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Research Article

Productiveness of Various Quantitative Traits of Chickpea (*Cicer arietinum* L) Genotypes under Tando Jam Climatic Conditions

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ABSTRACT

Chickpea, pulse crop which is important and cultivated on about 18 Million hectares worldwide. It also has a critical diet component for large populations of semiarid tropical climates and is one of the most beneficial crops for the farming system's sustainable productivity. Chickpea originates from a fairly narrow center of origin, Mediterranean Middle East Anatolia, although they enjoy large variations from their wild ancestors. The current research was conducted at Tandojam climatic conditions in 2019 to evaluate the chickpea genotype's performance regarding yield, and its related traits using RCBD (randomized complete block design) within three replications. Heritability and correlation were studied in this experiment to evaluate the genotypic yield performance. Seed index and seed plot-1 exhibited significant results with p<0.01 and p< 0.05 probability level, while yield kg ha-1 revealed non-significant. DG-89 exhibited maximum seed index, seed plot-1, and seed yield kg ha-1 (25.00), (760.00), and (10556). Correlation, between yield kg ha-1 and yield character, revealed a significant relationship with each other respectively. Heritability estimates observed high heritability (h2-99.82). Hence, it is concluded that genotype DG-89 performed the best among other genotypes for yield and its related characteristics.

Keywords: Chickpea, Yield kg ha-1, Correlation, Heritability.

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INTRODUCTION

Chickpea, scientifically known as (Cicer arietinum L)., is a member of the Cicereae tribe within the Fabaceae family, specifically belonging to the Papilionaceae subfamily (Singh and Diwakar, 2018). Chickpea (Cicer arietinum L.), is a temperate self-pollinated legume crop that originated from southeastern Turkey. It is an annual species with a diploid genome size of 738 Mb and chromosomal number 2n = 2x = 16. Chickpea (Cicer arietinum L.), encompassing the desi and kabuli varieties, is a beloved pulse crop globally. Its cultivation spans over fifty countries, from the Indian subcontinent and southern Europe to the Middle East. This ancient pulse crop is one of the world's most vital legume crops (Ladizinsky, 2017). Desi and Kabuli represent two widely cultivated chickpea cultivars worldwide. Morphologically distinct, Desi (microsperma) is characterized by its pink flowers and a seed coat that is both colored and notably thick. Conversely, Kabuli (macrosperma) features white flowers and seeds that are either white or beige, bearing a distinct ram's head shape, a thin seed coat, and a seed surface that is smooth to the touch (Moreno and Cubero, 2020). Globally, chickpea cultivation spans over 13.2 million hectares, with an annual yield of 13.1 million tons, yet its productivity remains below 1 ton per hectare, despite having the potential to reach 6 tons per hectare (Murty et al., 2010).

The primary challenges to chickpea production encompass both biotic (such as *Helicoverpa*, *Bruchus*, *Aphidoidea*, and *Ascochyta*) and abiotic (including drought, heat, salt, and cold) stresses, leading to a 10% decrease in yield (Kumar et al., 2018). However, to boost chickpea productivity, it is imperative to tackle these biotic and abiotic stresses (Roorkiwal et al., 2020). Consequently, chickpea breeders worldwide are concentrating on developing cultivars with multiple resistances to both biotic and abiotic factors (Seyedimoradi et al., 2020). Additionally, advanced chickpea genotypes with exceptional yield have been developed through the integration of genes offering resistance to drought, cold, salinity, fungi, and pod borers (Li et al., 2015). A range of strategies including, traditional breeding methods, molecular breeding, and modern plant breeding techniques are being employed to address these challenges (Kumar et al., 2018). High yield is the main aim of crop breeders involved in crop improvement programmes. A better insight into yield's association with its component traits can help improve the chickpea yield. The nutritional value of chickpeas is enriching in high content of vitamins (Gupta et al., 2021), minerals viz., calcium, magnesium, phosphorus, and potassium, and important amino acids, including lysine, methionine, threonine, valine, and leucine, along with ß-carotene, (Jukanti et al., 2012; Thudi et al., 2014).

