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Evaluation of Sunflower (*Helianthus annuus* L.) Varieties for Growth, Yield and Yield Components under Irrigation at Lowland Area of South Omo Zone, Southern Ethiopia

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Abstract

Sunflower is an important oil crop in the world. However, the yield of this crop is limited mainly due to shortage of improved varieties suited to specific area. This field experiment was conducted during 2019/2020 cropping season to evaluate sunflower varieties for yield production at Omorate and Weyito in South Omo Zone, Southern Ethiopia. The experiment contains three varieties namely Red-Black, OISA and Local. The experiment was conducted using randomized complete block design with four replications. Data were collected on days to maturity, plant height, heads per plant, head diameter, thousand seed weight and grain yield and subjected to analysis of variance using SAS software program. The result of this study revealed that, there was no significant difference among varieties in days to physiological maturity and plant height while significant interaction of varieties and location effect on heads per plant and head diameter was highly significant effect. There was also significant effect on grain yield and thousand seed weight. The result of this study revealed that, there was significant different among varieties on grain yield traits. The highest (2824.1 kg ha^{-1}) and (2797.6 kg ha^{-1}) grain yield were recorded from Red-Black and OISA variety, respectively among tested treatments. The highest yielder variety Red-Black showed by 0.95% (2797.6 kg/ha) and 35 % (2092.1 kg/ha) yield increment as compared to variety Oissa and Local, respectively. As the result of this study, Red-Black and Oissa varieties well performed, respectively at study area. However, the experiment has to be repeated by including more released varieties and across over seasons with consideration of farmer's preference of the sunflower varieties to reach at conclusive recommendation.

Keywords: *Sunflower varieties; Performance evaluation; Grain yield*

Introduction

Sunflower (*Helianthus annuus* L.) is one of the few crop species that originated in North America (most originated in the fertile crescent, Asia or South or Central America). It is a diploid plant with 2n=34 chromosomes (Fick, 1989). Sunflower oil is widespread because high quality and is one of the five basic nutrients for human food (Demirer et al., 2004). Sunflower is categorized as a low to medium drought sensitive crop. The drought-tolerant nature can be attributed to its extensive root system, which can extract water and nutrients to a depth of 3m. Sunflower is grown in many semi-arid regions of the world. It is tolerant of both low and high temperatures but more tolerant to low temperatures. Optimum temperatures for growth are 21.3 to 26°c, but a wider range of temperatures

(18 to 35°c) show little effect on productivity. Extremely high temperatures have been shown to lower oil percentage, seed fill and germination (Eman, 2015).

Sunflower is one of the most important oil crops and preferable source of edible oil in worldwide including of Ethiopia. Besides its primary use in human consumption sunflower oil has a wide range of applications and can be used as a supplement in the chemical industry as well as in the pharmaceutical industry. Sunflower meal, a side product from oil extraction, is rich source of protein and it is efficiently utilized when blended with meal of soybean for use in the livestock feeding (Seiler and Jan, 2010). Sunflower oil is also a rich source of (64%) of linoleic acid, which helps in washing out cholesterol deposition in the coronary arteries of the heart and good for heart disease (MOANR, 2016).

Sunflower was grown on about 6,738.00 ha in Ethiopia from which about 7,953.72 tons are produced in the year 2017, with the average regional yield of 1.18t ha^{-1} (CSA, 2017). However, the country grain yield is far less than the attainable yield (2.5 to 3.5 t ha^{-1}) under good management conditions at farmers field (MOANR, 2016). Low yield of sunflower is attributed to several production constraints which include shortage of improved varieties, poor crop management practices, moisture stresses, low soil fertility, diseases and insect pests (Farahvash et al., 2011).

