



Performance Evaluation of Chickpea Varieties (*Cicer arietinum* L.) at Bule Hora and Abaya Southern Ethiopia

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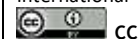
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Abstract

Chickpea is among the major pulse crops grown in southern Ethiopia including Borana and West guji zone. The area has potential to the production of Chickpea for food and nutrition security as well as export commodity. However, scarcity of varieties that fit to the environment is one of the major constraints of production. Therefore, this experiment was conducted to evaluate 9 chickpea varieties to select adaptable varieties for yield and agronomic traits. The field experiment was conducted in 2017 and 2018 at two locations (Abaya and Bule hora) and varieties were planted in Randomized complete block design. Data were collected on yield and important agronomic traits. Analysis of variance computed for individual locations and combined analysis over locations revealed significant variations among varieties. Moreover, Varieties showed a grain yield as high as 1087.5kg/ha and 873.79kg/ha at Bule hora and Abaya respectively. Minjar variety is significantly high yielding variety at both locations with yield advantage of 26.13% and 52.07% over variety mean at Bule hora and Abaya respectively and therefore recommended for both locations and locations with similar agro ecologies.

Keywords: Adaptability; Mean grain yield; Yield related traits.

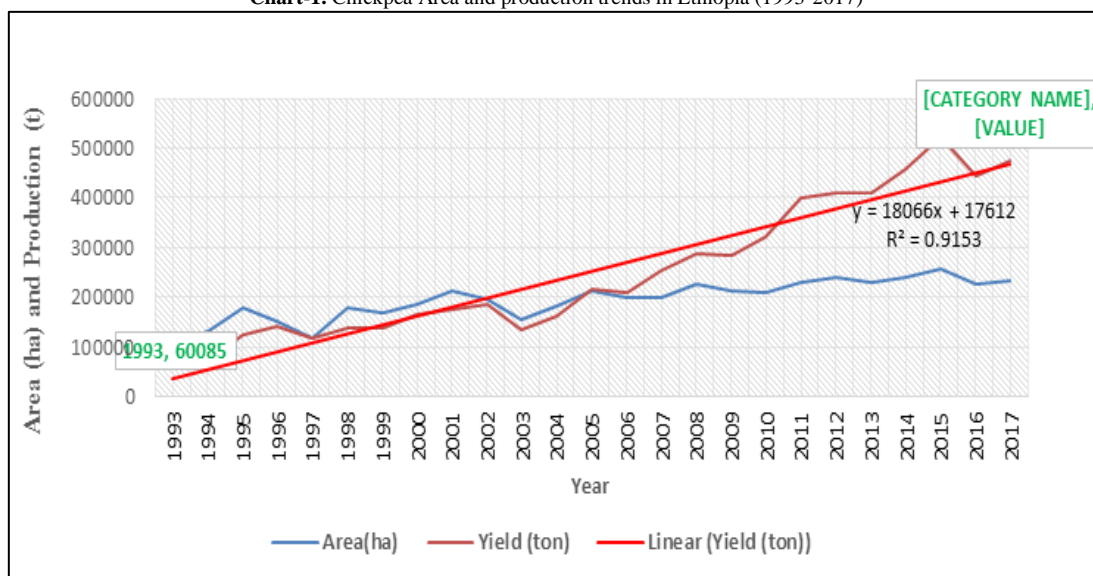
1. Introduction

Chickpea (*Cicer arietinum* L.) is a diploid species with 2n=16 chromosomes. It is a self-pollinated crop, with natural cross-pollination of up to one per cent [1]. Chickpea is among the oldest crops, being domesticated in the Fertile Crescent 10,000 years ago [2] and named as Bengal gram (Indian), Chickpea (English), Garbanzo (Latin America), Hommes, Hamaz (Arab world), Nohud, Lablabi (Turkey), Shimbra (Ethiopia). It is the lone domesticated species among the 44 species comprising 33 perennial and eight annual wild species and highly preferred pulse for human consumption within the genus *Cicer* [3], family *Fabaceae*, tribe *Cicerae*. Chickpea is grown in tropical, sub-tropical and temperate regions. It is a valued crop and provides nutritious food for an expanding world population and will become increasingly important with climate change [4]. Chickpea contains nutritive seeds with high protein content, 25.3-28.9 %, after dehulling [5], 38-59% carbohydrate, 3% fiber, 4.8-5.5% oil, 3% ash, 0.2% calcium, and 0.3% phosphorus. Digestibility of protein varies from 76-78% and its carbohydrate from 57-60% [5]. Chickpea seeds are eaten fresh as green vegetables, parched, fried, roasted, and boiled; as snack food, sweet and condiments; seeds are ground and the flour can be used as soup, dhal, and to make bread; prepared with pepper, salt and lemon it is served as a side dish [6]. Chickpea is beneficial to a healthy diet. For example a half-cup serving provides 7 g of protein (10% of our daily requirement) and 6 g of fiber (20% of our daily requirement) [7]. It plays a significant role in improving soil fertility by fixing the atmospheric nitrogen. It can fix up to 140 kg N ha⁻¹ from air and meet most of its nitrogen requirement [8].

