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Evaluation of Chickpea (Cicer arietinum L.) Varieties for Yield and Yield Components Under Irrigated Condition at lowland Area of South Omo Zone

Awoke Tadesse[1]*, Muhaba Sultan[2]

Southern Agricultural Research Institute, Jinka Agricultural Research Center, Jinka, P.O. Box. 96,Ethiopia

Corresponding author E-mail address: awoketadese3@gmail.com

Abstract

Chickpea is Ethiopia's most important food legume crop. However, due to a lack of better cultivars suited to specific places and other limiting factors, the production of this crop is limited. A field experiment was done at Dasenech and Nyangatom in the South Omo Zone, Southern Ethiopia, during the 2019/2020 cropping season to evaluate chickpea varieties. Teketay, Mastewal, Minjar, Dalote, and Natole were among the five kinds of chickpea planted in a randomized full block design with three replications. The day to maturity, plant height, primery branch number per plant, pods per plant and grain production, and hundred seed weight were all collected and analyzed using the SAS software program. The primary components of varieties had a significant ($P \leq 0.05$ or $P \leq 0.01$) effect in the current study's combined value analysis of variance, however the interaction of location and variety had a non-significant effect in all recorded traits . In the research region, the highest grain yield (1162.1 kg ha^{-1}) was reported from the Teketay variety, while the lowest grain yield (652.6 kg ha^{-1}) was recorded from the Dalote variety. Therefore, Teketay variety can be recommended for chickpea producing farmers, investors, and agro-pastorallist at Dasenech, Nyangatom, and its vicinity.

Keywords: chickpea varieties, yield, yield components

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a diploid plant with two sets of chromosomes (2n=16). It is a self-pollinated crop with up to 1% natural cross-pollination (Varshney et al., 2013)). Chickpeas have one of the most nutritious nutritional profiles of any dry edible bean. Chickpea seeds contain 23 % protein, 47 %t starch, 56% fat, 6% crude fiber, 6% soluble sugar, and 3% ash on average (Yadeta and Geletu, 2002). Having high protein content, it is also rich in zinc, dietary fiber, calcium, magnesium, phosphorus, potassium, iron, and vitamins (Guler *et al*., 2001).

Chickpeas are commonly separated into two varieties for breeding purposes: Desi and Kabuli. The size and color of the seeds are used to make this differentiation. Desi varieties have small (1500 seeds/lb) and colorful seeds, whereas Kabuli varieties have large (800 seeds/lb) and white seeds (Moussa *et al*., 2000).

According to Yucel et al. (2006), Desi chickpea accounts for around 95% of Ethiopian chickpea production. Chickpeas are grown using residual rainwater at the end of the main rainy season. Double-cropping will boost productivity of a scarce land resource and provide an extra source of revenue for the farmers (MOANR 2016). Forage, hay, and silage are all made from straw. Chickpea is a good source of protein for feeds, according to several animal feeding research conducted elsewhere. It is also a good rotational crop, similar to other pulse crops, and so maintains soil fertility (Ahmad *et al.*, 2011).

Chickpea is grown in numerous zones and specific woredas in Ethiopia Southern Nations, Nationalities and Peoples Regional State (SNNPRS). However, in the South Omo zone not yet stared to grow chickpea. In general, in Southern Nations region chickpea occupies about 9,773.39 hectares of land annually with an estimated production of 183,822.82 quintals (CSA, 17). The regional average yield of 1.88 t/ha, which is far below the potential yield (2.3-3.6 t ha^{-1}) (MOANR 2017). Reasons for low yields in the region include the use of unimproved varieties, poor crop management, and unreliable rainfall and pest incidence and severity (Temesgen, 2007). Goa et al. (2017) reported that chickpea varieties produced significant difference in the yield at different locations. Thus a well-adapted variety for suitable agro-ecology in the lowland area of the South Omo Zone is required . Therefore, this study was carried out with the objective of selecting a well-performing and high-yielding variety for study areas.

