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Evaluation on Performance of Chickpea (*Cicer Arietinum* L.) Genotypes under irrigation of Werer Afar, Ethiopia

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ABSTRACT

Majors Chickpea producer regions in Ethiopia: Amhara, Oromia, S.N.N.P. and Tigray, respectively. Chickpea grain production in area coverage in Ethiopia is about 242,703.73 hectares (ha) and whereas grain production is 4,994,255.50 Quantal (qt) and also with national average yield of 20.58 qt per ha. Ethiopia standpoints first among chickpea producers in Africa and seventh in the world. Chickpea grains are an essential part of the daily diet for people in many developing countries where a larger proportion of the population cannot afford animal products. Chickpea (*Cicer arietinum* L.) Belongs to family of Fabaceace and sub family faboideae to the genus Cicer that consists of 43 species. In the Afar regions of Ethiopia cropping system is predominantly mono crop type with cotton being the principal main season crops. After the harvest of cotton the fields are left unplanted till the next main season. Of-season offers a greater opportunity for growing chickpea. However still there is no improved variety for the area. The objective of this experiment was to evaluate the performance of the 66 chickpea genotypes which was evaluated during off-season 2017/18 under 6 x11 alpha lattice design having three replications and aim of identifying those with a better seeds yield under irrigated conditions. Data were collected for days to 50% flowering, days to 90% maturity, total number of pod per plant, total number of seed per pod, plant height, total number of seed per plant, number of secondary branches, biomass, hundred seed weight, seed yield and harvest index exhibited highly significant differences($P<0.01$) among genotypes. On the other hand, genotypes exhibited significant differences ($P<0.05$) for number of primary branches per plant. Generally the study revealed that the importance of considering these characters in the process of selection of genotypes for yield and according 5% selection intensity ten genotypes were superior than Habru, the released variety (check), for chickpea seed yield; the result suggested ICCV-11102 and FLIP-03-155C to be evaluated further in Low land of Afar Region under irrigation.

Keywords: ***Cicer arietinum*** **L., Genotypes, Seed yield, Yield components**

INTRODUCTION

Chickpea (***Cicer arietinum*****L**.) is grown from temperate to sub-tropical regions of the world, with some 72% of world production from South Asian countries (Foyer *et al*., 2016). Chickpea is the third most important pulse crop and is grown on about 13.5 million hectares of land in the World (FAO, 2015). Ethiopia standpoints first among chickpea producers in Africa and seventh in the world. It accounts for 60% of Africa's total Chickpea production (FAOSTAT, 2014). The Majors Chickpea producer regions in Ethiopia are: Amhara, Oromia, S.N.N.P. and Tigray, respectively. Chickpea grain production in area coverage in Ethiopia is

about 242,703.73 hectares and whereas grain production is 4,994,255.50 Quantal (qt) and also with national average yield of 20.58 qt per ha (CSA, 2017).

Chickpea grains are an essential part of the daily diet for people in many developing countries where a larger proportion of the population cannot afford animal products (Mike, 1988). Chickpea role in reducing the gap in protein nutrition of cereal-dominated diets in developing countries, it offers high quality feed for livestock. Moreover, as a legume, its cultivation fits well in cereal-cereal or cereal-fallow rotation systems where it contributes to the system sustainability and reduces the need for nitrogen fertilization. (Samarah *et al.,* 2009).

Chickpea (*Cicer arietinum* L.) Belongs to family of Fabaceace and sub family faboideae to the genus Cicer that consists of 43 species (Van der Maesen, 1987). Its primary center of diversity is in the Productive Crescent where the crop was first domesticated or cultivated in an area of south-eastern Turkey and adjoining Syria. Chickpea is now cultivated throughout the semi-arid regions of the world (Knights *et al.,* 2007). There are two main types of chickpea, distinguished by their seed size, shape and color: Desi produces relatively small seeds with an angular shape, light tan to dark color, and Kabuli produces large, rounded white to pale cream color seeds. Kabuli chickpea seeds are grown in temperate regions whereas the Desi type is grown in the semi-arid tropics (NaserMaheri-Sis *et al.,* 2008).