According to Central Statistical Agency [9] in Ethiopia, Pulse crops production ranks second in terms of production area. Pulses grown in Ethiopia covered 12.33% (1,549,911.86 hectares) of the grain crop area and 9.69% (about 28,146,331.73 quintals) of the grain production. In Ethiopia, chickpea is mainly grown in the central, northern and eastern highland areas of the country at an altitude of 1400-2300 m.a.s.l., where annual rainfall ranges between 700 and 2000 mm [10, 11]. It is best adapted to the areas having Vertisols [8].

Chickpea production has increased from 60085 tons (1993) to 473570 tons (2017). The production areas are also increased from 109750 hectare (1993) to 473570 hectare (2017) [12].

Chart-1. Chickpea Area and production trends in Ethiopia (1993-2017)



Source: Food and Agricultural Organizations of the United States Statistics [12]

In the study areas, shortage of chickpea varieties that adapt to the prevailing environments are the top chickpea production constraints. Therefore, this study was incited with the objective to test the adaptability of chickpea varieties for yield and yield related traits in the study areas.

2. Materials and Methods

2.1. Site Description

The experiment was conducted at Bule hora and Abaya during 2017 and 2018 cropping season. The experimental areas are located in the Southern part of the country in the Oromia Regional State. Bule hora and Abaya are located at 465 and 365 km far from Addis Ababa city, respectively.

2.2. Experimental Materials

For this study, 9 released Chickpea varieties were obtained from Debrayayit Agriculture Research Centre (DzARC) and evaluated for adaptability of the varieties

Table-1. Released Chickpea varieties use in the experiment

S.No	Variety	Year of release	Breeding center
1	Dhera	2016	DZARC
2	Arerti	1999	DZARC
3	Hora	2016	DZARC
4	Ejeri	2005	DZARC
5	Habru	2004	DZARC
6	Natoli	2007	DZARC
7	Minjar	2010	DZARC
8	Dalota	2013	DZARC
9	Dimtu	2016	DZARC

2.3. Experimental Design and Managements

The experiment was laid out in Randomized Complete Block Design. Each entry was planted in a plot having 6 rows of 3 meter length. Four rows were harvested and two border rows were left to exclude border effect. The row and plant spacing was kept at 40 cm and 10 cm, respectively. Individual plot size was 2.4 m x 3 m=7.2 m² and 1m and 1.5m between plot and block, respectively. 60kg NPS/ha Fertilizer was applied at the time of planting. All other agronomic managements were applied uniformly in all experimental plots as per national recommendation for the crop.

2.4. Data Collection

The following data were collected during the experiment time both from the whole plot, net plot and sampled plants by random selection method from the middle of four rows of each plot.

2.5. Data Recorded on Plant Basis

Plant height at harvest (cm): Height of five randomly taken plants during harvest period from each experimental plot was measured in centimeter from the ground level to top of the plants and the average height was recorded.

