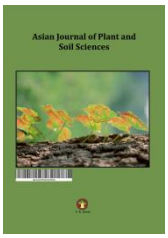

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An Evaluation on Cultivation Process of Soya Bean Varieties for Yield and Shattering Character at Moisture Stress Area in Western Tigray, Ethiopia

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Authors' contributions

This work was carried out in collaboration among all authors. Author AAK design the study, perform the statistical analysis, wrote the protocol first draft of the manuscript. Authors YBK and GA manage analysis of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aim of the current study was to evaluate released soya bean varieties for seed yield and shattering properties at moisture stress area under field condition. Field experiment was conducted at Humera district during 2017 cropping season using sixteen released soya bean varieties. Treatments were evaluated with RCBD and replicated three times. Number of days from planting to days of flowering and days of maturity, number of pod per plant, pod shattering and seed yield were showed a significant (P<0.01) variation among varieties. While; Seed per pod, hundred seed weight, seed moisture and number of branch per plant weren.t significant difference among the varieties. All

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varieties were resistance to pod shattering except AFGAT (18.5%) and tgx-1332644 (27.5%) were moderately resistance and moderately susceptible, respectively. Heights seed yield was recorded from the varieties Awassa-95 (14.92kg/ha) followed by Cocker (14.89kg/ha). Lowest seed yield was recorded on the varieties Belesa-95 (8.01kg/ha) and tgx-1332644 (8.96kg/ha). Association showed that there was a significant positive and negative association of among yield and yield component. The strongest correlations are obtained between date of flowering and branch per plant. In addition, hundred seed weight was positively correlated with both pod per plant, seed per pod and plant height. It was concluded that the high yielder and early-maturing (Hawassa-95 and Cocker) varieties are suitable for the lower rainfall distribution areas to improve the soya bean production and productivity.

Keywords: Soya bean; pod shattering; yield and early maturity.

1. INTRODUCTION

Soybean is known as (*Glycine max* L. Merril); it has a chromosome count of 2n=40. It belongs to the genus *Glycine* within the family Leguminosae. The cultivated soybean is self-fertilized crop and it was derived from China from wild type [1]. It is a medium-altitude crop and is well adapted to areas located in altitudes ranging from 1300 to 1800masl and receiving rainfall of 900 to 1300mm [2]. It is an important source of edible vegetable oil and protein for both humans and animals; and it improves soil fertility by fixing atmospheric nitrogen [3]. It is indeed a valuable crop that serves as an excellent source of protein, making it a crucial component in addressing malnutrition and food insecurity in many developing countries. The protein content of soybeans is approximately 40%, making it one of the richest plant-based sources of protein available. It is also containing a substantial amount of oil (20%), including culinary and industrial uses [4].

According to the Food and Agriculture Organization (FAO) of the United Nations, Ethiopia is one of the largest producers of soybeans in Africa. The country has been focusing on expanding its soybean production to improve food security and increase income for farmers. Soybeans are rich in protein and essential amino acids, making them an important source of nutrition for both humans and animals. This high protein content makes soybeans a significant dietary staple for populations that struggle with obtaining adequate protein intake. To improve soybean yield to a level that can compete favorably with global standards, concerted research efforts are essential. Several key strategies can be employed to enhance soybean yield through breeding and selection of appropriate varieties. Morphological traits refer to the physical characteristics of a plant, including height, branching pattern, leaf size, and root system. These traits influence the plant's ability to intercept sunlight, absorb water and nutrients from the soil, and develop a robust structure to support the growing pods. Information on these traits is lacking, particularly in the study area with its high potential for soybean production. The overall objective of the current study was to evaluate released soya bean varieties for grain yield, yield parameters and shattering characters under field condition.

2. MATERIALS AND METHODS

2.1 Description of Study Area

The field experiment was conducted during 2017 in main crop growing season in western Tigray (Humera station) (Fig. 1.). The site is located at 14^{o} 00' 85" North latitude and 36^{o} 34' 52" East longitude. The elevation of this station is about 600 meters above sea level. The experimental site is characterized by hot to warm temperature and high evaporation condition (hot to warm semiarid lowland agro ecology) [5]. They differ mainly in their altitude, temperature and amount of annual rainfall. The mean annual temperature of the area is 29 ^{0}c and the rainy months extend from late June to the middle of September. The remaining 8-9 months are dry and hot. The dominant soil type is chromic black vertisol, deep clay with low organic matter content [6].