In the Afar region of Ethiopia the cropping system is predominantly mono crop type with cotton being the principal main season crops. After the harvest of cotton the fields are left unplanted till the next main season. Of-season offers a greater opportunity for growing chickpea. The government and Non-government Institutions such as ICRISAT and ICARDA try to promote the crop under irrigation condition within this region in the form of participatory variety selection and adaptation trial in order to reduce food security problem and to improve nutrition in the regions. However still there is no improved variety for the area. For exploring the fitness of chickpea in this region it is necessary to estimate the genetic performance of different plant characters of economic importance and their heritability. Crop improvement depends on the availability of genes for better agronomic traits, such as disease resistance, earliness and high yield. Crop improvement depends on the availability of genes for better agronomic traits, such as disease resistance, earliness and high yield.

The chickpea development program of Ethiopian has mainly focused on selection of genotypes for rained fed area. However, there is no adequate information on variability performance of grain yield and its related components for the new chickpea accessions under irrigated agriculture of Afar Regions. The objective of this experiment was to evaluate the performance of the chickpea genotypes under irrigation and aim of identifying those with a better seeds yield under irrigated conditions.

MATERIALS AND METHODS

Description of Experimental Site

The experiment was conducted at Werer Agricultural Research Center which is one of the Agricultural Research Centers of Ethiopian Institute of Agricultural Research during the cool season (November, 2017 to February, 2018 G.C). It is located in Afar National Regional State of the Federal Government of Ethiopia 280 km East of Addis Ababa with an altitude of 740 m.a.s.l. and at latitudes of 9° 60'N and 40° 09' E longitude. The dominant soil type of the study areas is Chromic Vertisol (clay to silt clay) with particle size distribution of Sand 3.83%, Silt 61.1% and clay 35.07 % with a bulk density of 1.17% (Wendemagegn and Abere, 2012). The pH of the soil is slightly alkaline and ranges from 7.5 to 8.5. The average annual rainfall 540 mm and the annual temperature range 190C -34^{0}C.

Treatments and Experimental Design

About 66 (65 accessions and one standard check) were obtained from Debre Zeit Agricultural research center. The Experiment was laid out in Alpha Lattice Design consisting of six incomplete blocks with three replications. Each block was planted with 11 entries. Each experimental plot was 4m x 0.60m (2rows per plot). Inter and intra row spacing of 30cm x 10 cm were used. Each plot was planted with two seeds per hill and thinned to one plant per hill 15 days after emergence. Agronomic practices such as irrigation, insecticides and weeding were applied to the crop during experiment.

Table 1.Listsof 66 chickpea genotypes used in the study.