Chickpea productivity is reduced by an array of abiotic factors i.e., drought, heat, excessive salt, and cold (Asati et al., 2022), and biotic factors including *Ascochyta* blight, Fusarium wilt, and *Helicoverpa armigra* (Sahu et al., 2020). Any crop development program's effectiveness largely depends on a selection that is further influenced by the presence and frequency of genetic heritability in the population of a particular crop species (Tripathi et al., 2022). The environment has a major impact on seed productivity, a major polygenic trait (Singh et al., 2014). Assessing major characteristics and their interrelatedness is important in developing selection criteria for improving existing genotypes. The correlation coefficient is a method for identifying the important characteristics influencing the dependent characteristics, such as seed yield, and they assist in developing the selection criteria for simultaneously improving several characteristics and economic values.

MATERIALS AND METHODS

The experiment was conducted at Tandojam climatic condition, in 2019 to evaluate heritability and correlation analysis in quantitative traits in chickpea varieties grown in a Randomized Complete Block Design (RCBD) within three replications.

Experimental details:

The experiment was done on six rows in different locations. The distance between rows was six feet, and the length of each row was five feet. The distance between plants*plants was three inches. Sanyas, Cholla, DG-89, DG-92, C-612, DG-111, Sathiryo, and Rabat these eight varieties were collected from different institutes that had been used for breeding purposes.

Eight characters were selected days to flowering 90%, days to maturity 90%, plant height (cm), number of pods plant^{-1}, number of branches plant^{-1}, seed index (100 grains wt. g), yield plot^{-1} (g), and yield hectare^{-1} (kg) mainly purpose was to check the performance of different varieties to adaptation in saline soil and in water stress area.

Statistical analysis

Data was statistically analyzed using analysis of variance (ANOVA) according to Gomez (1984), correlation coefficients were determined following the procedures of Raghavrao (1983), and heritability in a broad sense was estimated as suggested by Gardener (1961).

RESULTS

To investigate the heritability and correlation analyses in quantitative traits of chickpea (*Cicer arietinum* L.) genotypes, the studies were demonstrated at Tandojam climatic condition, in 2019. The mean squares drawn from the analysis of variance for the traits days to flowering 90%, days to maturity 90%, plant height (cm), number of pods plant^{-1}, number of branches plant^{-1}, seed index (100 grains wt. g), yield plot^{-1} (g) and yield ha^{-1} (kg) values are presented in Table 1 and 2. The mean performance of chickpea genotypes regarding growth and yield parameters are presented in Tables 3 and 4. Moreover, the results for correlation coefficients (r) and heritability and regression analysis for the various traits are presented in Tables 5 and 6.

The mean squares is regarding to chickpea grain yield and its contributing traits of various genotypes (Tables 1 and 2) showed that all the genotypes differed significantly (P<0.05) from each other.

Growth and yield performance of tested genotypes

The related days to flowering 90% are presented in Table 3 showing that genotype Sathiryo surpassed all the tested genotypes and produced maximum days to flowering 90% (74.00), followed by C-612 (85.00), DG-89 and DG-92 (95.66), 73111 (96.00), Rabat (97.00) and Cholla (98.33);. In comparison, Sanyas displayed the lowest days to flowering 90% (98.66).

Table 1. Mean squares from analysis of variances for days to flowering 90%, days to maturity 90%, plant height (cm), and number of pods $plant^{-1}$.

Source of Variation	DF	Days to flowering 90%	Days to maturity 90%	Plant height (cm)	Number of pods $plant^{-1}$
Replications	2	0.542	14.292	0.2917	15.2917
Genotypes	7	224.185**	173.333**	55.6190**	50.4524^{NS}
Error	14	0.685	9.530	0.3869	1.1488

** = Significant at 1% probability level.

Table 2. Mean squares from analysis of variances for the number of branches plant-1, seed index (100 grains wt. g), yield plot-1 (g), and yield ha-1 (kg).

Source of Variation	DF	Number of branches $plant^{-1}$	Seed index (100 grains wt. g)	Yield $plot^{-1}$ (g)	Yield ha^{-1} (kg)
Replications	2	0.29167	26.3317	1189.1	179071
Genotypes	7	0.42262**	25.8781**	85927.2**	1.6657^{NS}
Error	14	0.10119	19.7317	146.6	29965.1

** = Significant at 1% probability level.

Table 3. Performance of chickpea genotypes for days to flowering 90%, days to maturity 90%, plant height (cm), and number of pods plant-1.