2.2 Plant Materials and Field Managements

A total of 16 soya bean varieties were used in the field experiment (Table 1). The varieties were obtained from Federal research institute. The experiment was laid out in randomized complete block design (RCBD) with three replications. Each treatment were randomly assigned into a plot area of 15m^{2} (5m row length and 3m width),

which consisted of 5 rows of soya bean. The spacing between block and plot will be 2m and 1m, respectively. The spacing between plants and rows were 5 cm and 60 cm, respectively. Seeds are sown on June 2017 on three time's ploughed plots of land. Each experimental plot are received the same rate of NPS (100 kg/ha). The other management practices were applied equally and properly as per the recommendations.

2.3 Data Collection

2.3.1 Yield and yield components

Yield components including plant height, number of branches per plant, number of pod per plant, number of seeds per pod, hundred seed weight, seed yield (kg/ha**)** and shattering were determined. Plant height and number of branches were measured from five randomly selected plants in each plot. However, number of pods per plant and number of seeds per pod were counted from five randomly selected plants and pods from each plot, respectively**.** The weight of hundred counted seeds was recorded in gram for individual plots. Similarly, seed yield (kg/ha**)** was measured from threshed and cleaned plots separately using a sensitive balance and converted into kilogram per hectare.

2.3.2 Assessment of pod shattering

Pod shattering was measured on visual observation in the field. The number of shattered pods were counted and expressed as percentage. Varieties were classified into five categories based on their reaction to pod shattering as described in Table 2.

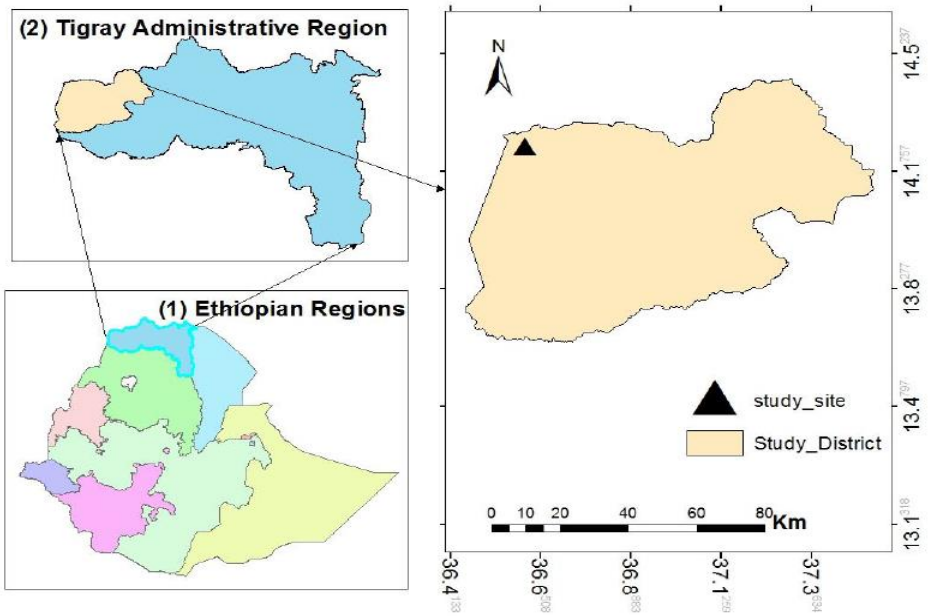

Fig. 1. Map (location) of the study area

Table 1. Description of released soya bean varieties on this experiment during 2017 main cropping season

S.No.	Varieties	S.No.	Varieties
1	Crawford	9	Ags-7-1
2	Gozela	10	Welo
3	Cocker	11	Boshe
4	Jalale	12	Walliams
5	Davis	13	Awassa-95
6	Nova	14	Belesa 95
7	Clarc 63k	15	AFGAT
8	Wegayen	16	tgx-1332644