Ser N0.	Name Genotypes	Status	Source	Types	Ser N0.	Name Genotypes	Status	Source	Types
1	FLIP-09-371C	Not released	ICARDA	Kabuli	34	FLIP-08-38C	Not released	ICARDA	Kabuli
2	FLIP-08-42C	Not released	ICARDA	Kabuli	35	ICCV-11106	Not released	ICARDA	Kabuli
3	FLIP-09-376C	Not released	ICARDA	Kabuli	36	FLIP-88-85C	Not released	ICARDA	Kabuli
4	FLIP-09-50C	Not released	ICARDA	Kabuli	37	FLIP-07-4C	Not released	ICARDA	Kabuli
5	FLIP-93-93C	Not released	ICARDA	Kabuli	38	FLIP-09-114C	Not released	ICARDA	Kabuli
6	FLIP-09-161C	Not released	ICARDA	Kabuli	39	FLIP-08-53C	Not released	ICARDA	Kabuli
7	ICCV-11102	Not released	ICARDA	Desi	40	FLIP-05-157C	Not released	ICARDA	Kabuli
8	FLIP-03-128C	Not released	ICARDA	Kabuli	41	FLIP-09-189C	Not released	ICARDA	Kabuli
9	FLIP-09-277C	Not released	ICARDA	Kabuli	42	FLIP-09-348C	Not released	ICARDA	Kabuli
10	FLIP-03-155C	Not released	ICARDA	Kabuli	43	FLIP-05-19C	Not released	ICARDA	Kabuli
11	FLIP-09-134C	Not released	ICARDA	Kabuli	44	FLIP-09-185C	Not released	ICARDA	Kabuli
12	FLIP-09-188C	Not released	ICARDA	Kabuli	45	FLIP-09-157C	Not released	ICARDA	Kabuli
13	FLIP-03-101C	Not released	ICARDA	Kabuli	46	FLIP-09-354C	Not released	ICARDA	Kabuli
14	FLIP-07-26C	Not released	ICARDA	Kabuli	47	FLIP-09-360C	Not released	ICARDA	Kabuli
15	FLIP-09-184C	Not released	ICARDA	Kabuli	48	FLIP-09-379C	Not released	ICARDA	Kabuli
16	FLIP-09-179C	Not released	ICARDA	Kabuli	49	FLIP-08-41C	Not released	ICARDA	Kabuli
17	FLIP-09-187C	Not released	ICARDA	Kabuli	50	FLIP-09- 240C	Not released	ICARDA	Kabuli
18	FLIP-09-146C	Not released	ICARDA	Kabuli	51	FLIP-03-125	Not released	ICARDA	Kabuli
19	FLIP-09-359C	Not released	ICARDA	Kabuli	52	FLIP-09-6C	Not released	ICARDA	Kabuli
20	FLIP-09-171C	Not released	ICARDA	Kabuli	53	FLIP-09-343C	Not released	ICARDA	Kabuli
21	FLIP-09-174C	Not released	ICARDA	Kabuli	54	FLIP-09-233C	Not released	ICARDA	Kabuli
22	FLIP-09-126C	Not released	ICARDA	Kabuli	55	FLIP-09-380C	Not released	ICARDA	Kabuli
23	FLIP-09-438C	Not released	ICARDA	Kabuli	56	FLIP-09-140C	Not released	ICARDA	Kabuli
24	FLIP-09-244C	Not released	ICARDA	Kabuli	57	FLIP-09-393C	Not released	ICARDA	Kabuli
25	FLIP-09-347C	Not released	ICARDA	Kabuli	58	FLIP-09-357C	Not released	ICARDA	Kabuli
26	FLIP-03-40C	Not released	ICARDA	Kabuli	59	FLIP-09-120C	Not released	ICARDA	Kabuli
27	FLIP-09-339C	Not released	ICARDA	Kabuli	60	ICC-4958/EJERE-	Not released	ICC-4958XEJEREP6-19	Desi

						P6-19		CROSSING	
28	FLIP-09-162C	Not released	ICARDA	Kabuli	61	ICCX-060045-F3-P203-BP	Not released	ICCX060045-F3-P203-BP TLL	Desi
29	FLIP-09-241C	Not released	ICARDA	Kabuli	62	ICCV-11115	Not released	ICCV-11115	Desi
30	FLIP-09-18IC	Not released	ICARDA	Kabuli	63	ICC-4958/EJERE-P2-20	Not released	ICC-4958XEJEREP2-20 CROSSING	Desi
31	FLIP-09-261C	Not released	ICARDA	Kabuli	64	ICCX-060039-F3-P65-BP	Not released	ICCX-060039-F3-P65-BP TLL	Desi
32	FLIP-08-98C	Not released	ICARDA	Kabuli	65	ICCV-09108	Not released	ICCV-09108 ICRSAT	Desi
33	FLIP-09-309	Not released	ICARDA	Kabuli	66	Habru variety (Check)	released	DZARC	Kabuli

Traits Evaluated

The data for the following traits were recorded from five randomly selected plants from each experimental plot, and average value was considered: Days to 50% flowering, Days to physiological maturity, Number of pods per plant, Number of Seeds per plant, Number of branches per plant: Number of primary branches, Number secondary branches, Hundred seed weight, Plant height, Biomass, Harvest index and Grain yield per plot.

Statistical Analysis

Analysis of Variances

All collected data were subjected to analysis of variance using appropriate computer using SAS software (SAS, 2004). Duncan's Multiple Range Test (DMRT) at probability of 0.05 was used to separate the means and ranges for significant parameters.

RESULT AND DISCUSSION

The results clearly showed the presence of considerable variations among genotypes for the traits measured. This indicated possibility of making further study on these genotypes exploit the existing variability in chickpea improvement program specifically under irrigable agriculture of Afar region. Selection for different quantitative characters will certainly enhance improvement of chickpea accessions and eventually help to increase chickpea crop production in Ethiopia.

