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Performance Evaluation and Trait Relationship of Kabuli Chickpea Genotypes under Irrigation

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Abstract

The improvement of new genotype with better performance than exist cultivars is one of the point that required from crop breeding strategy. Eleven chickpea genotypes including with three cultivars were evaluated based on randamized complete block design with four replications with aim to identify genotypes that have high in grain yield performance under irrigation and that alliviate the food security challenges in the future breeding effort. Significat genotypes effect were observed for days to maturity, number of pod per plant, plant height, hundred seed weight, grain/seed yield and harvest index. This Indicates variation of genotype performances that shows hopeful for breeding program.The mean performance of seed yield for chickpea genotypes in this study indicated that out of eleven studied chickpea genotypes, four genotypes DZ-2012-CK-0074 (2.07t ha^{-1}), DZ-2012-CK-0196 (1.94t ha^{-1}), DZ-2012-CK-0202 (1753kg/ha) and DZ-2012-CK-0208 (1.69t ha^{-1}) had higher in seed yield than the standard checks (Habru, Ejere and DZ-10-4) and the grand mean (1.274t ha^{-1}) performance. In addition to this high number of pod per plant, hundred seed weight and harvest index must be considered in order to increase seed yield. Hence they had significant and positive correlated to seed yield performance.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops worldwide, being an excellent source of protein [1]. Chickpea is the third important food legume both in area and production after common beans and faba beans in Ethiopia [2]. Chickpea is a valued crop and provides nutritious food for an expanding world population and will become increasingly important with climate change. The nutritional value of chickpea in terms of nutrition and body health has been recently emphasized frequently by nutritionist in health and food area in many countries around the world. Chickpeas are a very important legume crop and have abundant protein, carbohydrate, lipid, fiber, isoflavone, and mineral contents [3]. There are two distinct types of chickpea (*Cicer arietinum* L.), called *desi* and kabuli, that differ in size, color and surface of seeds, flower color and morphology. Both these types are divergent geographically and

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broadly vary in their adaptation, nutrition, biotic and abiotic stress tolerance [4]. The Kabuli type is characterized by larger seed sizes that are smoother and generally light colored [5].

Currently the development of irrigation-based chickpea production is considered the most important alternative approach in combating climate change and maximizing productivity, especially in moisture-stress areas and in areas where water and land for irrigation is available. In Ethiopia, where production of chickpea (especially Kabuli type) is becoming an important part of agriculture, although many superior varieties (both desi and Kabuli types) are available, they have been evaluated and released based on rainfed production [6]. The cropping system of Afar region is predominantly mono crop type with cotton being the principal main season crops. After harvest of cotton the fields are left fallow till the next main season. Of-season offers a greater opportunity for growining chickpea due to following reason: available of cultivable land, availability of irrigation water during of season, the ability to chickpea withstand temperature [11].

Chickpea is a nutrition-rich, cropping-system friendly, climate-resilient, and low-cost production crop. It has large economic potential in the sub-Saharan Africa (SSA) region, where it currently accounts for only approximately half a million hectares of the approximately 12 million hectares of total chickpea production land worldwide [8]. The challenge of alleviating hunger and improving food and nutrition security for millions of farmers in sub-Saharan Africa (SSA) is a long-standing challenge for the research and development practitioners. The sustainable development goals (SDG), specifically SDG 2 commits to end hunger by 2030 [9]. Therefore, this research aim to identify genotypes that have high in grain yield performance under irrigation and that alliviate the food security challenges in the future breeding effort.

Materials and Methods

Experimental Site

The experiment was conducted at Worer during 2018 cropping season. Worer which is found in Afar regional state with an altitude of 740 masl and at latitude of 9°60'N and 40°09'E Longitude. The dominant soil type of the study area is Chromic vertisol with particle size distribution of sand 3.83%, silt 61.1% and clay 35.07%. The pH of the soil slightly alkaline range fom 7.5 to 8.5. The average annual temperature ranges from 19°C-34°C with average rainfall 540mm.

