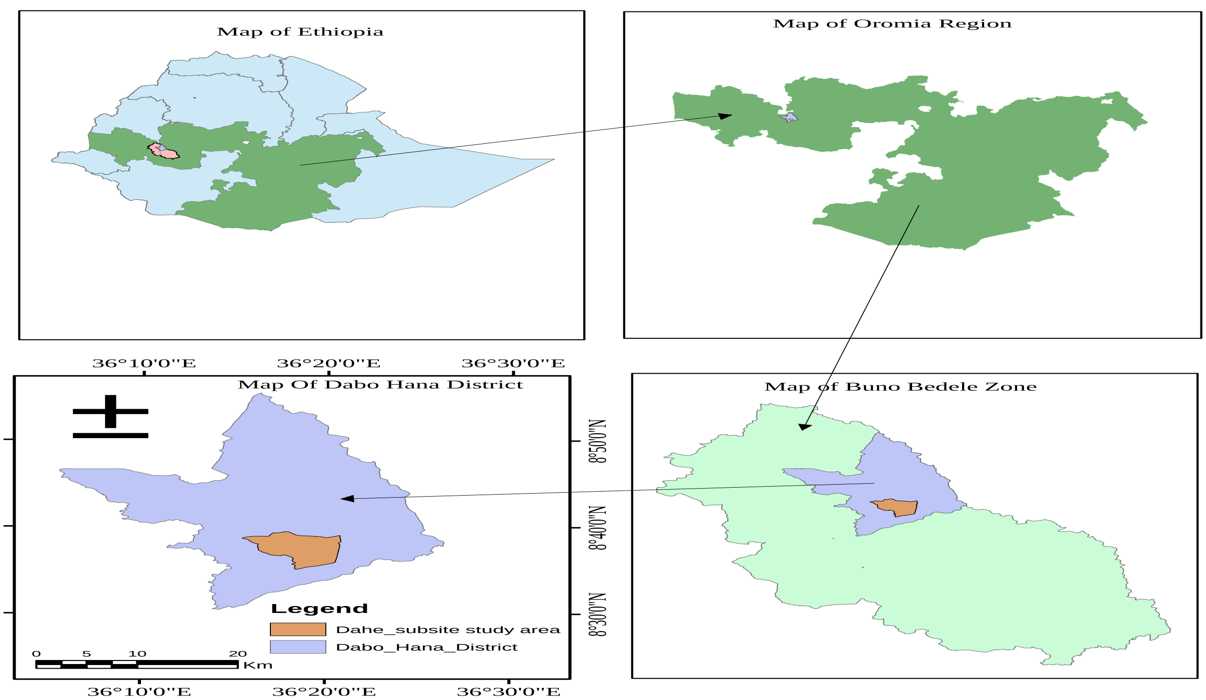

Fig. 3: Map of study Area (Dabo Hana district)

2.2 Experimental materials and design

The study was comprised 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 (7.2 m^2). The spacing between rows and plants was 40cm and 10cm respectively.

2.3 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%.

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

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}.

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

3. Results and Discussion

3.1 Analysis of variance

The combined analysis of variance for grain yield was presented in Table 2. The combined analysis of variance exhibited highly significant difference between tested 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 grain yield and indicate that season was not affected the response of varieties on the studied parameters like grain yield.

3.2 The mean agronomic traits of the soybean varieties

The combined mean value of the grain yield and yield-related characters of the seven soybean varieties is presented below in Table 4. The highest plant height was observed in Cheri (86.72 cm) whereas the lowest plant height was recorded from Clark 63k (56.59 cm). 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 recorded from Katta (139.4) and Cheri (131.2) while the lowest was obtained from Clark (116.8), which means that early maturing than the others. Based on the combined data wide ranges of mean grain yield values between the minimum (1.85 t ha^{-1}) from Jalale and maximum (3.118 t ha^{-1} from Katta were observed (Table 3). Katta and Didesa had the highest grain yield of (3.138 t ha^{-1}) and (2.946 t ha^{-1}), respectively, while Jalale (1.851 t ha^{-1}) had the lowest grain yield. The lowest productivity and range compared to the current study was reported by Mesfin and Abush (2019), whose mean grain yield ranged from 1.43 t $ha^{-1}$to 2.97 t ha^{-1}.

4. Conclusion

Within the final 2 decades or more clark 63K were the prevailing soybean variety developed in Jimma, Buno Bedele and Illu Aba Bora zones of

Table 2: ANOVA of seven soybean varieties for grain yield 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

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

Genotype	DTF (days)	DTM (days)	PLH (cm)	NP/PL	NS/P	GY(qt/ha^{-1})
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, DTM = 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.

Table 4: Mean grain yield (t ha^{-1}) and diseases reaction of seven soybean genotypes tested over six environments in south-western Ethiopia during 2021-2022 cropping season

Genotype	Mean grain yield (t ha^{-1})					Mean	Disease data
	Dabo Hana		Bedele		Darimu		
	2021	2022	2021	2022	2022		
Boshe	1.056^{bc}	1.482^{c}	2.546^{a}	27.08	1.852^{cd}	2.265^{cd}	0
Cheri	2.032^{a}	2.418^{b}	2.941^{a}	26.44	2.315^{bcd}	2.540^{bc}	0
Clark 63k	0.875^{c}	1.477^{c}	2.24^{ab}	31.76	3.056^{abc}	2.293^{cd}	0
Cocker-240	1.315^{bc}	1.688b^{c}	2.576^{a}	25.14	2.315^{bcd}	2.342^{cd}	0
Didesa	2.032^{a}	2.229^{bc}	3.091^{a}	3.269	3.495^{ab}	2.946^{ab}	0
Jalale	0.713^{c}	1.729^{bc}	1.496^{b}	3.125	1.269^{d}	1.851^{d}	0
Katta	1.565^{ab}	3.750^{a}	3.080^{a}	2.986	3.935^{a}	3.138^{a}	0
GM	13.70	21.10	25.71	29.17	26.03	24.82	
LSD(0.05)	6.52	8.14	8.82	1.37	14.32	5.20	
CV %	27.20	21.79	29.20	27.70	30.9	31.7	
P-value	*	**	*	NS	*	**	

Note: GM= Grand mean, LSD = Least significant different, CV = Coefficient of variation, NS = Non-significant, *=significant at P<0.05 level, **=highly significant.

South western Ethiopia. Within the consider made for two year with discharged varieties, Katta (3.138 t ha^{-1}) and Didesa (2.95 t ha^{-1}) were found the two high yielding varieties based on 2 a long time mean.

In this manner, the two varieties Katta and Didesa were prescribed for further exhibit and advancement for the study region and regions with comparable agro-ecology within the Buno Bedele and Ilu Abba Bor zone of south-western Oromia. Encourage inquire about will be done utilizing more soybean varieties/genotypes, over more areas and a long time to come up with way better profoundly adjusted and steady genotypes.

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6. Conflicts of interest

Authors declare that there is no conflict of interest exists.

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