Results from analysis of variance showed highly significant ($P<0.01$) differences for days to 50% flowering, days to 90% maturity, total number of pod per plant, number of seed per pod, plant height, total number of seed per plant, number of secondary branches, biomass, hundred seed weight, yield t per ha and harvest index and on the other hand genotypes exhibited significant ($P<0.05$) differences for number of primary branches. This indicated the presence of variability among chickpea genotypes for most of the characters studied which can be exploited through selection to improve the crop for desired characters. Similar findings with Srivastava *et al.* (2017) who reported significant differences among the genotypes for days to 50% flowering, plant height, number of primary branches per plant, number of pods per plant, days to maturity, biological yield per plant, harvest index, and seed

yield per plant. Similar result was also supported by Zali *et al. (*2011) who reported highly significant differences among genotypes for all traits except number of pods per plant.

Chickpea seed yield for genotypes tested were ranged from 1.15 to 3.31t per ha, and the mean value was 2.28t per ha. Out of 66 tested chickpea genotypes about 51% genotypes were superior to the check variety however; the top three yielders genotypes were ICCV-11102, FLIP-03-155C and ICCX-060045-F3-P203-BP with grain yield t/ha of 3.31, 3.17 and 2.97, respectively. The highest number of pods per plant was recorded with Genotype ICCV-11115(125.2) and followed by ICCX060045-F3-P203-BP (111.47) and ICC-4958/EJERE-P2-20(106.33); while the lowest pods per plant was recorded with genotypes (FLIP-09-379C (39.00) and followed FLIP-09-125(40.27) and FLIP-09-357C(40.33).Thus implies that when we compare the genotypes with higher number of pods per plant with the genotypes with lower number of pods per plant the accession with higher number of pods per plant had high seed yielder than with lower. This indicates that Chickpea seed yield depends mainly on pod per plant. Similar result was reported by Babar *et al*. (2008) and they suggested that more pods per plant and bold seed size are major yield contributing factors in selecting high yielding chickpea cultivars. Chickpea Seed yield is a combination these and other traits that contributed to the higher chickpea seed and became is an advantage to harvest satisfactory seed yield. The similar result also reported by Kamla desai *et al*. (2015) and they suggested that yield a dependent character, is the resultant effect of a number of quantitative characters. Genotypes like, ICCV-11102, FLIP-03-155C and ICCX-060045-F3-P203-B are the most important in terms of seed yield production. This showed that the presence opportunity to improve chickpea traits and yield potential of the crop through selection and other breeding methods.

Data related to the mean performance of the quantitative traits of (table 2) shows the lowest days to 50% flower recorded for Genotype ICCV-060045-F3-P203-BP (33.00) and followed by ICCV-4958/EJERE-P6-19 (33.33) and FLIP-03-155C (39.33); while the highest days to maturity recorded for genotype FLIP-88-85C (110.00) and followed FLIP-09-360C (108.33) and FLIP-09-380C (107.67). It is assumed that among the studied genotypes (ICCV-060045-F3-P203-BP (33.00), ICCV-4958/EJERE-P6-19 (33.33)) were contained shorter days to 50% flowering in the experiment indicating the genotypes are earlier as compared to others chickpea genotypes, as its transition from vegetative to reproductive phase took only about a month, while its maturity happen less than three months.

Table 2. Mean square of chickpea genotypes for grain yield and other agronomic traits evaluated under irrigation at Werer Condition.

Source	DF	Mean Squares					
		DFF	DM	PPP	SPFP	PHT	SPP

Replication	2	26.20^{ns}	288.26**	3297.74**	0.13**	365.73**	4102.50**
Block(Rep)	15	91.92**	86.07**	557.94^{ns}	0.04**	180.94**	886.3^{ns}
Genotypes	65	179.36**	72.76**	1015.18**	0.04**	84.55**	1360.43 **
Error	115	0.29	25.31	353.78	0.02	11.04	680.31

Keys: ** = highly significant (P < 0.01), * = Significant (P < 0.05) and ns = Non-significant (P > 0.05). DF = Degree of freedom, DFF = Days of 50% flowering, DM = Days of 90% Maturity PPP = Number of Pod per plant, SPFP = Number of Seed per pod, PHT = Plant height, SPP = Number of total seed per plant.

Table 2 continued.