Experimental Design and Trial management: The expriment was laid out in randamize complete blocks design with four replications. The experimental plot was 4m x 1.20m (4 raws per plot). Inter and intra row spacing of 30cm x 10cm were used. Each plot was planted with two seeds per hill and thinned to one plant two weeks after seed emerged. Agronomic practices such the land tillage was prepared by tracter three times, irrigation were supplied by furrow irragation system and two hand weeding were applied to the crop during experiment.

Experimental Materials

Eleven Chickpea genotypes were planted and Evaluated at Worer Agricultural Research Center with three standard checks; which was obtained from Debre Zeit Agricultural Research Center in Table 1.

Table 1: Experimental materials used in the study at Werer.

Genotype code	Genotypes Name	Source	Chickpea type	Status
1	DZ-2012-CK-0083	DZARC	Kabuli	NVT
2	DZ-2012-CK-0196	DZARC	Kabuli	NVT
3	DZ-2012-CK-0202	DZARC	Kabuli	NVT
4	DZ-2012-CK-0254	DZARC	Kabuli	NVT
5	DZ-2012-CK-0074	DZARC	Kabuli	NVT
6	DZ-2012-CK-0209	DZARC	Kabuli	NVT
7	DZ-2012-CK-0255	DZARC	Kabuli	NVT
8	DZ-2012-CK-0256	DZARC	Kabuli	NVT
9	DZ-2012-CK-0212	DZARC	Kabuli	NVT
10	DZ-2012-CK-0208	DZARC	Kabuli	NVT
11	DZ-2012-CK-0257	DZARC	Kabuli	NVT
12	HABRU	DZARC	Kabuli	NVT
13	EJERE	DZARC	Kabuli	NVT
14	DZ-10-4	DZARC	Kabuli	NVT

Data Collected

Stand Count (SCT): were recorded on plot based two weeks after emergence inorder to check the establishing the number of plants in a plot and comparing it with the expected crop numbers, whereas plant population records only numbers. It allows to determine germination rate, and plant health. They are based on visual inspection and plant calculation on plot/on small pre-defined field areas.

Days to 50% flowering (DFF): Days that was taken to reach 50% flowering was recorded by counting the days it takes to flower from sowing date.

Days to Physiological Maturity (DPM): This was the day when above 90% of the pods in the plot matured, and it was recorded as the time of maturity for each plot.

Number of Pods Per Plant (NPPP): Taking five plants as a sample from a plot, numbers of pods per plants were counted and the mean average numbers of pods were computed and taken as representative of the plot, specifically genotype.

Grain yield per plot (GY): Grain yield per plot was measured in order to know the exact weight of yield per plots.

Hundred Seed Weight (HSW): Hundred seed weight was conducted by weighing randomly selected 100 seed. It is directly/positively correlated with seed size, i.e, the higher the weight of hundred seeds, the larger the size of individual seeds of that genotype. This is necessary to know the plants died and unable to reach for harvesting due to adverse effects of environment at 12% moisture content.

Plant height (PH): Plant height was measured immediately after plants stop growing (when the plants on the plot showing 80% maturity).

Biomass (BM): Biomass is surely necessary to compute Harvest Index of the crop plant through taking a weight of above ground vegetative plant parts with seeds and without seeds.

Harvest Index (HI): This harvest index was computed by dividing weight of actual yield (seed yield) for total biomass weight and multiply it with 100, where, HI = (Seed Yield /Biomass Yield * 100).

Data Analysis

Data Analysis was performed by SAS Software Version 9.00 [10] (2002). Dancun's multiple range test (DMRT) were at P≤ 0.05 was used to separated means. Pearson's correlation coefficients (P≤ 0.05) was used to determine the correlation among the measured traits.

Table 2: Analysis of variance of chickpea genotypes under irrigated for nine agronomic traits.