Genotypes	Days to flowering 90%	Days to maturity 90%	Plant height (cm)	Number of pods $plant^{-1}$
Sanyas	98.66	144.00	60.00	33.33
Cholla	98.33	145.00	61.66	35.33
DG-89	95.66	141.00	59.33	42.33
DG-92	95.66	141.33	60.00	44.33
C-612	85.00	124.00	48.33	33.33
73111	96.00	143.33	61.33	35.00
Sathiryo	74.00	129.67	58.33	35.66
Rabat	97.00	141.00	60.33	37.33
S.E.±	1.4489	5.4060	1.0893	1.8770
LSD 0.05	0.6755	2.5206	0.5079	0.8751

The related days to maturity of 90% are presented in Table 3 showing that genotype C-612 surpassed all the tested genotypes and produced maximum days to maturity of 90% (124.00), followed by Sathiryo (129.67), DG-89, and Rabat (141.00), DG-92 (141.33), 73111 (143.33) and Sanyas (144.00);. In comparison, Cholla displayed the lowest days to maturity 90% (145.00). The related plant height (cm) presented in Table 3 shows that genotype Cholla surpassed all the tested genotypes and produced plants of maximum height (61.66 cm) followed by 73111 (61.33 cm), Rabat (60.33 cm), DG-92 (60.00 cm), Sanyas (60.00 cm), DG-89 (59.33 cm) and Sathiryo (58.33 cm); In comparison, C-612 displayed lowest plant height (48.33 cm). The significant ($P<0.05$) maximum number of pods $plant^{-1}$ was observed in genotype DG-92 (44.33), followed by DG-89 (42.33), Rabat (37.33), Sathiryo (35.66), 73111 (35.00), Cholla (35.33) and Sanyas (33.33); In comparison, the minimum number of pods $plant^{-1}$ (33.33) was noted in C-612. DG-92 was at par with the other tested genotype, producing 3.66 number of branches $plant^{-1}$ ($P<0.05$), followed by genotypes Rabat (3.00), Sanyas (3.00), Cholla (3.00), DG-89 (3.00), 73111 (3.00) and C-612 (2.66); In comparison, Sathiryo resulted in lowest number of branches $plant^{-1}$ (2.33). Genotype 73111significantly ($P<0.01$)

surpassed other commercial lines with the highest seed index (25.33 g), followed by Sanyas (25.00 g), DG-89 (25.00 g), PC- Cholla (25.00 g), DG-92 (24.33 g), Sathiryo (22.33 g) and C-612 (20.33 g); In comparison, the lowest seed index (17.20 g) was produced by the genotype Rabat. Genotype DG-89 significantly (P<0.01) surpassed other commercial lines with maximum yield plot^{-1} (760.00 g), followed by DG-92 (667.33 g), Cholla (649.33 g), Rabat (621.67 g), Sanyas (600.00 g), 73111 (591.00 g) and Sathiryo (313.33 g), In comparison, the lowest yield plot^{-1} (288.33 g) was produced by the genotype C-612. The significant (P<0.05) maximum yield ha^{-1} was observed in genotype DG-89 (10556 kg ha^{-1}), followed by DG-92 (9269 kg ha^{-1}), Cholla (9019 kg ha^{-1}), Rabat (8727 kg ha^{-1}), Sanyas (8333 kg ha^{-1}), 73111 (8208 kg ha^{-1}) and Sathiryo (4352 kg ha^{-1}); In comparison, the minimum number of pods plant^{-1} (4005 kg ha^{-1}) was noted in C-612.

Table 4. Performance of chickpea genotypes for number of branches plant-1, seed index (100 grains wt. g), yield plot-1 (g), and yield ha-1 (kg).

Genotypes	Number of branches plant-1	Seed index (100 grains wt. g)	Yield plot-1 (g)	Yield ha-1 (kg)
Sanyas	3.00	25.00	600.00	8333
Cholla	3.00	25.00	649.33	9019
DG-89	3.00	25.00	760.00	10556
DG-92	3.66	24.33	667.33	9269
C-612	2.66	20.33	288.33	4005
73111	3.00	25.33	591.00	8208
Sathiryo	2.33	22.33	313.33	4352
Rabat	3.00	17.20	621.67	8727
S.E.±	0.5571	7.7789	21.207	303.14
LSD 0.05	0.2597	3.6269	9.8877	141.34

Table 5. Correlation (r) coefficients among various traits in chickpea cultivars.