Source	Mean squares						
	DF	PB	SB	BM	HSW	GYD	HI
Replication	2	50.03**	0.672^{ns}	3.61**	5.48^{ns}	0.68^{ns}	0.13**
Block(Rep)	15	6.13**	23.62**	0.54**	38.03**	0.41^{ns}	0.02**
Genotypes	65	3.90*	58.36**	0.38**	71.20**	0.62**	0.02**
Error	115	2.49	5.63	0.23	3.18	0.29	0.01

Keys: PB = number of Primary Branches, SB = number of Secondary Branches, BM = Biomass ton per hectare, HSW = Hundred seed weight, GYD = yield ton per hectare, HI = Harvest

Mean Performances of Chickpea Genotypes

Range and mean values for 12 characters of 66 chickpea genotypes evaluated at Werer research center during 2017-18 off-seasons are presented in table 3. Out of the 66 genotypes, 34 genotypes (51%) were superior to the check for seed yield. Seed is an important component of chickpea yield. Seed yield of the genotypes were in the ranges of 1.15 to 3.31t per ha with the mean value of 2.28t per ha. Among these genotypes, ICCV-11102, FLIP-03-155C, ICCX-060045-F3-P203-BP, FLIP-09-241C,ICCV-11115, FLIP-07-4C, FLIP-09-380C, FUB-09-309, ICCX-060039-F3-P65-BP and FLIP-09-185C, respectively were the top ten genotypes at 5% selection intensity with mean grain yield of 2.7(FLIP-09-185C) to 3.3 t per ha (ICCV-11102) table 3. These top 10 genotypes showed 21 to 47% yield advantage over the check variety. On the other hand 79% of the genotypes were superior to the check for 100 seed weight (HSW).

Relating to phonological characters, days to 50% flowering ranged from 33.0 to 63.3 with mean of 53.5 whereas days to 90% maturity ranged from 83.67 to 110 with a mean of 101.40. The lowest days to 50% flower recorded for Genotype ICCV-060045-F3-P203-BP (33.00) and followed by ICCV-4958/EJERE-P6-19 (33.33) and FLIP-03-155C (39.33); while the highest days to maturity recorded for genotype FLIP-88-85C (110.00) and followed FLIP-09-360C (108.33) and FLIP-09-380C (107.67).

Mean performances of genotypes for the number of pod per plant, number of seed per pods and plant height (cm) varied from 39.00 to 125.20, 0.93 to 1.39, 46.55 to72.99 with averages of 62.81, 1.12 and 59.79 while for number of seed per plant, number of primary

branches and number of secondary branches the mean performances were in the ranges of 34.53 to 171.13, 5.07 to 11.35 and 5.60 to 26.50 with an average of 59.12, 7.55 and 12.45 respectively. Among the evaluated chickpea genotypes the highest number of pods per plant was recorded with genotype ICCV-11115(125.2) and followed by ICCX060045-F3-P203-BP (111.47) and ICC-4958/EJERE-P2-20(106.33); while the lowest pods per plant was recorded with genotypes (FLIP-09-379C (39.00) and followed FLIP-09-125(40.27) and FLIP-09-357C(40.33). And also among the tested chickpea genotypes, higher plant heights were recorded for FLIP-09-380C (72.99) followed by FLIP-09-185C (68.59) and FLIP-09-244C (68.15) respectively (Table 3). While minimum plant height was recorded for the genotypes ICCV-11106 (46.55-0 cm) followed by ICC-4958/EJERE-P2-20(48.47), ICCV-11115(48.07) and ICCX-060045-F3-P203-BP (47.46).

Table 2. Mean performances for 66 chickpea genotypes with the Mean values of twelve characters of chickpea genotypes under irrigation of Werer condition.