Number of primary branches: Number of productive branches extending from the main stem was recorded from five randomly selected plants and average branch number was taken.

Pod length (cm): The length of five randomly selected pods from each of the five randomly selected plants was measured at harvesting and the average was used.

Number of pods per plant: this was recorded as average total number of pods of five randomly selected plants from each experimental plot at harvest.

Number of seeds per pod: This was recorded as average total number of seeds of five randomly selected plants from each experimental plot divided by total number of pod of the same plants at harvest.

Seeds per plant: Average number of seeds counted from five randomly selected plants.

2.6. Data Collection on Plot Basis

Days to Flowering: The numbers of days from the date of emergence to the date on which about 50% of the plants in each plot produce flowers.

Days to maturity: The number of days from planting to the date when 90% of the morphological observation of the plant turned to yellow straw colour.

Stand count at harvest: This was recorded by counting the total number of plants from the four middle rows of each plot at harvest.

Grain yield (g/plot): Grain yield in grams obtained from the central four harvestable rows of each plot was harvested, threshed and weighted using sensitive balance.

Grain yield (ton/ha): Grain yield obtained from each plot was used to estimate grain yield (tons) per hectare.

2.7. Data Analysis

2.7.1. Analysis of Variance

Analysis of variance (ANOVA) was computed for grain yield and other traits as per the methods described by Gomez and Gomez [13] using SAS computer software (Version 9) for Randomized Complete Block Design. Comparison of treatment means was made using Duncan Multiple Range test (DMRT) at 5% level of significance. Location wise analyses were performed and error variances were subjected to F-test for homogeneity test of variances. Variables with homogeneous error variances were directly used for combined analyses, while those with heterogeneous error variances were analyzed in individual locations. The combined analysis was based on mixed model (fixed genotype and random environment).

Individual locations and combined ANOVA were computed using the following mathematical model:

Individual locations ANOVA model

$$X_{ijkl} = \mu + G_i + B_{jk} + Y + GY_i + E_{ijk}$$

Where, X_{ijkl} = Observed value,

μ = general mean,

G_i = effect of variety,

B_{jk} = effect of replication (block),

Y = effect of year,

GY_i = variety x Year,

E_{ijk} = residual effects or experimental error. Additionally, g, r, y are numbers of genotypes, replications, locations and years, respectively

2.7.2. Combined ANOVA Model

$$X_{ijkl} = \mu + G_i + B_{jkl} + L_k + Y_l + GL_{ik} + GY_{il} + LY_{kl} + GLY_{ikl} + E_{ijkl}$$

Where, X_{ijkl} = Observed value,

μ = general mean,

G_i = effect of genotype,

B_{jkl} = effect of replication (block),

L_k = effect of location,

Y_l = effect of year,

$GL_{ik} + GY_{il} + LY_{kl} + GLY_{ikl}$ = effects of Genotype x Location, Genotype x Year, Location x Year, and Genotype x Location x Year interactions, respectively.

E_{ijkl} = residual effects or experimental error. Additionally, g, r, l, y are numbers of genotypes, replications, locations and years, respectively.

3. Results and Discussion

3.1. Analysis of Variance

The experiment was conducted at two locations viz. Bule hora and Abaya. Homogeneity of variance was computed for each location before the combined analysis of variance computed. The analysis of variance were computed for days to flowering, days to maturity, plant height, number of primary branches, pods per plant, seeds per pod, seeds per plant and grain yield per hectare. The individual location and the combined analysis of variance results are presented in subsequent sections.

3.2. Individual Location Analysis of Variance

Analysis of variance computed for each location revealed that variation among varieties were highly significant ($P < 0.01$) for all traits at both locations except seeds per pods are significant ($P < 0.05$) at Bule hora and not significant at Abaya (Table 2 and Table 4). The presence of variations among varieties under experiment for all the traits studied indicated the presence of sufficient variability among Chickpea varieties that would be exploited through selection. The year effect was highly significant ($P < 0.01$) at both location, indicated that the performance of varieties are different in different locations. Ercan, *et al.* [14], also reported different performance of Chickpea genotypes in different year and location.