Table 2. Percent and reaction for recording pod shattering

Scale	Percentage	Reaction
1	0	No shattered
2	1-10	Resistance
3	>10-25	Moderately resistance
4	>25-50	Moderately susceptible
5	>50	Susceptible

Sources; [7,8]

2.4 Data Analysis

Analysis of variance was done for yield and yield components (stand count at emergence, days to 50% flowering and maturity, plant height, number of branches per plant, number of pods per plant, and seeds per pod, and thousand seed weight) from the field experiment, to know the main effects and their interactions using Genstat version 18 software. Least Significant Difference (LSD) values were used to separate differences among treatment means at 5% probability level. ANOVA was performed using General Linear Model (GLM) Genstat 18 version.

3. RESULTS AND DISCUSSION

3.1 Yield and Yield Component

3.1.1 Days of flowering and days to maturity

The result showed that there was a significant variation (P<0.01) in the number of days from planting to flowering and maturity among the tested released soya bean varieties. This variation indicates that different soya bean varieties have distinct growth patterns and developmental timelines (Table 3). The maximum number of days of flowering had measured from the varieties Gozela (51.67) followed by Davies varieties. While, minimum days of flowering were measured on the varieties of Hawassa-95 (36) and Belesa- 95 (40). Highest days of maturity were calculated from the varieties of Crawford (93.1), Gozela (92.1), Cocker (90.67) and Jalale (90.67). However, lowest days of maturity were calculated from the varieties of tgx-1332644 (75.67), AFGAT (76.33), Belesa- 95 (78.67) and Hawassa-95 (79) (Table 3). The result indicated that early-maturing varieties are suitable for short rainfall areas. The result agrees with Tariku et al. [9] who stated that Cocker and Gonzela (year not specified) support the notion that early-maturing crop varieties are well-suited for areas with lower rainfall distributions. Early maturation allows crops to reach maturity before the onset of potential dry spells or drought conditions, thereby increasing the likelihood of a successful harvest. This is particularly important in regions where water scarcity is a significant concern.

3.1.2 Number of pod per plant and number of seed per pod

Number of pod per plant was showed that a significant (P<0.01) difference between varieties. Whereas; seed per pod wasn.t a significant ($P<0.05$) variation among varietie (Table 3) s. Maximum pod per plant was counted from varieties Hawassa-95 (52.67), Cocker (90.67), Jalale (47.67) and Gozela (46.67). Minimum pod per plant was counted from varieties Belesa (31) andWalliams (32.8) (Table 3). In general the number of pod per plant was is too low as compared with national level, this is it could be due the study area is hot to warm temperature and high evaporation condition this leads to Plant maturity accelerated, empty pod and embryonic abortion increased. The current result supported by Ku et al. [10,11] moderate or severe water deficit reduces the number of total pods associated with flower and pod abortion and reduces the quantity and quality of soybean seeds.

3.1.3 Plant height and number of branch per plant

Plant height was highly significant between tested soya bean varieties, while the number of branches on the plants did not exhibit significant differences. In this study, out of the total tested released soybean varieties five varieties shows plant height below the mean value (50.5cm). The tallest plant height was recorded from Clarc 63k (60.67cm) followed by Cocker (57.33cm) and Jalale (55.67cm) variety while the shortest plant height were recorded from variety Hawassa-95 (36cm) and tgx-1332644 (40.67cm) (Table 3).

Table 3. Yield and yield component of sixteen released soya bean varieties and one local check for yield and yield parameters at Humera districts during 2017 cropping season

