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Genetic Diversity and Traits Association in Parental and F_3 Populations of Chickpea

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ABSTRACT

Genetic diversity is an indicator for a plant breeder to proceed further. Five chickpea populations, i.e. three parental and two F_3 populations (NDC-4-20-4, ICC-19181, NDC-5-S10, ICC-19181 x NDC-4-20-4, ICC-19181 x NDC-5-S-10) were evaluated for variability and interrelationship at Malakandher research farm, The University of Agriculture Peshawar during chickpea growing season 2011-12. Analysis of variance revealed promising differences (P≤0.01) among populations for pods plant^{-1}, secondary branches plant^{-1}, seed yield plant^{-1}, days to flowering, harvest index, biological yield plant^{-1} and days to maturity. Furthermore, significant differences were shown for plant height, primary branches plant^{-1} and seed yield kg ha^{-1}. F_3 population of C_1 revealed maximum values for pod plant^{-1}, secondary branches plant^{-1} (14.87), seed yield plant^{-1} (19.66 g), biological yield plant^{-1} (36.91g) and harvest index (52.78 g). Whereas population of C_2 showed maximum values for days to flowering (141.33) and primary branches plant^{-1} (5.00). On the other hand, ICC-19181 showed minimum values for days to flowering (132), plant height (32.90 cm) and seed yield plant^{-1} (14.13 g). Correlation analysis showed highly significant and positive association of grain yield plant^{-1} with pods plant^{-1}, secondary branches plant^{-1}, biological yield plant^{-1} and harvest index while significant correlation with days to flowering, days to maturity whereas non-significant correlation was revealed for plant height and primary branches plant^{-1}. This study suggests that pods plant^{-1}, secondary branches plant^{-1}, seed yield plant^{-1}, biological yield plant^{-1} and harvest index are the key component in grain yield. C_1 (ICC-19181 x NDC-4-20-4) population can be used in future chickpea breeding programs for higher yield.

Keywords: Chickpea, diversity, F_3 populations, parental, traits

INTRODUCTION

Genetic variation among traits is important for breeding and in selecting desirable genotypes. On the other hand, an analysis of the correlation between seed yield and yield components is essential in determining selection criteria. Chickpea (*Cicer arietinum* L.) ranks third among the world's pulse crops after dry bean and dry peas. It belongs to family Fabaccae and sub family Faboidae. The genus *Cicer* L. (family Fabaceae) consists of 44 species including 35 perennials, 8 wild species and one domesticated chickpea. Chickpea is an edible legume and is high in proteins and is one of the earliest cultivated grain legumes. Chickpea is the cheapest and readily available source of proteins 22%, 64% carbohydrates, 5% fats, 6% crude fiber and 3% ash (Sattar *et al*., 1990). It makes up the deficiency of cereals diets and also helps in the replenishment of soil fertility by fixing atmospheric nitrogen through symbiosis. Chickpea is playing a vital role in providing food for the poor people of this country. It is generally cultivated under rainfed agriculture system. The introduction of chickpea in a cereal-based rotation, which is used particularly in developing countries, can break the disease and pest cycle, and thus increase the productivity of the entire rotation (Jodha and Subba Rao, 1987). Correlation is one of the most common and most useful statistics which is a single number that describes the degree of relationship between two variables. It is a statistical technique that can show whether and how strongly pairs of variables are related to each other (Biabani *et al.*, 2011). The information on correlations among various economic traits provides the basis of selection and synthesis of improved cultivars. Genetic variability is a measure of the tendency of individual genotypes in a population to vary from one another. Variability is different from genetic diversity, which is the amount of variation seen in a particular population. The variability of a trait describes how much that trait tends to vary in response to environmental and genetic influences. Genetic variability in a population is important for biodiversity, because without variability, it becomes difficult for a population to adapt to environmental changes and therefore makes it more prone to extinction. Genetic variability and correlation is very important for breeding programs, therefore this study was conducted to evaluate the genetic variability in parental and F3 populations of chickpea and asses correlation between different traits of chickpea populations.

MATERIALS AND METHODS

Sample Preparation

A field study was conducted at the research farm of The University of Agriculture, Peshawar (latitude 34.02^0, longitude 71.47^0, altitude 364 m) during chickpea growing season 2011-2012. The experimental material including five chickpea populations (3 parental and two F3 populations i.e. NDC-4-20-4, ICC-19181, NDC-5-S-10 and ICC-19181 x NDC-4-20-4, ICC-19181 x NDC-5-S-10 respectively, were evaluated in a randomized complete block (RCB) design using three replications. Row to row and plant-to-plant spacing was 30 and 10 cm, respectively. Standard cultural practices were followed throughout the growing season. Data was recorded on ten randomly selected plants in parents and 60 randomly selected plants in F_3 populations for each of the following parameters.