In Ethiopia, Getachew, *et al.* [15] reported the presence of highly significant variation among 17 Kabuli type Chickpea genotypes conducted in five environments. He also reported the existence of significant variation for days to flowering, days to maturity, plant height, pods per plant, seed per pod, 100 seed weight and Grain yield. Ercan, *et al.* [14], Rozina, *et al.* [16], Dan, *et al.* [17] and Desai, *et al.* [18] also reported highly significant variation for plant height, pods per plant, seeds per plant, hundred seed weight and grain yield in Chickpea which is in line with this finding.

Table-2. Mean squares from combined analyses of variance over two years for 8 traits of Chickpea varieties grown at Bule hora in 2010 and 2011 E.C

Source of variation	df	GY (kg/ha)	FD	MD	PH (cm)	NPB	PPP	SPPnt	Spp
Year (Y)	1	9144171.941 ***	200.296 ***	852.04 ***	121.50**	12.907 ***	4911.57 4***	4907.760 ***	0.042
Variety (V)	8	221172.044* **	52.031* **	94.573 ***	138.013* **	2.250* *	238.270 **	483.868* **	0.055
Reps.withn (Y)	4	12870.114	12.106	28.764 **	17.484	4.788* **	793.759 *	740.088* **	0.023
Y* V	8	75879.754** *	6.369	5.781	13.613	2.610* *	44.297	99.891	0.008
Pooled Error	32	5575.47	6.553	5.493	11.188	0.627	69.045	80.962	0.031
CV (%)		9.29	4.097	2.058	7.76	18.40	26.03	29.92	19.14

ns, *, **&***, non-significant, significant at $P < 0.05$, $P < 0.01$ and $P < 0.001$, respectively. DF= degree of freedom, FD= days to flowering, GY (kg/ha) = Grain yield in kilogram per hectare, MD= days to maturity, PH (cm) = plant height in centimeter, NPB= number of primary branch, PPP= pods per plant,

Table-3. Mean squares from combined analyses of variance over two years for 8 traits of Chickpea varieties grown at Abaya in 2010 and 2011 E.C

Source of variation	Df	GY (t/ha)	FD	MD	PH (cm)	NPB	PPP	SPPnt	Spp
Year (Y)	1	660731.049 ***	168.894 ***	665.004 ***	1026.17 ***	66.223 ***	156.400* *	109.796* *	0.0017
Variety (V)	8	275176.187 ***	68.970* **	183.719 ***	172.247 ***	2.640* *	162.655* **	260.067* **	0.084*
Reps. withn(Y)	4	4170.035	9.532	21.217	23.072	1.930* *	12.890	2.070	0.028
Y* V	8	35941.645* **	3.164	63.473* **	14.256	1.346	6.8785	20.572	0.022
Pooled Error	32	2068.333	10.251	8.811	9.535	0.663	14.684	20.387	0.036
CV (%)		10.85	5.82	2.995	8.152	17.556	24.61	31.49	21.078

ns, *, **&***, non-significant, significant at $P < 0.05$, $P < 0.01$ and $P < 0.001$, respectively. DF= degree of freedom, FD= days to flowering, GY (kg/ha) = Grain yield in kilogram per hectare, MD= days to maturity, PH (cm) = plant height in centimetre, NPB= number of primary branch, PPP= pod per plant

3.3. Combined Analysis of Variance Over Location

Location wise analyses were performed and error variances were subjected to F-test for homogeneity of variance. Variables with homogeneous error variances were subjected to combined analysis, and as well as evaluation of varieties performance were conducted using the pooled mean values over locations. Whereas, for those traits with heterogeneous error variances, evaluation of varieties were conducted using each location mean values. Accordingly, pods per plant, seeds per plant and grain yield exhibited heterogeneous error variances and the mean squares for locations were also significant indicating the performance of the genotypes cannot be evaluated on the basis of pooled mean values over locations. However, the homogeneity of error variances for flowering date, maturity date, plant height, number of primary branches and seeds per pods were homogeneous that allowed evaluation of the genotypes on the basis of combined mean values over locations.