Genotypes	Characters					
	DFF	DM	PPP	SPFP	PHT	SPP
FLIP-09-371C	62	106.33	60.6	1.00	64.08	55.87
FLIP-08-42C	55	98.67	45.07	1.11	61.51	48.33
FLIP-09-376C	63	99	53.73	1.29	60.97	52.33
FLIP-09-50C	53.67	99	55.53	1.12	57.67	49.07
FLIP-93-93C	56	106	60	1.39	67.13	66.13
FLIP-09-161C	50.67	103	55	1.00	61.83	45.67
ICCV-11102	47.33	87.33	125.2	1.08	56.03	110.53
FLIP-03-128C	56	103.33	55.73	1.00	53.18	51.22
FLIP-09-277C	57.67	104.67	49.73	1.03	55.43	37.8
FLIP-03-155C	39.33	100.33	77.4	1.12	64.1	73.33
FLIP-09-134C	59	106	78.27	1.16	65.23	67.6
FLIP-09-188C	52.67	102.33	57.07	1.00	57.65	45.4
FLIP-03-101C	56.33	98	50.8	1.00	58.18	44.73
FLIP-07-26C	62.67	102	49.67	1.05	60.61	47.27
FLIP-09-184C	60.67	103.67	54.33	1.04	57.34	52.53
FLIP-09-179C	51.33	103.67	55.53	1.11	53.59	64.73
FLIP-09-187C	57	102	47.13	1.01	53.16	40.67
FLIP-09-146C	51.67	105.67	51.6	1.00	60.65	42
FLIP-09-359C	63	101	45.87	1.09	58.67	43.87
FLIP-09-171C	50	97.67	81.8	1.09	56.57	75.33
FLIP-09-174C	59	98.33	57.27	1.00	58.83	45.2
FLIP-09-126C	48.67	95	56.73	1.13	57.48	62.37
FLIP-09-438C	47.33	99	52.07	1.28	62.82	49.67
FLIP-09-244C	48	102.33	61	1.28	68.15	58.67
FLIP-09-347C	62	104.67	61.27	1.37	62.83	53.27
FLIP-03-40C	58.33	103.33	58	1.39	62.14	59.07
FLIP-09-339C	63.33	107	44.47	1.00	65.27	40.2
FLIP-09-162C	43.33	99.67	46.13	1.15	62.64	45.33
FLIP-09-241C	50.33	101.67	69.27	1.16	60.83	60.87
FLIP-09-18IC	49.67	102.67	52	1.12	64.73	42.4
FLIP-09-261C	56.67	100.33	69.4	1.00	58.57	57.53
FLIP-08-98C	50.33	97	62.33	1.07	57.89	60.8
FUB-09-309	56.67	100.33	49.8	1.00	56.93	42.93
FLIP-08-38C	52.33	103	64.32	1.13	56.35	54.8
ICCV-11106	47	104	82.07	1.35	46.55	94
FLIP-88-85C	62	110	52.87	1.08	57.57	53.6
FUB-07-4C	47	93	102.87	1.2	65.01	81.4

FLIP-09-114C	59.33	100.67	56.2	1.13	66.89	60.2
FLIP-08-53C	61.67	102.67	47.87	1.00	59.57	41.47
FLIP-05-157C	51.67	100	61.4	1.05	59.77	54.87
FLIP-09-189C	63.33	106.67	43.13	1.01	65.67	38.13
FLIP-09-348C	59.33	101.33	48.87	1.29	60.17	40.73
FLIP-05-19C	59	104	58.53	1.12	65.52	56.6
FLIP-09-185C	59.33	102.67	65.67	1.12	68.59	51.27
FLIP-09-157C	48.33	102.33	49.13	1.12	63.85	44.87

Table 3 continued

Genotypes	Characters					
	DFF	DM	PPP	SPFP	PHT	SPP
FLIP-09-354C	47.33	104.33	50.47	1.11	64.74	64
FLIP-09-360C	62.67	108.33	60.87	1.08	60.51	50.4
FLIP-09-379C	63.33	103	39	1.19	66.61	36.4
FLIP-08-41C	47.67	106	61.67	1.19	61.77	50.8
FLIP-09- 240C	47	99	64.2	1.15	58.19	63.53
FLIP-03-125	62	106.33	40.27	1.16	54.26	43.73
FLIP-09-6C	62.33	102.33	67.27	1.25	61.09	64.87
FLIP-09-343C	42.67	87.33	97.2	1.06	53.34	79.53
FLIP-09-233C	61.67	101.33	64.47	1.20	61.18	67.73
FLIP-09-380C	50	107.67	61.6	1.39	72.99	59.33
FLIP-09-140C	59.33	103	46	1.25	67.52	47.4
FLIP-09-393C	55	101.33	74.47	1.07	60.99	61.4
FLIP-09-357C	59	106.33	40.33	1.00	61.1	34.53
FLIP-09-120C	62.67	105	49.87	1.03	58.81	48.6
ICC-4958/EJERE-P6-19	33.33	107.33	81.33	1.08	55.17	77.2
ICCX-060045-F3-P203-BP	33	94.33	111.47	1.08	47.46	82.13
ICCV-11115	42.33	83.67	93.53	1.17	48.07	171.1
ICC-4958/EJERE-P2-20	45	99.33	106.33	1.13	48.47	95.13
ICCX-060039-F3-P65-BP	39.67	99.67	104.07	1.28	57.22	103.9
ICCV-09108	42.67	103.67	70	1.12	52.88	62.87
Habru variety(Check)	45.33	91.67	78.27	1.23	55.39	72.87
Mean	53.53	101.40	62.81	1.13	59.79	59.12
Min	33	83.67	39	1.00	46.55	34.53
Max	63.33	110.00	125.2	1.39	72.99	171.1
LSD	7.66	8.14	30.42	0.21	5.4	42.18
CV	8.85	4.96	29.95	11.41	5.56	44.12