Sunflower is becoming a high potential crop in Southern region in general and south omo zone in particular. However, in so far no improved varieties were evaluated yet and recommended for the area. Therefore, to exploit potential area for sunflower production evaluating and promoting high yielder sunflower varieties are a paramount importance. Because of this information generated in this study is helpful to identify best high yielding sunflower varieties for the area and small scale holder farmers to produce these crops in the future which will support in food security and income generation. Hence, the present study was to identify superior soybean variety/ies in terms grain yield and desirable agronomic traits from the tested varieties for study area.

Materials and Methods

Description of the Study Area

Two experiments were conducted during 2019/2020 cropping season at Dasenech (Omorate) and Benna Tsemay (weyito). Omorate which located South Omo Zone in Southern Nations, Nationalities and People's Regional State. It is situated between 54°37′–4°48′ N and 35°56′–36°20′ E with altitude of 365 above sea level. The rainfall distribution of the area is bimodal, with a primary rainy season between March to May and secondary small rain between Septembers to December. The monthly minimum and maximum temperature of 24.4 and 37.8°C, respectively.

Weyito also located South Omo Zone in Southern Nations, Nationalities and People's Regional State. It is situated between 5°01' and 5°73' North latitude & 36°38' and 37°07' East longitude with altitude of 588 meter above sea level. The rainfall distribution of the area is bimodal with main rainy season extends from January to May and the second cropping season, from July to October. It receives annual average rainfall of 876.3 mm and the monthly average minimum and maximum temperatures of 18.2 and 37.3°C, respectively. All the metrological data a given above for the two location are long term averages.

Experimental Design and Treatments

Three sunflower varieties namely: Red-Black, Oissa and Local, were used for current study. This experiment was laid out using randomized complete block design (RCBD) with four replications at two locations in Omorate and Weyito.

Experimental Procedure and Management

The land was ploughed twice disked and harrowed once and ridged 0.7m apart by tractor, after which corrected by labour. Two seeds per hole were sown on ridges by hand at 0.25m intra-row and 0.7m furrow spacing. Thinning was done two weeks after emergence to maintain the target intra-row spacing. The plot size was 24.01m2 (4.9mx4.9m) and which accommodated seven furrow per plot. The spacing between replications and pots was 2 meter. Plots were furrow irrigated every 4-6 days from planting up to flowering and then every 7-9 days up to physiological maturity according weather condition at Omorate location while at Weyito location, plots were furrow irrigated at every 6-8 days from planting up to flowering and then every 9-10 days up to physiological maturity according weather condition. No any fertilizer was applied as well as agrochemicals during growing period because all varieties were growing healthy and no diseases and insects problem were observed. The first, second and third weeding and hoeing were performed 20, 40 and 60 days after emergence, respectively. The net harvestable row was 5 (five) excluding the two border rows.

Data Collected

Growth parameters

Plant height was measured at the time of physiological maturity from central rows as the mean height of five randomly taken plants from the ground level to the apex of each plant.

Yield and yield components

Number of heads per plant was counted from five randomly sampled plants at central row and the average value was considered. Head diameter was measured by ruler head from five randomly sampled plants at central row and then the average value was considered. The harvesting central rows per plot were harvested, sun dried to constant weight and shattered. The seed yield of each net plot was then weighed using an electronic balance. Thousand seeds weight (g) were weighted by taking of thousand randomly sampled seeds from the two harvested central rows

Statistical analysis

The various data collected were subjected to analysis of variance in randomized complete block design (RCBD) using SAS software version 9.2 (SAS, 2008) with a generalized linear model (GLM) procedure. Means were separated using least significant differences (LSD) test at 5% level of significance. Homogeneity of error mean square between the two sites was tested by the F-test on variance ratio.

Results and Discussion

Analysis of variance

The analysis of variance for the individual location was carried out first and significant differences ($P \leq 0.05$ or $P \leq 0.01$) among varieties were obtained for days to 90% of maturity, plant height (cm), primary branch, and pods per plant and grain yield at both locations (Table 1).