MATERIALS AND METHODS

Description of the study areas

The field experiment was conducted in Dasenech and Nyangatom districts in the lowland area of South Omo Zone during the 2019/2020 cropping season. Astronomically, Dasenech woreda found lies roughly between 4°37′–4°48′ North latitude and 35°56′–36°20′ East longitude, and Nyangatom between 5°05′–5°21 ′North latitude and 35°55′–36°14′ East longitude, respectively.The altitude of the areas varies between 353 -606m.a.s.l for Dasenech and 380 -497m.a.s.l for Nyangatom district, respectively. According to the districts' agricultural and natural resource office, the climate in these areas is dominantly of semiarid type. The districts have very small, erratic and variable rainfall and high ambient temperature. But in Nyangatom district has no agro-meteorological data due to the absence of an Weather station. In Dasenech district the rainfall pattern is bimodal, with a primary rainy season between March to May and secondary small rainfall between September to December (Figure 2). In these two districts (Administrative districts) the major livestock rearing, agro-pastorals widely practice rain-fed, flood retreat (nowadays very rarely) and irrigated agriculture. They grow sorghum as the number one crop followed by maize and horticultural crops like banana.

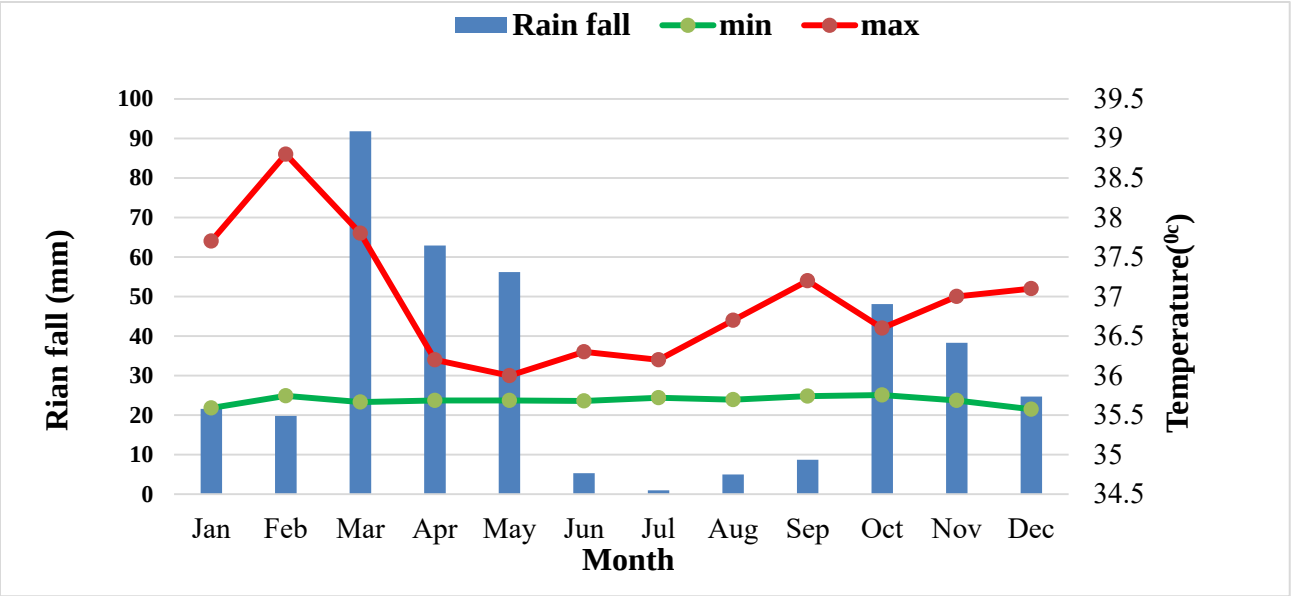

Figure 1. Monthly rainfall, minimum and maximum temperature at Dasenech distinct (2000-2019 G.C)

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Experimental materias and design

Five types chickpea varieties namely: Teketay, Mastewal, Minjar, Dalote and Natole were obtained from Debrezit Agriculture Research Center and used in the current study. This experiment was laid out using a randomized complete block design (RCBD) with three replications at two locations in Dasenech and Nyangatom.