Character	Number of branches plant^{-1}	Days to flowering 90%	Days to maturity 90%	Plant height (cm)	Number of pods plant^{-1}	Seed index (100 grains wt. g)	Yield ha^{-1} (kg)
Days to flowering 90%	0.5484**						
Days to maturity 90%	0.4925*	0.7844**					
Plant height (cm)	0.3313NS	0.5002*	0.8318**				
Number of pods plant-^{1}	0.4061*	0.1999 NS	0.3111 NS	0.2909 NS			
Seed index (100 grains)	0.1604NS	0.1378 NS	0.2986 NS	0.2586 NS	0.2030 NS		
Yield plot-1 (g)	0.5899**	0.8468**	0.8316**	0.7142**	0.5381**	0.2264 NS	
Yield hectare-1 (kg)	0.5904**	0.8461**	0.8314**	0.7137**	0.5366**	0.2257 NS	0.9997**

Correlation (r) coefficients among various traits in chickpea cultivars

The number of branches plant^{-1} had a positive and significant correlation with days to flowering 90% (r=0.5484**), days to maturity 90% (r=0.4925*), number of pods plant^{-1} (r=0.4061*), yield plot^{-1} (r=0.5899**) and yield hectare^{-1} (r=0.5904**). These traits are positive and non-significant, Correlated with plant height (r=0.3313^{NS}) and seed index (r=0.1604^{NS}). The days to flowering 90% had positive and significant correlation with days to maturity 90% (r=0.7844**), plant height (r=0.5002*), yield plot^{-1} (r=0.8468**), and yield hectare^{-1} (r=0.8461**). These traits are positive and non-significant, Correlated with the number of pods plant^{-1} (r=0.1999^{NS}) and seed index (r=0.1378^{NS}). The days to maturity 90% had a positive and significant correlation with plant height (r=0.8318**), yield plot^{-1} (r=0.8316**), and yield hectare^{-1} (r=0.8314**). These traits are positive and non-significant, Correlated with the number of pods plant^{-1} (r=0.3111^{NS}) and seed index (r=0.2986^{NS}). The plant height had a positive, and significant correlation with yield plot^{-1} (r=0.7142**) and yield hectare^{-1} (r=0.7137**). These traits are positive and non-significant, Correlated with the number of pods plant^{-1} (r=0.2909^{NS}) and seed index (r=0.2586^{NS}). The number of pods plant^{-1} had a positive and significant correlation with yield plot^{-1} (r=0.5381**) and yield hectare^{-1} (r=0.5366**). These traits are positive and non-significant correlated with the seed index (r=0.2030^{NS}). The seed index had a positive and non-significant correlation with yield plot^{-1} (r=0.2264^{NS}) and yield hectare^{-1} (r=0.2257^{NS}). The yield ha^{-1} had a positive and significant correlation with yield ha^{-1} (r=0.9997**).

Regression coefficient

The heritability estimate for days to flowering is 90% (99.69 %), days to maturity 90% (94.50%), plant height (99.30%), number of pods plant^{-1} (97.72%), number of branches plant^{-1} (76.05%), seed index (23.75%), yield plot^{-1} (99.82%), and yield hectare^{-1} (-111.104%).

Table 6. Heritability estimate in broad sense (h2%b.s) for various traits in upland chickpea genotypes.

Traits	Phenotypic variance	Genotypic variance	Heritability
Days to flowering 90%	223.5	224.18	99.69
Days to maturity 90%	163.80	173.33	94.50
Plant height (cm)	55.23	55.619	99.30
Number of pods plant-1	49.30	50.45	97.72
Number of branches plant-1	0.32	0.422	76.05
Seed index (100 grains wt. g)	6.14	25.87	23.75
Yield plot-1 (g)	85780.6	85927.2	99.82
Yield hectare-1 (kg)	-29963.4	26968.76	-111.104