Prior to the combined analysis of variance, homogeneity of error variances was tested and all of the traits showed homogeneous error variances (Table 1). Having this confirmation, the data were pooled across locations and combined analysis of variance were performed and presented in Table 2. The mean squares obtained in combined analysis of variance were used to separate varieties effects, location and their interactions. The mean squares from the combined analysis of variance over the two locations showed statistically significant ($P \leq 0.05$ or $P \leq 0.01$) difference between locations for all the traits except days to maturity and thousand seed weight. The combined analysis of variance over the two locations revealed significant differences ($P \leq 0.05$ or $P \leq 0.01$) among varieties for most of the studied traits. The presence of significant differences among the tested varieties might be due to the existence dissimilarity in genetic composition among them, for that fact characters may be differ in their genetic properties. Besides, environmental influences might be the possible causes of their significant differences or both.

Phenology and Growth parameters

The combined analysis of variance as shown in Table 1 indicates the main effects of varieties and location as well as their interactions had no significantly ($P>0.05$) effects on days to physiological maturity and plant height (Table 1). Even though there was no statistically different among tested varieties on plant height, results of combined means value for plant height ranged from 171 cm to 179.8cm (Table 2).

Yield and yield components

Number of heads per plant

The analysis of variance as shown in table 1 indicates the main effects of varieties and location as well as their interactions had significantly ($P \leq 0.01$) effects on heads per plant (Table 1). The large number of heads 15.75 and 9.35 were recorded from local variety at weyto and Omorate, respectively (Table 3).

Heads diameter (cm)

In this study, the analysis of variance showed that, the main effects of varieties and location as well as their interactions had significantly ($P \leq 0.01$) effects on heads diameter (Table 1). The large heads diameter 32.15 and 20.75cm were recorded from Oissa variety at Omorate and weyto, respectively (Table 3). This result was in agreement with Esmaeel et al. (2015) who found a significantly difference among sunflower varieties and they obtained the maximum (27.91 cm) and (11.77 cm) head diameters.

Source	Degree of freedom	Days to 90% maturity	Plant height	Heads per plant	Head diameter	Grain Yield	Thousand seed weight
Replication	3	0.375 *	72.8*	0.173 *	41.35*	41019*	13.8*
Varieties	1	0.542^{ns}	175.2^{ns}	348.1**	116.3**	1420334**	95.7^{ns}
Locations	2	3.375^{ns}	2646.0^{ns}	31.7**	500.5**	731225**	92.0^{ns}
Varieties x locations	2	0.875^{ns}	12.5^{ns}	25.2**	2910621**	171238^{ns}	146.3^{ns}
Error	15	0.508	199.4	0.960	198256	98767	54.6
CV (%)		0.57	8.01	19.86	12.7	12.19	10.17
Mean Square of Error (MSE)							
Omorate	-	0.41667	24.58	1.19	11.45	113647	81.87
Weyito	-	0.77778	37.64	0.84	5.31	234075	30.31
F max	-	1.87^{ns}	1.53^{ns}	1.42^{ns}	2.16^{ns}	2.06^{ns}	2.6^{ns}

Ns= non-significant, *=significant, **= highly significant, ***= very highly significant at P<0.05, CV=Coefficient of variance

Table 1: *Mean square for growth, yield and yield components of sunflower varieties tested at two locations (Omorate and Weyito) and homogeneity test (F-max test) in 2019/20 cropping season.*

Varieties	Day to 90% maturity			Plant height (cm)		
	Omorate	Weyito	Combined	Omorate	Weyito	Combined
Red-Black	125.5a	124.5a	125a	180.25a	161.75a	171.0a
Oissa	125a	124 a	24.5a	191.50a	168.00a	179.8a
Local	124.5a	124.0a	124a	188.75a	167.75a	178.3a
LSD(0.05)	1.12	1.5	1.14	10.58	33.40	14.645

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significant; LSD (0.05) = Least Significant Difference at 5% level.