		Mean Square of the Traits								
Source of variation	**Degree of freedom**	**SCT**	**DFF**	**DPM**	**NPPP**	**PH**	**HSW**	**BM**	**GY**	**HI**
Treatment	13	66.38ns	387.12**	22.14**	783.58**	68.21**	282.6**	504.41	111.2**	497.78**
Replication	03	296.4	30.97619	34.45	864.64278	110.61	2.86	771	2.710952	6.77
Error	**39**	55.9	51.2	126.0	229.8	23.9	12.9	308.6	6.6	283.07

Table 3: Mean Performance Evaluation of Kabuli chickpea Genotypes under irrigated.

		Trraits								
Genotypic Code	**Genotypes**	**SCT**	**DFF**	**DPM**	**NPPP**	**PH**	**HSW**	**BM**	**GY**	**HI(%)**
1	DZ-2012-CK-0083	32	49	99	44.25	36.75	30.25	58.33	810	16.57
2	DZ-2012-CK-0196	32	33	91	61.00	29.65	35.63	45.83	1938	51.01
3	DZ-2012-CK-0202	28	38	93	54.60	31.40	35.90	45.85	1753	38.84
4	DZ-2012-CK-0254	25	58	89	33.93	35.40	22.28	56.25	1078	21.02
5	DZ-2012-CK-0074	30	38	103	37.35	28.70	39.05	49.98	2065	42.81
6	DZ-2012-CK-0209	37	44	71	36.00	35.75	33.15	47.93	1468	30.91
7	DZ-2012-CK-0255	37	54	85	39.10	41.15	23.68	39.58	593	18.20
8	DZ-2012-CK-0256	27	61	97	45.75	39.30	33.35	66.65	780	12.48
9	DZ-2012-CK-0212	31	47	99	33.40	42.75	29.58	56.25	643	13.59
10	DZ-2012-CK-0208	32	40	90	51.95	28.35	32.88	37.50	1685	48.24
11	DZ-2012-CK-0257	33	68	98	32.35	38.03	17.43	56.25	503	10.55
12	HABRU	33	52	95	53.61	33.35	23.75	68.75	1650	24.04
13	EJERE	37	46	98	75.65	46.50	22.55	64.60	16.00	26.28
14	DZ-10-4	30	53	92	75.43	35.94	8.53	31.25	1268	59.25
Mean		32	49	93	48.17	35.93	27.71	51.78	1274	29.56
LSD		11.65	10.24	16.06	21.68	6.99	5.14	25.13	3.67	24.06
CV		25.73	14.75	12.09	31.47	13.61	12.96	33.93	20.15	56.92

Result and Discussion

The results of Analysis Of Variance(ANOVA) showed that there were significant diffirences at(P≤ 0.01) in the gonotypes for all traits that is for days to fifty flowering(%), number of pod per plant, plant height, hundred seed weight, grain yield and harvex index. except for Stand count (SCT) and biomass (BM). The result similar with the findings of [11]. Who reports on significant reports at (≤ 0.05) days to 90% maturity, number of pod per plant, plant height, hundred seed weight, yield ton per ha and harvest index. Except for biomass. Also [12] reported Similar result for seed yield/ha, 100seed weight, harvest index, plant height. Except biomass in Table 2.

Range and mean performance

The mean values for the 14 kabuli Chickpea genotyoes studied at Worer are presented in Table 3.

The mean performance of seed yield for chickpea genotypes in this study indicated that out of fourteen studied chickpea genotypes the highest seed yield was recorded by DZ-2012-CK-0074 (2.065t ha^{-1}) genotype, followed by DZ-2012-CK-0196 (194t ha^{-1}), DZ-2012-CK-0202 (1.75t ha^{-1}) and DZ-2012-CK-0208 (1685kg/ha) genotype. These four genotypes also higher in seed yield than standard checks (Habru, Ejere and DZ-10-4) and grand mean (1.27t ha^{-1}). Therefore this result indicate the potentiality of kabuli chickpea genotypes under irrigation that perform more than national productity (1682kg/ha) as shown in the Table 3.

