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Adaptation Study of Improved Chickpea (*Cicer arietinum* L.) Varieties at Mid and highland of Guji zone, Southern Ethiopia

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A field experiment was conducted at Bore on station, Ana Sora on farm and Adola sub-site of Guji Zone of Southern Oromia using six improved Chickpea varieties under rain fed condition during 2015/16 cropping season. The study was envisaged to assess the adaptability of six improved chickpea varieties (Arerti, Dalota, Ejere, Habru, Natoli and Teketaye) at three locations in Guji Zone. The field experiment was laid out in randomized complete block design (RCBD) with three replications for one year (2015/16) in six rows per plot with 2.4 meters width and three meters length and with spacing of 40 and 10 centimeters between rows and plant, respectively. There result revealed that significant (P < 0.05) difference were observed among the varieties on number of pods plant-1, hundred seed weight and grain yield (kg ha-1) at three locations. The varieties Dalota and Habru were superior yielder overall at three location except of Teketaye which was high yielder at Ana Sora on farm. However, the overall means indicate that Dalota and Habru were superior yielder. Therefore, from this study, Dalota (2411 kg ha^{-1}) and Habru (1822 kg ha^{-1}) were selected and recommended that which had comparably highest yields to be adopted for cultivation in three district of Guji Zone of Southern Oromia.

Keyword: Adaptation, Chickpea, *Cicer arietinum*, Guji Zone, Midland, Highland

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INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an ancient crop that belongs to the legume family. It has been grown in Africa, the Middle East, and India for centuries and eaten as dry pulse or green vegetable (Corp *et al*., 2004). It is a cool season annual pulse crop that is grown in tropical, subtropical, and temperate regions of the world (Muehlbauer and Tulu, 1997). Most production and consumption of chickpea (95%) takes place in developing countries.

Chickpea is Ethiopia's most important pulse crop widely grown in highland and semi-highland regions of the country mainly on clay soil. It ranked second next to faba bean, which occupies about 239,747.51 hectares of land annually with estimated production of 4,586, 822.55

quintals (CSA, 2014/15). It is also an excellent source of human and animal food and also plays an important role in the maintenance of soil fertility, particularly in the dry, rain fed areas (Katerji *et al*, 2001) and it fixes *Rhizobium* bacteria on roots(Akcin,1988). The chick pea plant and its straw are used as forage, hay and silage in the v*ertisol* soils of Ethiopian highlands. Previous livestock feeding experiments have been carried out in another place show chickpea to be a good source of protein for feeds, except that the amino acids methionine and cystine are deficient. Besides, similar to other pulse crops it is a good rotational crop and thus improves soil fertility (Yasin and Mathewos, 2016).

Chickpea is an important source of protein for millions of people in the developing countries, particularly in South Asia and Africa, who are largely vegetarian either by choice or because of economic reasons. In addition to having high protein content (20-22%), complex carbohydrates, fiber, minerals (phosphorus, calcium, magnesium, iron and zinc) and β-carotene while low in in fat and cholesterol (Corp *et al*., 2004).

Productions of chickpea have not been yet under production in the potential areas of Guji zone. Based on the weather condition and soil type of the area was highly suitable for this crop production. Therefore, this activity was carried out to evaluate and select the best performing chickpea variety for the target areas.

MATERIALS and METHODS

Description of the study areas

The study were conducted at Bore on-station, Ana sora on farm and Adola sub-site of Bore Agricultural Research Center ,Guji Zone Southern Oromia during the '*Bona*' cropping season of 2015. The areas located within the altitude range of 1725-2754 m.a.s.l.

Treatments and Experimental Design

Six (6) improved Chickpea varieties were introduced from Debrezeit Agricultural Research Center/EIAR. The treatments were arranged in randomized complete block design (RCBD) with three replications. The plot size was 7.2m^2 with 6 rows of 40cm spacing between rows and 10cm between plants while the net harvesting area of 4.48m^2 (the four central rows).The experiment was conducted with the following varieties: *Arerti, Dalota, Ejere,Habru, Natoli and Teketaye.* At the time of planting, all plots received a basal application of NPS at the rate of 50kg/ha. The experimental fields and experimental units were managed as per the recommended practices for chickpea.