The ANOVA results of combined analysis over locations are presented in table 4. The result of combined analysis of variance revealed the presence of highly significant ($P < 0.01$) difference among locations, varieties and varieties by environment interaction for traits suggested differences in environments and the presence of sufficient

genetic variability for these trait that can be exploited in breeding programs. Highly significant variation for grain yield other yield related traits in chickpea were also reported by various authors [14, 15, 18-20]. The significant differences were observed between locations for all traits. This indicates that the two locations were significantly different for the performance of varieties for these traits. The significant differences between locations were reported in chickpea by Desalegn and Pichiah [19], Desai, *et al.* [18] and Getachew, *et al.* [15].

The presence of significant varieties x location interaction (table 4) suggested that varieties had differential performance at the two locations for these traits. The differential performance of varieties across environment varies significantly and the performance of plants depends directly on the environmental conditions [21]. Other authors also reported the significant influence of genotype by location interaction on the performance of chickpea [15, 18, 19].

Table-4. Pooled Mean squares from combined analyses of variance over two locations and two years for four traits of Chickpea varieties grown at B/Hora and Abaya in 2010 and 2011E.C

Source of variation	DF	FD	MD	Pht	NPB
Locations (L)	1	2498.891***	5896.333***	736.333***	3.067*
Replications (L)	4	21.356*	28.01**	22.638	4.803***
Years (Y)	1	368.521***	5.787	926.935***	68.800***
L * Y	1	0.669	1511.259***	220.735***	10.329***
Varieties (V)	8	116.214***	262.318***	283.613***	2.065**
L*V	8	4.787	15.974	26.647*	2.825***
Y*V	8	7.219	50.459***	13.026	0.945
L *V*Y	8	2.315	18.796*	14.843	3.011***
Pooled Error	68	8.143	8.024	10.806	0.720
CV		4.767	2.66	8.12	18.976
Mean		59.85	106.47	40.49	4.47

ns, * **&***, non-significant, significant at P<0.05, P<0.01 and P<0.001, respectively. DF= degree of freedom, FD= days to flowering, L =locations, MD= days to maturity, PH (cm) = plant height in centimeter, NPB= number of primary branch, Rep= Replications, V= Variety, Y= year

3.4. Mean Performance of Varieties

3.4.1. Crop Phenology

Flowering duration of nine varieties of chickpea ranges from 59.75-69.25 and 49.67-60.00 days at Bule hora and Abaya respectively while the maturity duration of varieties ranges from 109.00-120.67 and 90.5-106.08 days at Bule hora and Abaya respectively. The mean performances of for these traits are presented in Tables 5 and 6. The varieties showed early flowering and maturity at Abaya than Bule hora. This might be due to the altitude and temperature differences of the two locations, where by Abaya is located at an altitude of 1442 m. a. s. l. with mean minimum and maximum temperature of 12.6-29.9 °C while Bule hora is located at an altitude of 2322 m. a. s. l. with mean minimum and maximum temperature of 15-30 °C. The pooled mean over location and year (Table 7) for flowering and maturity date ranges from 54.71-64.63 and 99.75-113.38 days respectively. The earliest maturing varieties was Dimtu (99.75 days) followed by Dalota (101.29 days) and Minjar (102.29 days) while the late maturing variety was Dhera (113.375 days) followed by Hora (110.58) and Areri (109.67) (Table 7). Four varieties exhibit lower number of days to maturity than over all mean.

3.4.2. Growth Traits

Mean performances of genotypes for plant height at Abaya ranged from 33.3 cm to 50.06cm with location mean of 37.88 cm; whereas mean performance of varieties for plant height ranged from 37.0 cm to 53.8 cm with location mean of 43.10 cm at Bule hora (Tables 5 and 6). The mean values of chickpea for plant height ranged from 36.18 to 51.93 with over all mean values of 40.49. Similar result for mean and range for plant height in Chick pea varieties were also reported previously by Dan, *et al.* [17] and Ercan, *et al.* [14]. Genotypes attained higher plant height at Bule hora than at Abaya.