The maximum number of pod per plant was recorded for Ejere (75.65) genotype and followed by DZ-10-4 (75.43), DZ-10-4, DZ-2012-CK-0196 (61.00) and DZ-2012-CK-0202 (54.60). whereas the lower number of pod per plant was recorded for genotype DZ-2012-CK-0257(32.35) and DZ-2012-CK-0212(33.40) with average mean of 27.71. This variation number of pod per plant indicate that the presece of difference potentaial of plant pod holding capacity that may interest trait to plant breeder to improve chickpea seed yield.

As it shown that in the table 3 of mean performance; the lowest days to maturity was recorded by DZ-2012-CK-0209 genotype. It takes 71days after sowing to matury. Comparing with the late muture genotype it takes to mature before one month than the late maturity genotype. So such genotype was economically important and must be selected for lowland area of Afar region.

The minimum number of plant height was recorded for DZ-2012-CK-0196 (29.65cm) while, the lowest was recorded by

EJERE (46.75cm) genotype with average mean 35.93 cm. The muximum number of biomass weight was recorded by HABRU (68.75g) genotype followed by DZ-2012-CK-0256 (66.65g) and EJERE (64.60g) genotypes. While the minimum number of weight was recorded for genotype DZ-10-4 (31.25g) and DZ-2012-CK-0208 (37.50g). The maximum harvest index was recorded by DZ-10-4(59.25g) genotypes whereas, the lowest harvest index was recorded by DZ-2012-CK-0257 (10.55%) genotype in the Table 3.

Trait Relationship

The results of correlation analysis of yield and yield components and between yield is presented in table 4. Correlation coefficient analysis for seed yield under irrigated conditions indicated that seed yield is significant and positive correlated with harvest index, number of pod per plant and hundred seed weight in the table 4. The result is similar the findings of [13] and [14]. This indicate that traits my serve as effective selection criterial for chickpea seed yield improement. But in this study days to flowering, biomass and plant height significant and negative correlated with seed yield this obtained result was similar with findings of [15].

Hundred seed weight significant and negative correlated with days to flowering but none significant and negative correlated to days to maturity, to number of pod perplant and to plant height. Harvest index significant and positive low correlated to handred seed weight, however, none significant and low negative correlated to scand count, days to flowering, days to maturity. Above ground biomass significant and positive correlated to scand count but none significant and positive low correlated with days to flowering, days to maturity, plant height, number of pod per plant and hundred seed weight.

Table 4: Correlation coefficients for Nine Characters of Kabuli chickpea Genotypes in the Study.

Traits	SCT	DFF	DPM	NPPP	PH	HSW	BM	GY
SCT								
DFF	-0.2076							
DNM	-0.209	0.1928						
NPPP	0.0843	-0.185	0.1276					
PH	0.1938	0.3088*	-0.349**	0.0506				
HSW	0.0521	-0.5075**	-0.0064	-0.2037	-0.294*			
BM	0.3789	0.0509	0.210	0.191	0.284*	0.1416*		
GY	0.0319	-0.580**	0.072	0.3728*	-0.2004	0.4764**	-0.291*	
HI	-0.1298	-0.6376**	-0.2209**	-0.1532	0.3768**	0.513**	-0.6215	0.817**

Conclusion

Significant genotype effect were observed for days to flowering, number of pod per plant, plant height, hundred seed weight, grain/seed yield and harvest index. These significant difference in ndicates that variation of genotypes performance on potential of seed yield and its components, that could be hopeful selection for interested traits.

Out of eleven studied chickpea genotypes, four genotypes DZ-2012-CK-0074 (2.067t ha^{-1}), DZ-2012-CK-0196 (1.94t ha^{-1}), DZ-2012-CK-0202 (1.75t ha^{-1}) and DZ-2012-CK-0208 (1.69t ha^{-1}) had higher in seed yield than the standard checks (Habru, Ejere and DZ-10-4) and the grand mean (1.27t ha^{-1}) performance. These indicates that there is high potential genotypes that have hopeful response under the irrigation condition and may support as parental line for further breeding strategy.

In addition to this high number of pod per plant, hundred seed weight and harvest index must be considered in order to increase seed yield. Hence they had significant and positive correlated to seed yield performance.

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