DISCUSSION

Based on the overall mean performance of genotypes, though DG-89 and DG-92 performed well for a couple of traits none of the genotypes were superior for all the traits simultaneously. (HAMDI et al., 2003) also reported that seed yield was positively and significantly correlated with pod numbers, and harvest index and negatively with flowering duration. A high positive, Correlation between the number of pods per plant and the seed yield may be attributed to the increased sink strength (Diaz Carrasco et al., 1985; Nakaseko, 2015) also suggested that yield could be raised by selecting for earliness, tallness, and more pods per plant, which is evident in the present study. Amongst the yield-contributing characters, plant height showed a positive and significant correlation with biomass, indicating that increased plant height is associated with more production of biomasses. The number of pods per plant exhibited a significant positive association with plant height. Days to 50% flowering reveal a significant correlation with all the traits except harvest index at genotypic levels. Likewise, days to 50% flowering revealed a significant correlation with the number of pods per plant. A positive, Significant association was noted between days taken to flowering and 100-seed weight. A significant and positive association has been reported between days to flowering and grain yield per plant (Yadav et al., 2015). A positive and significant association occurred between the days to maturity with most of the traits except the number of seeds per pod and 100-seed weight with which there was a significant negative correlation. Grains per plant have been reported to be positively and significantly correlated with days to maturity (Atta et al., 2008). Plant height showed a positive, Correlation with seed yield, number of pods per plant, and seeds per pod. A positive correlation of plant height with seed yield has also been reported by (Kumar et al., 2018). Biomass had a significant correlation with plant height at genotypic levels as similarly reported by (Luthra and Sharma, 1990). The highest significance of days to flowering, days to maturity, number of pods per plant, number of seeds per pod, stand count at harvest, plant height, and biomass showed that any improvement of these traits may result in the increment of seed yield. Similarly, (Zerfu et al., 2021) revealed that the range for PCV was 3.96% days to maturity to 30.1% for biological yield, and the GCV ranged from 1.24% for days of maturity to 28.153% for biological yield. Heritability estimates vary as a small value recorded for days to maturity (9.74%), and a high value recorded for hundred seed weight per plant (96.52%). Hundred seed weight, biological yield, plant height, grain yield, and harvest index have high heritability and highest expected genetic advance. Most of the characters studied show high heritability estimates indicating the possibility of improving these traits through selection. Grain yield showed positive and highly significant association with biological yield, number of pods, number of the primary branches, hundred seed weight, and days to maturity. (Nawaz et al., 2018) reported that line C2-P7-1-1 showed maximum mean value for days to 90% maturity (123.7), seed pod-1 (1.9), and harvest index (27.7%), whereas, line C2-P8-2-5 exhibited maximum mean value for plant height (68.3 cm), primary branches plant^{-1} (3.8) and biological yield (2010.6 kg hectare^{-1}). Maximum pods plant^{-1} (28.8), was attained by line C2- P8-3-1, whereas, maximum secondary branch plant^{-1} (8.8) was noted for C2-P8-3-4. Moreover, C2-P7-1-8 exhibited maximum mean value for 100 grains wt (25.9 g) and grain yield (463.8 kg hectare^{-1}). The heritability estimates for days to 90% maturity (15.46), plant height (5.98), primary branches plant^{-1} (0.60), secondary branches plant^{-1} (1.67), pods plant^{-1} (5.81), seed pod^{-1} (0.24). 100 grains wt (3.17), grains yield (209.58), biological yield (598.45), and harvest index (7.00). (Arshad et al., 2004). The positive association between grain yield and yield attribute is also in accord with an earlier study on character association in chickpeas by (Arshad et al., 2004). Correlation indicated that the number of branches plant^{-1}, days to flowering 90%, days to maturity 90%, plant height (cm), number of pods plant^{-1}, seed index (100 grains wt. g), and yield ha^{-1} (kg) had significant and positive exhibited effects. In contrast, (Singh et al., 1995) reported high direct effects of biological yield, pods per plant, and 100-seed weight with supplemental irrigation as opposed to this study conducted under rainfed conditions that is subject to terminal drought challenges. (Talebi et al., 2007) reported a negative direct effect of days to maturity in agreement with the present study.

CONCLUSION

It was concluded that genotype DG-89 showed more promising performance with maximum yield ha^{-1} than the rest of the tested genotypes. Yield kg ha^{-1} and other contributed traits showed better performance in the genotype DG-89 among all the genotypes upon trail performance.

AUTHOR CONTRIBUTIONS

Conceived and designed the experiments: Babar Ali & Nazia Nahiyoon, Performed the experiments: Babar Ali, Aziz Jan Baloch, & Tariq majodano, Analyzed the data: Babar Ali & Nawab Jan Baloch, contributed materials/ analysis/ tools: Rashid Ali Khokhar, Wrote the paper: Babar Ali.

COMPETING OF INTEREST

The authors declare no competing interests.

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