Agronomical Data Collected

Phenological and growth parameters

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 % flower initiation: Days to flower initiation was recorded as the number of days required from planting to the time when 50% of plants in plots produced at least one flower.

Days to physiological maturity: Days to physiological maturity was recorded as the number of days required from planting to the time when 95% of plants showed a yellow color in each plot before senescence

Plant height: Plant height was recorded from ten randomly taken plants from four central rows at physiological maturity from ground to the tip of the main stem and then the mean was recorded as height per plant (cm).

Yield component and yield

Number of pods per plant: The number of total pods in ten randomly taken plants from four the central rows were counted at physiological maturity and the means were recorded as the number of pods per plant.

Number of seeds per pod: The number of total seeds from the above pods was counted and then the total number of seeds was divided by the total number of pods to get average number of seeds per pod.

Hundred seed weight: Hundred seed was counted from the harvested bulk and their weight (g) was recorded and adjusted at 10% seed moisture.

Grain Yield: 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%.

$$\text{Adjusted Grain Yield} = \frac{(100-\text{MC}) \text{ X Undjusted grain yield}}{100-10},$$

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

Statistical Data Analysis

The recorded data were subjected to analysis of variance using Gen Stat discovery 15th edition software following the standard procedures outlined by Gomez and Gomez (1984). Comparisons among the treatment means were

Table 1. Mean days to 50% emergency, days to 50% flowering, days to physiological maturity and plant height of Chickpea varieties at Bore on station, Ana sora on farm and Adola sub-site during 2015/16 cropping season.

Varieties	Phenology and Growth Parameters											
	Bore On-station				Ana Sora on farm				Adola sub-site			
	DE	DF	DM	PH(cm)	DE	DF	DM	PH(cm)	DE	DF	DM	PH(cm)
Dalota	9^{b}	75^{a}	153.7^{a}	59.77^{a}	9.33^{a}	75.67^{a}	154.3^{a}	67.10^{a}	9^{a}	52.67^{a}	82.00^{a}	52.20^{bc}
Habru	9.67^{a}	72.33^{b}	144.3^{c}	56.77^{a}	9.33^{a}	72.33^{c}	144.3^{b}	63.46^{a}	8^{b}	52.67^{a}	84.67^{a}	62.33^{a}
Arerti	10^{a}	71^{b}	145.0^{bc}	58.20^{a}	10.0^{a}	71.00^{c}	145.0^{b}	68.27^{a}	8^{b}	52.67^{a}	85.00^{a}	46.77^{c}
Natoli	10^{a}	75^{a}	146.3^{bc}	56.17^{a}	9.67^{a}	75.00^{ab}	146.3^{b}	62.40^{a}	9^{a}	54.00^{a}	84.00^{a}	50.03^{c}
Teketaye	10^{a}	72.33^{b}	147.7^{b}	61.10^{a}	10.0^{a}	73.00^{bc}	147.7^{b}	75.60^{a}	7.33^{c}	52.67^{a}	83.00^{a}	50.27^{c}
Ejere	9^{b}	71^{b}	144.3^{c}	57.13^{a}	9.33^{a}	71.00^{c}	144.3^{b}	66.63^{a}	9^{a}	52.00^{a}	82.00^{a}	57.00^{ab}
Mean	9.6	72.78	146.89	58.20	9.61	73.00	147.00	67.20	8.40	52.78	83.44	53.10
LSD (5%)	0.42	2.37	3.22	NS	NS	2.37	3.53	NS	0.42	NS	NS	6.05
CV (%)	2.5	1.8	1.2	7.7	4.9	1.8	1.4	9.3	2.8	1.8	1.6	6.4

Means within the same column followed by the same letter (s) are not significantly different at 5% level of significance; DE=Days to emergency, DF=Days to flower, DM = days to maturity, PH = Plant height (cm), LSD = Least Significant difference; NS = Not significant; CV = Coefficient of Variation

done using Fishers protected least significant difference (LSD) test at 5% Level of significant.