Table 2: *Means values of plant height and day 90% maturity of sunflower varieties tested at two locations in 2019/2020.*

Varieties	Heads per plant			Head diameter (cm)		
	Omorate	Weyito	Combined	Omorate	Weyito	Combined
Red-Black	1.00b	1.25b	1.125b	30.50a	18.75ab	24.63ab
Oissa	1.00b	1.25b	1.125b	32.15a	20.75a	26.45a
Local	9.35a	15.75a	12.55a	21.25b	17.00b	19.13c
LSD(0.05)	0.30	1.15	1.26	5.85	3.2	2.8

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significant; LSD (0.05) = Least Significant Difference at 5% level

Table 3: *Means values of yield components of sunflower varieties tested at two locations in 2019/2020.*

Varieties	Grain yield (kg/ha)			Thousand seeds weight		
	Omorate	Weyito	Combined	Omorate	Weyito	Combined
Red-Black	2850.0a	2798.2a	2824.1a	74.25a	76.15a	75.5a
Oissa	3065.0a	2530.2a	2797.6a	80.50a	66.87a	73.69a
Local	2342.5b	1841.8b	2092.1b	69.13a	68.50a	68.81a
LSD(0.05)	491.36	625.96	398.65	15.5	10.53	10.22

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significant; LSD (0.05) = Least Significant Difference at 5% level

Table 4: *Means values of yield and thousand seeds weight of Sunflower varieties tested at two locations in 2019/2020.*

Grain yield (kg ha^{-1})

Results combined analysis of variance of the current study showed the main effects of variety high significant (P<0.01) effect and location had significantly (P<0.05) effect while their interactions no significantly effects on grain yield. The highest grain yield (2824.1kg ha^{-1}) and (2147.9kg ha^{-1}) was recorded from Red Black and Oissa varieties, respectively and the lowest grain yield (2092.1kg ha^{-1}) was recorded for variety local. The possible reason for the observed the significance difference among tested varieties might be due to existence dissimilarity in genetic composition among them, for that fact characters may be differ in their genetic properties. Moreover, environmental influences might be the possible causes of their significant differences or both. The result of this study is in agreement with the research finding of Esmaeel et al. (2015) who observed a significantly difference among sunflower varieties. Similarly, Milan et al. (2019) who studied on evaluate of sunflower varieties found that, a significantly difference on grain yield of sunflower varieties.

Thousand Seeds weight (g)

The combined analysis of variance showed that the main effects of varieties and location as well as their interaction had no significance (P<0.05) effects on thousand Seeds weight. Even though there was no statistically different among tested varieties on thousand Seeds weight, The highest of thousand Seeds weight (75.5g) was recorded for variety Red Black and the lowest of thousand seeds weight (68.81) was recorded for variety Local (Table 4). This result is in line with Natalija et al, (2015) who obtained minimum and maximum values for 1000 seed weight were 56.67 and 87.83 g. respectively.

Conclusion and Recommendation

Sunflower is an important an oil seed in Ethiopia. However, the yield of this crop is limited mainly due to shortage of improved varieties suited to specific area. This field experiment was conducted to evaluate sunflower varieties for grain yield production at Omorate and Weyito in South Omo Zone, Southern Ethiopia. The experiment contains three varieties namely Red Black, OISA and Local. The experiment was conducted using randomized complete block design with four replications. Data were collected on days to physiological maturity, plant height, heads per plant, pod diameter, grain yield and thousand seed weight and subjected to analysis of variance using SAS software program. The result of this study revealed that, there was significant difference among varieties in these parameters at both locations except days to maturity, plant height and thousand seed weight (Omorate and Weyito).

From the combined results of this study the highest grain yield (2824.1kg ha^{-1}) and (2147.9kg ha^{-1}) was recorded from Red Black and Oissa varieties, respectively. Therefore, it can be concluded that variety Red Black followed by Oissa variety well performed and can be recommended for the growers in the study area and its vicinity. Moreover, it can recommend from these findings that further investigation on different varieties along with other agronomic practice can be a step forward to identify more realistic effect of different varieties on the yield improvements of sunflower.

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