Field management

The land was ploughed twice, disked and harrowed once and ridged with 0.5m by tractor, after which the furrow was corrected by labor. Two seeds per hole were sown on ridges by hand at 10cm intra-row and 60cm furrow spacing. Thinning was done two weeks after emergence. The plot size was 25m2 (5mx5m) and which accommodated ten furrows per plot. The spacing between replications and plots was 2 m. The crops were irrigated by furrow every 6-8 days from planting up to flowering and then every 9-11 days up to physiological maturity according to weather conditions. No fertilizer and agrochemicals were applied during the growing period. The first, second and third weeding and hoeing were performed 20, 40 and 60 days after emergence, respectively. The net harvestable row constituted eight rows excluding the border two rows.

Data collection

Phenological and growth parameters

The number of days from planting to when 90% of the plants displayed yellow, pod color, and the seed hardened in the pods was used to determine physiological maturity. Plant height was measured from the ground level to the apex of each plant at the time of physiological maturity from central rows as the mean height of five randomly selected plants. The average value was used to calculate the number of primary branches per plant, which was determined by counting primary branches of the main stem from five randomly selected plants in the central row Yield and yield components.

The number of pods per plant was determined from five randomly sampled plants at the central row and the average value was considered. The 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.

Statistical analysis

The data were gathered and analyzed using SAS software version 9.2 (SAS, 2008) using the generalized linear model (GLM) approach in a randomized complete block design (RCBD). RCBD Model: Y_{ij} = Mean + $Block_i$ + Trt_j + $Error_{ij}$. The least significant differences (LSD) test was used to separate the means at a 5% level of significance.

RESULTS AND DISCUSSION

Analysis of variance

First, analysis of variance for the individual location was carried out 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).

Before the combined analysis of variance, homogeneity of error variances were tested and all traits showed homogeneous error variances . Having this confirmation, the data were pooled across locations and a combined analysis of variance was performed and presented (Table 1). The mean squares obtained in the combined analysis of variance were used to separate genotypic effects, location, and their interactions. The mean squares from the combined analysis of variance over the two locations showed a statistically significant ($P \leq 0.05$ or $P \leq 0.01$) difference between locations for pods per plant and grain yield and combined analysis of variance over the two locations revealed significant differences ($P \leq 0.05$ or $P \leq 0.01$) among varieties for all of the studied traits. Combined analysis of variance showed non-statistically significant ($P \leq 0.05$ or $P \leq 0.01$) difference the interaction effect of locations with varieties. The presence of significant variances across the studied varieties could be attributable to genetic composition discrepancies between them, as characteristics may differ in their genetic properties. Furthermore, environmental factors could be the source of their considerable varies. Similar results have been reported by Yasin and Mathewos (2016), who observed significant variation among chickpea varieties for most of the characters they measured at different locations.

Phenological and growth parameters

Days to physiological maturity

In this study, combined analysis of variance showed that the main effect of varieties was a highly significant (P<0.001) effect on days to maturity, while the main effect of location and the interaction effect were not significant (Table 1). Significantly more days (115.7) to physiological maturity were recorded for variety Natolii, while the lowest days (110.2) was obtained for variety Teketay among tested varieties (Table 2). This study result was similar to the finding of Fikru (2004) which reported that the presence of sufficient variability for days to 90% maturity in chickpea verities which indicates the genetic variation of varieties.

Plant height at maturity

In this study, combined analysis of variance (Table 1) indicates the main effects of varieties had significantly (P<0.01) difefrent effects, while locations and their interactions had no significant effects on plant height. The tallest plant height (57.2cm) was observed from the Teketay variety and the shortest (48.4 cm) plant height was recorded from the Mastewal variety (Table 2). This variation is ascribed to the differences in the growing environment climatic conditions and genetic make-up of the varieties. This study result was in line with the finding of Alemu et al. (2014), who observed significant differences among chickpea varieties studied in Kellem Wollega Zone, Haro Sabu, Ethiopia.