RESULTS and DISCUSSION

Phenological and growth parameters

Data over location did not pooled in order to have clear information on adaptability of the varieties across location because of the dissimilarity in responses as revealed that by presences of variety by location interaction and the difference of agro-ecologies. In this study, analysis of variance of the three location shows that phenological and growth parameters; namely days to 50% emergency at Bore on station and Adola sub-site, days to 50% flowering at Bore on station and Ana sora on farm, days to physiological maturity at Bore on station and Ana sora on farm and plant height at Adola sub-site were significant ($P < 0.05$) difference among the varieties. Whereas non-significant difference were observed on days to 50% emergency at Ana sora on farm and Adola sub-site, on days to physiological maturity at Adola sub-site, and on plant height at Bore on station and Ana sora on farm (Table 1). Days to flowering ranged from 71-75 days for Bore on station and 71-75.67 days for Ana sora on farm, respectively. The day's differences to flowering between earlier and late flowered variety varies from 4.67-5 days. Days to maturity ranged from 144.3- 153.7 days for Bore on station and 144.3-154.3 days for Ana sora on farm. Similarly, plant height ranged from 46.77 - 62.33 cm for Adola sub site. These findings are in agreement with Ines C. Gonzales and Fernando R. Gonzales (2014) who reported considerable variation in the days to flowering, days to maturity and plant height of different chickpea varieties when planted under various environments. Similarly, Yasin and Mathewos (2016) also reported that significant difference among the varieties on plant height. In other study Chickpea varieties showed significant difference on plant height (Yasin *et al*., 2017).

Yield component and yield

Analysis of variance of the three locations showed that number of pods per plant and hundred seed weight were significant ($P < 0.05$) difference among the varieties. Whereas, on number of seeds per pod there was no significant difference observed among the varieties (Table 2). Variety Teketaye significantly had the highest average number of pod per plant (87 pods) while Arerti and Ejere significantly showed the lowest average of pod per plant (61.67 and 64.33 pods, respectively) at Bore on station. For Ana sora on farm and Adola sub-site the highest average number of pods per plant was recorded from variety Dalota (67.33 and 68.80, respectively). The lowest number of pods per plant was recorded from variety Natoli (41.33 and 42.37 pods) at Ana sora on farm and Adola sub-site, respectively. The varietal effect on the hundred seed weight was significant ($P < 0.05$) at three locations and the results (Table 2) indicated that the maximum hundred seed weight (37.78 g, 36.67 g and 40 g) were recorded in variety Dalota, followed by varieties Habru and Natoli with (35.56 g; 35 g), Ejere and Habru with (35 g; 33.33 g) and Habru, Natoli and Ejere with (35 g) at Bore on station, Ana sora on farm and Adola sub-site, respectively (Table 2).

Variety Dalota had the highest hundred seed weight

Table 2.Mean Number of pods plant^{-1}, Number of seeds pod^{-1} and hundred seed weight (g) of Chickpea varieties at Bore on station and Ana sora on farm and Adola sub-site during 2015/16 cropping season.

Varieties	Yield Component Parameters								
	Bore On-station			Ana Sora on farm			Adola sub-site		
	NPPP	NSPP	HSW(g)	NPPP	NSPP	HSW(g)	NPPP	NSPP	HSW(g)
Dalota	74.33^{ab}	1.33^{a}	37.78^{a}	67.33^{a}	1.00^{a}	36.67^{a}	69.80^{a}	1.33^{a}	40.00^{a}
Habru	67.33^{b}	1.00^{a}	35.56^{ab}	29.00^{b}	1.00^{a}	33.33^{abc}	45.93^{b}	1.00^{a}	35.00^{b}
Arerti	61.67^{c}	1.00^{a}	28.89^{c}	44.00^{b}	1.00^{a}	28.33^{d}	50.53^{b}	1.67^{a}	26.67^{c}
Natoli	77.33^{ab}	1.00^{a}	35.00^{ab}	41.33^{b}	1.00^{a}	30.00^{cd}	42.37^{b}	1.00^{a}	35.00^{b}
Teketaye	87.00^{a}	1.00^{a}	32.78^{b}	42.67^{b}	1.33^{a}	31.67^{bcd}	57.47^{ab}	1.00^{a}	31.67^{b}
Ejere	64.33^{bc}	1.00^{a}	34.44^{b}	43.33^{b}	1.00^{a}	35.00^{ab}	42.50^{b}	1.00^{a}	35.00^{b}
Mean	72.0	1.06	34.07	44.6	1.06	32.5	51.4	1.17	33.89
LSD(5%)	2.66	NS	3.19	18.87	NS	4.19	16.68	NS	4.69
CV (%)	23.5	22.3	9.9	23.8	22.3	7.3	18.2	28.6	7.8