Varieties showed considerable variations for number of primary branches that ranged from 3.23 for Ejare to 5.27 for Dalota at Bule hora (table 5); and 3.57 for Dimtu to 5.37 for Dhera at Abaya (table 6). The mean performance of varieties for number of primary branches were 4.60 at Abaya and 4.30 at Bule hora with pooled mean of 4.47. Six varieties recorded superior number of primary branches than the mean performance of varieties (Table 7). Existence of significant variations among Chickpea varieties for number of primary branches was also reported by Dan, *et al.* [17].

3.4.3. Yield and Yield Components

The variation of varieties for pods number per plant and seeds number per plant ranged from 23.57 to 44.97; and 21.6 to 52.83, respectively at Bule hora. The variation of these two traits ranged from 9.67 to 27.91 and 7.93 to 30.4, respectively at Abaya. Minjar had significantly higher pods, seeds number per plant and seed per pod at both locations (Tables 5 and 6). The existence of considerable variations for pods number, seeds number per plant and seed per pod was also reported by other authors in Chickpea Getachew, *et al.* [15], Dan, *et al.* [17] and Ercan, *et al.* [14]. The mean grain yield of varieties ranged from 571.7 kg to 1087.5kg; 226.57kg to 873.79kg at Bule hora and Abaya, respectively (Tables 5 and 6). At Bule hora, significantly highest mean grain yield was measured from Minjar (1087.5kg/ha) followed by Natoli (1030.94kg/ha) and the lowest mean grain yield was obtained from Hora

(571.7 kg/ha) followed by Dhera (600.35kg/ha). At Abaya the highest grain yield was obtained from variety Minjar (873.79kg/ha) followed by dalota (583.16kg/ha) and the lowest grain yield was measured from Dhera (160.42kg/ha) followed by Hora (226.57 kg/ha). Four varieties gave grain yields greater than mean grain yield of varieties at Bule hora and four varieties had grain yield greater than mean yield of varieties at Abaya as well. In all cases, Minjar is significantly well performing variety at both locations (Tables 5 and 6).

Table-5. Mean value of yield and yield related traits of 9 Varieties of Chickpea tested at Bule hora in 2010 and 2011 E.C cropping season

Variety	FD	MD	PH(cm)	NPB	PPP	SPPnt	Spp	GY(kg/ha)
Dhera	69.250a	120.667a	53.800a	5.00ab	34.63b	28.20b	0.850b	600.35fg
Areri	65.417bc	115.417b	37.000e	4.367a-c	28.07bc	24.967b	0.867b	689.06de
Hora	67.333ab	116.583b	42.133b-d	4.067b-d	33.33bc	29.36b	0.850b	571.70g
Ejere	65.00bc	115.500b	40.667c-e	3.233d	23.57c	21.60b	0.900b	856.15c
Habru	59.750	116.333b	45.000bc	4.400a-c	31.47bc	27.367b	0.900b	661.29ef
Natoli	66.083a-c	111.500c	39.867de	3.867cd	25.767bc	26.07b	0.967ab	1030.94ab
Minjar	63.417cd	109.583c	45.900b	4.567a-c	44.967a	52.833a	1.150a	1087.50a
Dalota	64.667bc	110.167c	41.733b-d	5.267a	35.40ab	26.067b	0.867b	759.38d
Dimtu	61.083de	109.00c	41.800b-d	3.967b-d	30.10bc	29.167b	0.967ab	975.18b
Mean	64.67	113.86	43.10	4.30	31.92	30.07	0.92	803.50
Range	59.75-69.25	109.00-120.67	37.0-53.8	3.23-5.27	23.57-44.97	21.6-52.83	0.85-1.15	571.7-1087.5

Means with the same letters in the same columns are not significantly different FD= days to flowering, GY (kg/ha) = Grain yield in kilogram per hectare, MD= days to maturity, PH (cm) = plant height in centimetre, NPB= number of primary branch, PPP= pod per plant, SPPnt= seed per plant, Spp = seed per pod