Varieties	DF	DM	NB	NPP	NSP	PH	SY	HSW	SM (%)
Crawford	49ab	93.1a	3.67	44abc	2.33	52.33ab	10.9abc	7.00	4.8
Gozela	51.67a	92.4a	2.00	46.67abc	2.33	51.67ab	11.85abc	10.67	4.8
Cocker	49ab	90.67ab	2.33	48.67ab	2.00	57.33a	14.89a	8.67	4.8
Jalale	50ab	90.67ab	2.33	47.67abc	2.33	55.67ab	14.46ab	10.0	4.8
Davis	51.67a	90.33ab	3.67	43.67abc	2.33	53.33ab	9.48abc	9.00	4.8
Nova	49.33ab	90.33ab	3.00	35.67abc	2.33	45.33ab	9.56abc	8.33	4.8
Clarc 63k	50.33ab	90.0ab	3.00	45.67abc	2.33	60.67a	11.41abc	7.67	4.8
Wegayen	51a	90.0ab	3.00	44.67abc	2.33	54.33ab	12.65abc	7.67	4.8
Ags-7-1	48.67ab	89.0ab	2.67	43.33abc	2.00	53. 00ab	11.69abc	7.67	4.8
Welo	46.33bc	88ab	2.67	43abc	2.00	49.67ab	10.42abc	8.33	4.8
Boshe	43cd	87ab	3.667	35bc	2.67	50.67ab	11.1abc	7.33	4.8
Walliams	51a	85.33b	2.33	32.8c	2.33	54.33ab	10.21abc	8.33	4.8
Awassa-95	36e	79.00c	2.33	52.67a	2.67	36.00b	14.92a	9.33	4.8
Belesa 95	40d	78.67c	3.33	31.00c	2.67	42.33ab	8.01c	8.69	4.8
AFGAT	43cd	76.33c	2	42.33abc	2.67	50.33ab	11.55abc	9.32	4.8
tgx-1332644	43cd	75.67c	2.33	38abc	2.67	40.67ab	8.96bc	6.68	4.8
Mean	47.06	86.56	2.77	42.1	2.38	50.5	11.38	8.42	4.8
Lsd (5%)	3.758	5.064	1.75	14.72	0.88	17.53	4.914	3.45	*
CV (%)	4.8	3.5	37.9	21	22.10	20.8	2.947	24.6	*

Note; DM: Date of Maturity; HSW: Hundred seed weight; DF: Date of flowering; NBP: Number of branch per plant; NPP: number of pod per plant; SPP: Seed per pod; SY: Seed yield; PH: Plant height; SM: Seed moisture

Table 4. Pod shattering character of released soya bean varieties

Varieties	Shattering scale	Shattering percentage	Reaction of pod shattering
Crawford	1.67bc	8.3	Resistance
Gozela	1.87bc	8.7	Resistance
Cocker	1.77bc	8.3	Resistance
Jalale	1.67bc	8.3	Resistance
Davis	1.2c	4.3	Resistance
Nova	1.33bc	5.2	Resistance
Clarc 63k	1.33bc	5.2	Resistance
Wegayen	1.33bc	5.7	Resistance
Ags-7-1	1.12c	2.2	Resistance
Welo	1.34c	3.4	Resistance
Boshe	1.21c	3.2	Resistance
Walliams	1.33bc	5.4	Resistance
Awassa-95	1.67bc	9.11	Resistance
belesa 95	1.33bc	4.5	Resistance
AFGAT	2.53b	18.5	Moderately resistance
tgx-1332644	3.53a	27.5	Moderately susceptible
Mean	1.542		
Lsd (5%)	0.9547		
CV (%)	0.5725		

3.1.4 Seed yield and hundred seed weight

In the study conducted on soya bean varieties, there was a significant difference in seed yield among the tested varieties. The statistical analysis revealed a p-value of less than 0.01, indicating that the observed difference in seed yield was unlikely to have occurred by random chance. However, the number of seeds per pod did not show significant differences among the varieties. Overall result of seed yield ranged from 8-01kg/ha to 14.92kg/ha. Heights seed yield was recorded from the varieties Awassa-95 (14.92kg/ha) followed by Cocker (14.89kg/ha). Lowest seed yield was recorded on the varieties Belesa-95 (8.01kg/ha) and tgx-1332644 (8.96kg/ha) (Table 3). The variation of result; it could be due the day of maturity and short period of rainfall distribution in study area. The result was lined with Tariku et al. [9] who reported that Cocker (27.9kg/ha) was among the high yielder released varieties. The number of flowers contributing to yield depends on whether the plant produces enough extra flowers to recover lost flowers or pods following a stress event [12].