Means within the same column followed by the same letter (s) are not significantly different at 5% level of significance;NPPP = Number of pods plant^{-1}, NSPP=Number of Seeds pod^{-1}, HSW(g)=Hundred Seed Weight, LSD = Least Significant difference; NS = Not significant; CV = Coefficient of Variation

Table 3.Mean grain yield in (kg ha^{-1}) of Chickpea varieties adaptation trial over three locations during cropping season of 2015/16.

Varieties	Grain Yield (Kg ha^{-1})			Overall Means
	Bore On-station	Ana Sora on farm	Adola sub-site	
Dalota	3038^{a}	1892^{ab}	2303^{a}	2411
Habru	2160^{ab}	1319^{bc}	1986^{ab}	1822
Arerti	1729^{bc}	1813^{ab}	1247^{bc}	1596
Natoli	1912^{bc}	1431^{bc}	1455^{bc}	1599
Teketaye	1139^{c}	2274^{a}	1444^{bc}	1619
Ejere	1656^{bc}	910^{c}	1226^{c}	1264
Mean	1939	1606	1610	
LSD (5%)	942.6	798.4	747.5	
CV (%)	27.3	27.9	26.1	

Means within the same column followed by the same letter (s) are not significantly different at 5% level of significance, LSD = Least Significant difference; NS = Not significant; CV = Coefficient of Variation

followed by Habru and Natoli over three locations whereas the variety Arerti had the lowest. This indicates that all the varieties respond not similarly to the tested locations. Another yield component measured was hundred seed weight. According to Yasin and Mathewos (2016) report significant difference among the varieties on number of pod per plant and hundred seed weight were observed. In other study Chickpea varieties showed significant difference on number of pods per plant (Yasin *et al*., 2017). On another hand Number of pods per plant varied from 3.2 to 12.9 pods (Bicer and Toncer., 2012) and number of pods per plant ranged from 1.0 to 15.0 in genotypes from ICARDA (Canci and Toker ,2009) were observed.

The study revealed that chickpea varieties showed significant ($P < 0.05$) difference on grain yield (kg ha^{-1}) at three locations (Table 3). Variety Dalota had the highest grain yield (3038 kg ha^{-1}); while Teketaye had the lowest grain yield (1139 kg ha^{-1}) at Bore on station. For Ana sora

on farm the highest grain yield was recorded from variety Teketaye (2274 kg ha^{-1}) followed by Dalota (1892 kg ha^{-1})and the lowest grain yield was recorded from Ejere (910 kg ha^{-1}) variety. At Adola sub-site the highest average of grain yield was recorded from variety Dalota (2303 kg ha^{-1}) followed by Habru (1986 kg ha^{-1}), whereas the lowest was recorded from Ejere (1226 kg ha^{-1}) variety. From the overall mean grain yield the highest yield was recorded from variety Dalota (2411 kg ha^{-1}) followed by Habru (1822kg ha^{-1}) while, the lowest from variety Ejere (1264 kg ha^{-1}). This indicates that all the varieties respond not similarly to the tested locations. This result are in line with those of Biru *et al*. (2014) who tested different improved Chickpea varieties and reported the average grain yield over environments varies from 520-2010 kg ha^{-1}. Similarly Yasin and Mathewos (2016) and Yasin *et al*.(2017) also reported that there was significant difference on grain yield among the variety at across location.

CONCLUSION AND RECOMMENDATION

Six Chickpea Varieties were tested for yield and Adaptation in three district of Guji Zone of Southern Oromia. Generally, the present study entails the presence of difference among the varieties for grain yield and some other traits. Varieties Dalota and Habru were selected for high grain and other agronomic parameters. Therefore, from this study, it could be recommended that Dalota and Habru which had comparably highest yields to be adopted for cultivation in three district of Guji Zone of Southern Oromia.

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