Table-6. Mean value of yield and yield related traits of 9 Varieties of Chickpea tested at Abaya in 2010 and 2011 E.C cropping season

Variety	FD	MD	PH(cm)	NPB	PPP	SPPnt	Spp	GY(kg/ha)
Dhera	60.00a	106.08a	50.06a	5.37a	9.67c	9.73cd	1.01ab	160.42g
Areri	57.25ab	103.92abc	35.37cd	5.00ab	13.37bc	10.50b-d	0.78bc	278.13f
Hora	56.750ab	104.58ab	37.93c	5.23a	11.47bc	7.93d	0.72c	226.57f
Ejere	53.750bc	100.42cd	37.80c	5.30a	13.20bc	11.77b-d	0.90a-c	353.94e
Habru	49.667d	101.08bcd	42.53b	4.83a-c	16.57b	14.50bc	0.88a-c	388.72de
Natoli	58.75a	97.75de	33.30d	4.13b-d	15.30b	13.23b-d	0.83a-c	420.66d
Minjar	53.917bc	95.00ef	35.17cd	4.46a-d	27.92a	30.40a	1.07a	873.79a
Dalota	53.833bc	92.42fg	34.10cd	3.87cd	16.53b	14.67bc	0.88a-c	583.16b
Dimtu	51.50cd	90.50g	34.63cd	3.57d	16.10b	16.30b	1.03ab	484.03c
Mean	55.046	99.08	37.88	4.64	15.568	14.337	0.90	418.82
Range	49.667-60.00	90.5-106.08	33.3-50.06	3.57-5.37	9.67-27.91	7.93-30.4	0.72-1.07	226.57-873.79

Means with the same letters in the same columns are not significantly different

FD= days to flowering, GY (kg/ha) = Grain yield in kilogram per hectare, MD= days to maturity, PH (cm) = plant height in centimetre, NPB= number of primary branch, SPPnt= seed per plant, Spp = seeds per pod, PPP= pods per plant

Table-7. Pooled Mean values of yield and yield related traits of 9 Varieties of Chickpea tested at Abaya and B/ hora in 2010E.C and 2011 cropping season

Variety	FD	MD	Pht	NPB
Dhera	64.63a	113.375a	51.933a	5.183a
Areri	61.33bc	109.667bc	36.183e	4.683ab
Hora	62.04b	110.583b	40.033c	4.650ab
Ejere	59.38cd	107.958c	39.233cd	4.267bc
Habru	54.71e	108.708bc	43.767b	4.617ab
Natoli	62.42ab	104.625d	36.583de	4.00bc
Minjar	58.67d	102.292e	40.533c	4.517a-c
Dalota	59.25cd	101.292ef	37.917c-e	4.567ab
Dimtu	56.29e	99.750f	38.217c-e	3.767c
Means	59.85	106.47	40.49	4.47

Means with the same letters in the same columns are not significantly different

FD= flowering date, MD= Maturity date, PH= plant height, NPB= number of primary branch,

4. Conclusions and Recommendations

The results of this investigation showed significant variation among varieties for all traits as well as significant effect of varieties by location interaction for grain yield and most yield related traits, which indicated the differential performance of varieties across environments. The highest mean grain yield was exhibited by Minjar (1087.5kg ha⁻¹) and Natoli (1030.94kg ha⁻¹) at Bule hora and Minjar had significantly highest mean grain yield (873.79kg ha⁻¹) at Abaya with About four varieties gave mean grain yield greater than grand mean at Bule hora and Abaya. Minjar variety is significantly high yielding variety at both locations with yield advantage of 26.13% and 52.07%

over variety mean at Bule hora and Abaya respectively. The prominent chickpea varieties Minjar and Natoli are promising varieties due to their relatively higher yield and some considerable traits at Bule hora and similar agro-ecologies while Minjar is promising variety at Abaya. Therefore, farmers and chickpea producers around study areas and similar agro ecologies can use those varieties for chick pea production.

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