Statistical Analysis

Data was analyzed using MSTATC software and MS-Excel. Correlation was computed according to the protocol of Steel and Torrie (1980).

RESULTS AND DISCUSSION

Days to Flowering

Analysis of variance for days to flowering revealed highly significant differences ($P \leq 0.01$) among chickpea populations. Data ranged from 132.66 to 141.33 with the coefficient of variation 0.98%, maximum days to flowering were observed for population of ICC-19181 x NDC-5-S-10 (141.33) while minimum value was observed for population of ICC-19181 (131.66) (Table-2). Saleem *et al*. (2002) and Noor *et al*. (2003) also reported high genetic variance for days to flowering. In chickpea, minimum days to flowering are desirable and thus parental population (ICC-19181) took minimum days to flowering (132.33 days). The correlation coefficient of days to flowering was positive and significant with days to maturity, biological yield plant^{-1}, seed yield (kg ha^{-1}) and significantly negatively correlated with pod plant^{-1}, secondary branches plant^{-1}, seed yield plant^{-1} and harvest index. Non-significant correlation was recorded for plant height and primary branches plant^{-1} (Table-3).

Table1. *Mean square values for different traits of chickpea populations during 2011-12.*

S.O.V	df	DM	DF	PH	PBP^{-1}	SBP^{-1}	PP^{-1}	BYP^{-1}	SYP^{-1}	HI
Replication	2	0.80	2.07	1.201	1.13	7.70	14.59	11.46	2.26	1.40
Genotype	4	159.33**	55.27**	90.017*	1.11*	24.04**	2093.41*	125.24**	48.32**	34.69**
Error	8	0.63	0.066	15.447	0.29	2.20	36.37	3.53	0.94	4.4

***=Highly significant, *=Significant [DM = Days to maturity, DF = Days to flowering, PH = Plant height, PBP^{-1} = Primary branches plant^{-1}, SBP^{-1} = Secondary branches plant^{-1}, PP^{-1} = Pods plant^{-1}, BYP^{-1} = Biological yield plant^{-1}, SYP^{-1} = Seed yield plant^{-1} and HI = Harvest index.]*

Table2. *Mean performance for days to flowering, days to maturity, plant height, pods plant^{-1}, primary branches plant^{-1}, secondary branches plant^{-1}, seed yield plant^{-1}, biological yield plant^{-1} and harvest index.*

Traits	Genotypes						
	NDC-4-20-4	ICC-19181	NDC-5-S-10	C1	C	CV	LSD
Days to flowering	133.67	132.33	141.00	134.33	141.33	0.98	
Days to maturity	197.00	198.33	214.66	201.67	198.33	0.39	
Plant height (cm)	45.80	32.90	45.33	41.87	45.47	9.20	
Pod plant-1	95.67	70.87	40.87	100.00	50.00	8.43	

Primary branches/Plant	4.63	4.23	3.53	4.40	5.20	12.27	0.58
Secondary branches/Plant	13.67	10.33	7.67	14.87	11.40	12..79	1.61
Seed yield plant^{-1}(g)	17.58	14.13	9.66	19.46	11.88	6.6	1.05
Biological yield plant^{-1}(g)	34.78	27.50	21.30	36.91	25.86	6.40	2.04
Harvest index (%)	50.53	51.48	45.23	52.78	45.93	4.2	2.

Table3. *Correlation coefficients for days to flowering (DF), days to maturity (DM), plant height (PH), pods plant^{-1} (PP^{-1}), primary branches plant^{-1} (PBP^{-1}), secondary branches plant^{-1} (SBP^{-1}), biological yield plant^{-1}, seed yield plant^{-1}, harvest index (HI) and seed yield (SY) (kg ha^{-1}).*