Table 3. Continued

Genotypes	Characters					
	PB	SB	BM	HSW	HI	GYD
FLIP-09-371C	7.67	11.13	6.53	34.67	42.96	2.69
FLIP-08-42C	9	12.90	6.81	47.41	32.54	2.17
FLIP-09-376C	8.33	9.67	6.25	30.28	32.28	1.88
FLIP-09-50C	7.4	15.67	5.14	31.87	44.39	2.22
FLIP-93-93C	11.35	12.16	8.89	28.85	28.47	2.35
FLIP-09-161C	6.2	8.70	6.39	34.43	30.48	1.88
ICCV-11102	7.93	14.00	6.53	24.59	51.98	3.31
FLIP-03-128C	6.13	15.20	5.97	36.39	35.16	1.99
FLIP-09-277C	8.27	20.67	8.19	33.1	21.97	1.64
FLIP-03-155C	7.67	10.90	8.89	29.67	35.83	3.17
FLIP-09-134C	9.27	13.00	8.89	32.72	29.81	2.62
FLIP-09-188C	6.87	140.00	6.39	37.27	43.2	2.59
FLIP-03-101C	6.8	14.02	5.69	33.98	34.47	2
FLIP-07-26C	5.07	9.60	3.19	37.99	48.89	1.39
FLIP-09-184C	8.67	5.60	5.42	36.39	50.18	2.72
FLIP-09-179C	8.13	10.30	7.5	34.4	27.64	2.08
FLIP-09-187C	6.27	12.67	6.67	38.7	42.55	2.62
FLIP-09-146C	8.07	10.90	7.64	34.91	27.07	1.98
FLIP-09-359C	5.87	14.60	6.67	41.68	31.07	1.7
FLIP-09-171C	7.8	9.50	6.11	31.09	38.75	2.24
FLIP-09-174C	7.73	13.87	6.11	34.11	36.14	2.16
FLIP-09-126C	7.73	19.93	9.31	28.95	28.38	2.54
FLIP-09-438C	6.73	9.00	7.92	29.58	34.08	2.58
FLIP-09-244C	6.53	9.22	6.67	29.87	39.02	2.52
FLIP-09-347C	8.93	9.77	8.89	33.63	30.4	2.49
FLIP-03-40C	7	13.31	6.81	38.23	37.39	2.4
FLIP-09-339C	7.6	13.53	10.7	35.78	22.43	2.38
FLIP-09-162C	7.2	15.60	6.25	33.87	31.13	1.85
FLIP-09-241C	7.27	12.07	7.92	34.11	38.3	2.96
FLIP-09-18IC	6.8	8.96	8.19	29.16	29.32	2.36
FLIP-09-261C	10.27	17.84	5.97	34.77	38.83	2.21
FLIP-08-98C	7.67	18.56	6.11	33.44	46.71	2.61
FUB-09-309	6.53	14.07	7.36	34.32	39.36	2.75
FLIP-08-38C	8.8	7.90	8.61	47.23	33.28	2.66
ICCV-11106	7.87	8.90	4.86	24.46	37.2	1.75
FLIP-88-85C	8.33	18.24	7.92	30.65	21.81	1.74
FUB-07-4C	6.73	10.5	7.5	32.93	42.29	2.86
FLIP-09-114C	10.05	11.89	8.61	35.88	23.14	1.8
FLIP-08-53C	5.47	15.83	4.72	38.97	36.09	1.7
FLIP-05-157C	6.42	8.33	5.00	38.61	42.62	2.08
FLIP-09-189C	5.8	25.53	7.92	40.89	28.68	2.04
FLIP-09-348C	8.43	7.00	6.39	36.89	31.35	1.9
FLIP-05-19C	7.4	10.30	6.53	34.59	33.91	2.14
FLIP-09-185C	7.87	8.60	7.64	37.08	36.59	2.73
FLIP-09-157C	7.33	6.40	7.64	39.29	36.06	2.63