3.1.5 Shattering character of released soya bean varieties

Pre-harvest soybean pod shatter can significantly affect yield potential, especially if it begins while plants are still green. Shattering may occur if there is a long interval between maturation and harvest. Slowing down harvest speed can reduce shatter and stubble losses. At high speeds, soybean pods can be stripped from the stem, shatter, and drop to the ground. Pod shattering based on the shattering level shows there was significant (*P<0.05*) variation among the soya bean varieties. All varieties were resistance to pod shattering except AFGAT (18.5%) and tgx-1332644 (27.5%) were moderately resistance and moderately susceptible, respectively (Table 4). The result was supported by Krisnawati et al. [13,14] who reported that five soya bean lines was resistance (7-10%) to pod shattering. In addition also [8] stated that genotypes SB-8, Gazelle, SB-74, SB-4 and Nyala were the most resistant to pod shattering and high grain yield, while Genotypes SB-90 and SB-25 were highly susceptible.

3.1.6 Association between yield and yield parameters

Correlations provide necessary information on the types of linkages between variables. The current study presents the association among the different soybean growth and yield parameters. It appears that some parameters are either positively or negatively correlated to others. Some positive correlations are significant while others are not. The same observation is made for negative correlations (Table 5). The strongest correlations are obtained between date of flowering and number of branches," it suggests that there is a significant relationship between the timing of flowering and the abundance of branches in a plant. This correlation could be indicative of various factors influencing both the flowering time and branch development in plants. In addition, hundred seed weight was positively correlated with both pod per plant, seed per pod and plant height. This implies that value increase of one of this parameter leads to the increase of the parameter to which it is significantly correlated. The result was line with result of Kasu-Bandi et al. [15,16] who reported that agronomic trait and yield was positively and significant correlated. In line with the current study's results, [17] also found that pod shattering exhibited a significant negative correlation with pod diameter. Additionally, they observed that plant height had a negative impact on the number of shattered pods per plant, although this effect was not statistically significant. A negative correlation is observed between shattering and date of maturity, number of branch and seed per pod. This result indicating that if the value of one of this parameter increases the other decreases. This is it could be due to Shattering may occur if there is a long interval between maturation and harvest.

Table 5. Association among initial stand count, stand count at harvesting, date flowering, plant height, number of branch, number of pod per plant, seed per pod, hundred seed weight, grain yield, date of maturity and pod shattering

	DM	HSW	DF	NB	NPP	NSP	PH	SH
DM								
HSW	0.17							
DF	0.67**	0.16						
NB	0.16	-0.52**	0.03					

	DM	HSW	DF	NB	NPP	NSP	PH	SH
NPP	0.34**	0.02	0.46**	0.11				
NSP	-0.61**	0.01	-0.51**	-0.00	-0.40**			
PH	0.56**	0.00	0.69**	0.049	0.50**	-0.57**		
SH	-0.00	0.24*	-0.17	-0.63**	-0.16	0.31**	-0.12	
yield	0.33**	0.37**	0.06	0.45**	-0.11	0.23*	0.36**	-0.27*

Note; DM: Date of Maturity; HSW: Hundred seed weight; DF: Date of flowering; NBP: Number of branch per plant; NPP: number of pod per plant; SPP: Seed per pod; SY: Seed yield; PH: Plant height; SH: Shattering.

4. CONCLUSION

Soybean crop plays a crucial role in Ethiopia's agriculture sector and contributes significantly to food security and nutrition. It is well adapted from lowland to mid altitude agro-ecologies of the country. Based on the present study, the performance of released soya varieties to some extent low yield was obtained as compared with national level. Heights seed yield was recorded from the varieties Awassa-95 (14.92kg/ha) followed by Cocker (14.89kg/ha). Lowest seed yield was recorded on the varieties Belesa-95 (8.01kg/ha) and tgx-1332644 (8.96kg/ha). All varieties were resistance to pod shattering except AFGAT (18.5%) and tgx-1332644 (27.5%) were moderately resistance and moderately susceptible. Considering mean yield; Hawassa-95 was the best early maturing soybean varieties that fit in the study areas. Further research is needed in future to cover a wide range of environments and varieties to screen high yielder.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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