Number of primary branches

Primary branches were highly significantly (P<0.05) affected by the main effects of variety and location. However, their interaction effect was not significant. The combined results showed that the highest number of the primary branches (8.38) was obtained from Teketay variety and the lowest (6.86) number of the primary branches was recorded from Dalote variety (Table 2). The difference in the number of primary branches among the varieties could be most probably due to the existence of dissimilarity in genetic composition among them, since characters may differ in their genetic properties in response to formation of the branches. This result conformed to the finding of Mohsen (2015) who reported that branch number per plant to be significantly different among chickpea varieties.

Table1: Mean squares for yield and yield components of chickpea varieties tested at two locations (Dasenech and Nyangatom) and homogeneity test (F-max test) in 2019/2020

Source	Degree of freedom	Days 90% maturity	Plant height	Primary branches per plant	Pods per pant	Grain yield	HSW
Replication	2	42.70*	102.2*	1.30*	1794.5**	87009*	2.43*
Varieties	4	26.21**	67.1**	3.17 *	395.4*	88454**	9.77**
Locations	1	2.70 ns	39.7 ns	0.30 ns	5127.4 *	357237 **	35.21 ns
Varieties x locations	4	0.62 ns	40.6 ns	1.67 ns	429.3 ns	188894 ns	7.02 ns
Error	18	1.18	14.2	1.65 ns	284.1	24883	2.02
CV (%)		0.96	7.31	17.09	22.25	19.01	6.79

Mean Square of Error (MSE)

Dasenech	-	0.95	10.71	1.21	284.4	1995	1.54
Nyangatom	-	1.63	9.43	1.41	146.8	2349	2.09
F max	-	1.19ns	1.13ns	1.17ns	1.94 ns	1.177ns	1.36

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

Table 2: Mean values of phenology and growth of chickpea varieties tested at two locations in 2019/2020

Varieties	**Days to 90% maturity**			**Plant height (cm)**			**Primary branch numbers**		
	Dasenech	**Nyangatom**	**Combined**	**Dasenech**	**Nyangatom**	**Combined**	**Dasenech**	**Nyangatom**	**Combined**
Teketay	110.7c	109.7c	110.2d	60.2a	54.1a	57.2a	8.47a	8.3a	8.38a
Mastewal	114.7a	113.3ab	114.0b	48.1b	48.7ab	48.4b	8.00a	8.1ab	8.05ab
Minijar	112.0bc	111.7bc	111.8c	48.3b	53.3a	50.8b	7.57a	8.1a	7.8ab
Dalote	112.7b	113.0ab	112.8bc	54.1ab	46.2b	50.1b	6.90a	5.8ab	6.86b
Naatolii	116.0a	115.3a	115.7a	52.1b	49.1ab	50.6b	7.13a	6.6ab	7.8ab
LSD(0.05)	1.396	2.406	1.48	6.16	5.78	5.08	7.07	2.23	1.68

The means in columns separated by the same letter(s) are not significantly different; LSD (0.05) = Least Significant Difference at a 5% level of significance

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Yield and yield components

Number of pods per plant

The combined analysis of variance (Table 1) indicates that the main effects of varieties and location had highly significant (P<0.05) effects, while their interactions had no significant effects on the number of pods per plant. The highest mean number of capsules per plant (85.68) was recorded for variety Teketay and the lowest number of capsules per plant (63.70) was recorded for variety Dalote (Table 3). The difference in the number of pods per plant might be because the number of pods per plant is regulated by the genotypes of chickpea or the existence of different climatic conditions. This result was in agreement with the study of Fernando and Gonzales (2014) who found that, the number of pods per plant was genetically influenced by the breeding material for the development of chickpea cultivars developed in different environmental conditions. Similarly, Yasin (2014) explained that significant difference among chickpea varieties in field experiment could be due to genetic variability.