Traits	DF	DM	PH	PP^{-1}	PBP^{-1}	SBP^{-1}	BYP^{-1}	SYP^{-1}	HI	SY
DF	-	0.53*	0.49	-0.78**	0.09	-0.46*	0.66**	-0.73*	-0.31*	0.81**
DM		-	0.243	0.30*	-0.59**	-0.57*	-0.55*	-0.55*	-0.49*	0.45
PH			-	-0.10	0.06	0.033	0.004	-0.08	0.39	0.49*
PP^{-1}				-	0.22	0.80**	0.95**	0.95**	0.74*	-0.18
PBP^{-1}					-	0.31	0.24	0.18	0.009	0.93
SBP^{-1}						-	0.92**	0.87**	0.49*	0.03
BYP^{-1}							-	0.98**	0.68*	-0.05
SYP^{-1}								-	0.80**	-0.14
HI									-	0.24*
SY										-

***=Highly significant, *=Significant*

Days to Maturity

The data regarding, days to maturity manifested meaningful differences among populations. Data ranged from 197.00 to 214.66 with the coefficient of variation 0.39 %, maximum days to maturity were taken by NDC-5-S-10 (214.66), while minimum days were taken by NDC-4-20-4 (197.00) (Table-2). Noor *et al.* (2003) and Saleem *et al.* (2002) reported high significant differences for days to maturity. In chickpea, minimum days to maturity are desirable which is shown by population of NDC-4-20-4 i.e. 197.00 days. The association of said trait was positive and significant with pods plant^{-1} while negative significantly correlated with primary branches plant^{-1}, secondary branches plant^{-1}, biological yield plant^{-1} and harvest index (Table-3), while non-significantly correlated with the rest of the parameters studied. Atta *et al.* (2008) reported highly significant positive correlation of days to maturity with grain yield plant^{-1}.

Plant Height (cm)

The data regarding, plant height showed significant differences ($P \leq 0.05$) for chickpea populations. The mean value ranged from 32.90 to 45.80 with the coefficient of variation 9.20%, maximum plant height was observed for NDC-4-20-4 (45.80 cm) while minimum value was observed for ICC-19181 (32.90 cm) (Table-2). Akhtar *et al.* (2011) also reported highly significant differences among chickpea population for plant height. Plant with shorter stem are desirable in chickpea, the population of ICC-19181 showed minimum plant height in the populations studied. Plant height revealed positive and significant correlation with seed yield, while negative and non-significant correlation is observed with pods plant^{-1} and seed yield plant^{-1} (Table-3). Akhtar *et al.* (2011) reported significant and positive correlation between plant height and yield, 100-seed weight and number of pods plant^{-1}. Cel *et al.* (2005) also reported positive and significant relationship between plant height, grain yield plant^{-1} and secondary branches plant^{-1}. Khan *et al.* (1983) reported that plant height was positively correlated with yield.

Number of Pods Plant^{-1}

Statistical analysis of pods plant^{-1} showed highly significant differences ($P \leq 0.01$) among chickpea populations. Data ranged from 40.87 to 100 with the coefficient of variation 8.43%, maximum number of pods plant^{-1} was observed in (ICC-19181 x NDC-4-20-4) (100.00), while minimum number of pods plant^{-1} was observed in NDC-5-S-10 (40.87) (Table-2). Malik *et al.* (2010), Saleem *et al.* (2002), Ali *et al.* (2002), Thakur and Anil (2008) and Akhtar *el al.* (2011) also reported significant differences among genotypes for number of pods plant^{-1}. Maximum number of pods plant^{-1} gave more seed yield, in the populations studied, the population of C_1 showed maximum number of pods plant^{-1}. Number of pods plant^{-1} showed positive and highly significant correlation with secondary branches plant^{-1}, biological yield plant^{-1} and seed yield plant^{-1} whereas positive and significant correlation were recorded for harvest index while non-significant correlation were shown for primary branches plant^{-1} and seed yield (Table-2). Malik *et al.* (1983). Ali *et al.* (2010), Akhtar *et al.* (2011), Saleem *et al.* (2002), Noor *et al.* (2003), Khan *et al.* (1983) and Atta *et al.* (2008) reported that number of pods plant^{-1} was positively significantly correlated with yield and other traits.

Primary Branches Plant^{-1}

Analysis of variance presented significant differences among populations for primary branches plant^{-1}. Primary branches plant^{-1} were varied from 3.53 to 5.20 with the coefficient of variation 12.27%, maximum primary branches plant^{-1} were observed for ICC-19181 x NDC-5-S-10 (5.20), while minimum values were observed for NDC-5-S-10 (3.53) (Table-2). Primary branches plant^{-1} showed positive and non- significant correlation with secondary branches plant^{-1}, biological yield plant^{-1}, seed yield plant^{-1}, seed yield (kg ha^{-1}) and harvest index (Table-3). Khan *et al.* (1983) and Atta *et al.* (2008) reported positive and significant correlation of primary branches plant^{-1} with yield.