Table 3. Continued

Genotypes	Characters					
	PB	SB	BM	HSW	HI	GYD
FLIP-09-354C	6.53	8.87	5.42	31.6	43.93	2.37
FLIP-09-360C	6.4	10.77	8.61	35.22	30.44	2.57
FLIP-09-379C	8.27	10.64	8.61	35.16	28.71	2.33
FLIP-08-41C	8	14.2	6.53	37.56	24.74	1.45
FLIP-09- 240C	7.27	8.8	7.5	28.62	35.49	2.1
FLIP-03-125	7.27	6.5	3.61	34.98	39.08	1.15
FLIP-09-6C	7.4	22.5	8.06	35.82	21.3	1.72
FLIP-09-343C	7.73	17.93	6.25	35.7	38.61	2.3
FLIP-09-233C	9.4	26.5	8.61	28.13	35.67	2.71
FLIP-09-380C	5.8	7.73	10.3	29.39	28.12	2.77
FLIP-09-140C	6.8	8.1	6.81	37.13	27.3	1.83
FLIP-09-393C	7.53	10.43	6.94	34.16	36.52	2.5
FLIP-09-357C	7.07	15.78	5.69	31.78	31.62	1.66
FLIP-09-120C	8.73	12.07	6.11	36.84	27.88	1.66
ICC-4958/EJERE-P6-19	8.27	10.69	5.14	28.04	49.51	2.54
ICCX-060045-F3-P203-BP	7.93	11.27	5.56	26.52	53.84	2.97
ICCV-11115	7.53	16.9	5.42	24.21	54.53	2.96
ICC-4958/EJERE-P2-20	7.6	9.7	5.14	26.25	52.14	2.64
ICCX-060039-F3-P65-BP	7.33	6.8	6.11	24.69	46.18	2.74
ICCV-09108	6.33	9.5	5	25.59	43.13	2.14
Habru variety(Check)	7.6	14.6	6.39	29.26	35.71	2.25
Mean	7.55	12.43	6.86	33.55	35.89	2.28
Min	5.07	5.6	3.19	34.67	21.3	1.15
Max	11.35	26.5	10.7	47.41	54.53	3.31
LSD	2.55	3.84	3.23	2.88	0.87	0.14
CV	20.91	19.07	29.1	5.31	24.25	3.68

Conclusion

Results from analysis of variance showed highly significant differences for days to 50% flowering, days to 90% maturity, total number of pod per plant, number of seed per pod, plant height, total number of seed per plant, number of secondary branches, biomass, hundred seed weight, yield t per ha and harvest index. On the other hand genotypes exhibited significant differences for number of primary branches. This indicated the presence of variability among chickpea genotypes for most of the characters studied which can be exploited through selection to improve the crop for desired characters. Out of the 66 genotypes, 34 genotypes were superior to the check for seed yield. Seed is an important component of chickpea yield. Seed yield of the genotypes were in the ranges of 1.15 to 3.31t per ha with the mean value of 2.28t per ha. Among these genotypes, ICCV-11102, FLIP-03-155C, ICCX-060045-F3-P203-BP, FLIP-09-241C, ICCV-11115, FLIP-07-4C, FLIP-09-380C, FUB-09-309, ICCX-060039-

F3-P65-BP and FLIP-09-185C, were the top ten genotypes at 5% selection intensity with mean grain yield. ICCV-11102 and FLIP-03-155C was the best genotype in terms of seed yield under irrigable agriculture of Werer and hence, could be promoted for future breeding program.

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