Grain yield

The combined analysis of data from the two experimental sites (Dasenech and Nyangatom) showed a highly significant differences (P<0.01) in grain yield by the main effects of varieties and locations, while their interaction for grain yield did not show a statistically significant difference (Table 1). Results of the

combined value showed that the highest grain yield (1162.1kg ha-1) was recorded for variety Teketay and the lowest grain yield (652.6kg ha-1) was recorded for variety Dalote. Teketay variety was a significantly higher yielding variety at both locations with mean yield (1253.7 $kgha^{-1}$) and (1070.5 $kgha^{-1}$) at Dasenech and Nyangatom, respectively. The mean grain yield ranged from 708.0 kg ha-1 to 1253.7kgha-1 and 597.2 kg ha-1 to 1070.5kgha-1 for Dasenech and Nyangatom, respectively.. This result was slightly similar to the finding of Ejigu *et al* ,(2020), who studied different improved chickpea varieties at Bule Hora and Abaya in Southern Ethiopia and reported that average grain yield over environments varied within the same varieties.

Hundred seed weight

The combined analysis of variance showed that hundred seed weight was significantly influenced by the main effects of varieties, while location and their interaction had no significant ($P<0.05$) effects on hundredseedweight. The highest of hundred seed weight (22g) was recorded for variety Dalote followed by variety Natolli (21.85g) and the least thousand-seed weight (19.1g) was recorded for variety Mastewal (Table 3). These results are in agreement with Mirza *et al*. (2007) who was of the experience that varieties hundred- seed weight significantly varieties among variety and locations.

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Table 3: Means values of yield and yield components of chickpea varieties tested at two locations in 2019/2020

Varieties	Pods per plant			Grain yield (kg/ha)			Hundred- seed weight (g)		
	Dasenech	Nyangatom	Combined	Dasenech	Nyangatom	Combined	Dasenech	Nyangatom	Combined
Teketay	105.33a	79.87a	85.68a	1253.7a	1070.5a	1162.1a	20.7b	19.5	20.1ab
Mastewal	91.50a	68.93ab	78.65a	1000.0b	976.3a	988.2b	18.5b	19.7	19.1b
Minijar	86.57a	64.77ab	77.75a	820.0d	790.6b	805.3c	18.5b	20.2	19.25b
Dalote	79.47a	47.93b	63.70a	708.0e	597.2c	652.6d	24.0a	20.3	22a
Naatolii	81.33a	51.97b	73.05a	912.0c	834.5b	873.3c	23.7a	20.5	21.85a
LSD(0.05)	41.44	22.81	24.88	84.10	102.72	80.30	2.33	2.72	1.98

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

CONCLUSION

This field experiment was conducted during the 2019/2020 cropping season to evaluate chickpea varieties at Dasenech and Nyangatom districts under irrigation in the lowland area of South Omo Zone, Southern Ethiopia. Five chickpea varieties which includedTeketay, Mastewal, Minjar, Dalote, and Natole were sown in a three-replication randomized complete block design. Plots were furrow irrigated every 5-7 days from planting up to flowering and then every 8-10 days up to physiological maturity according to weather condition at Dasenech

location while at Nyangatom location, 6-8 days from planting up to flowering and then every 9-11 days up to physiological maturity according to weather condition. The day to maturity, plant height, primary branch number per plant, pods per plant, grain yield, and hundred- seed weight were all collected and analyzed using the SAS software program. The main effect locations revealed significant difference in pods per plant and grain yield, whereas the main effect varieties showed significant difference for all studied traits. On the other hand, the interaction effect of locations and varieties was not significantly different for all studied traits.

Combined mean results showed that the highest grain yield (1162.1 kg ha-1) was produced from the Teketay variety. Therefore, it can be concluded that variety Teketay isperformed well among other tested varieties 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 more varieties along with other agronomic practices can be a step forward to identify the more realis effects of different varieties on the yield of chickpea.

CONFILECT OF INTEREST

The authers have no declayed any confilect of interests

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