Secondary Branches Plant^{-1}

The analysis of variance for branches plant^{-1} disclosed highly significant differences ($P \leq 0.01$) among the populations. Data ranged from 7.67 to 14.87 with the coefficient of variation 12.79%, maximum secondary branches plant^{-1} were observed for (ICC-19181 x NDC-4-20-4) (14.87), while minimum values were observed for NDC-5-S-10 (7.67) (Table-2). Malik *et al.* (2010), Saleem *el al.* (2002) and Noor *et al.* (2003) also reported significant differences among genotypes for secondary branches plant^{-1}. In chickpea, the plant having more secondary branches gives higher yield and in the populations studied, C_1 (ICC-19181 x NDC-4-20-4) showed maximum secondary branches plant^{-1}. Secondary branches plant^{-1} revealed positive and highly significant correlation with biological yield plant^{-1}, seed yield plant^{-1} and pod plant^{-1} whereas significant correlation were recorded for harvest index, days to flowering and days to maturity while non-significant correlation were shown for plant height, primary branches plant^{-1} and seed yield kg ha^{-1} (Table-3).

Biological Yield Plant^{-1} (g)

The analysis of data for biological yield plant^{-1} revealed highly significant differences ($P \leq 0.01$) among populations. Data ranged from 21.30 to 36.91g with the coefficient of variation 6.4%, maximum biological yield plant^{-1} was observed for (ICC-19181 x NDC-4-20-4) (36.91 g) while minimum values were observed for (NDC4-20-4) (21.30 g) (Table-2). Malik et al. (2010), Thakiir and Anil (2008) also reported highly significant differences among genotypes. Biological yield plant^{-1} showed positive and highly significant correlation with days to flowering, pods plant^{-1}, secondary branches plant^{-1} and seed yield plant^{-1} and positive significant correlation with harvest index whereas negatively significant correlation were shown with days to maturity. While non-significant correlations were recorded for plant height, seed primary branches plant^{-1} and seed yield kg ha^{-1}.

Seed Yield Plant^{-1} (g)

The mean square data for seed yield plant^{-1} showed highly significant differences ($P \leq 0.01$) among populations. Data ranged from 9.66 to 19.66 g with the coefficient of variation 6.6%, maximum seed yield plant^{-1} was observed in population of ICC-19181 x NDC-4-20-4 (19.66 g), while minimum seed yield plant^{-1} was observed for NDC-5-S-10 (9.66 g) (Table-2). Saleem *et al* (2002). Ali *et al* (2002) and Thakur and Anil (2008) reported highly substantial variation among genotypes for grain yield plant. Highly significant positive correlation of seed yield plant^{-1} was observed with harvest index, secondary branches plant^{-1}, pods plant^{-1} and biological yield plant^{-1} and negative significantly correlated with days to maturity and days to flowering whereas non-significantly correlation was noted with plant height and seed yield kg ha^{-1}. Thakur and Anil (2008), Ali et al. (2010), Akhtar et al. (2011), Cel et al. (2005), Saleem el al. (2002), Khan et al. (1983) and Atta et al. (2008) also reported that grain yield plant^{-1} was positively correlated with yield and other traits.

Harvest Index (%)

The analysis of data showed highly significant differences ($P \leq 0.01$) among populations. Data ranged from 45.23 to 52.78% with the coefficient of variation 4.28%, maximum harvest index was observed for (ICC19181 x NDC-4-20-4) (52.78%), while minimum harvest index was observed for NDC4-20-4 (45.23%) (Table-2). Malik et al. (2010) also reported maximum variation among genotypes for harvest index. Harvest index showed positive and highly significant correlation seed yield plant^{-1} and significant correlation were recorded with pod plant^{-1}, secondary branches plant^{-1}, biological yield plant^{-1} and seed yield kg ha^{-1} while non-significant correlation was shown with plant height and primary branches plant^{-1}.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

All populations studied differ significantly for most of the traits. ICC-19181 showed minimum days to flowering and days to maturity. While population of C_1 (ICC-19181 x NDC-4-20-4) showed maximum value for most the yield contributing traits and has higher yield than other populations of chickpea studied. Seed yield plant^{-1} showed positive and highly significant correlation with harvest index, secondary branches plant^{-1}, pods plant^{-1} and biological yield plant^{-1} while negative and significant correlation were shown for days to maturity and days to flowering whereas non-significant correlation was recorded for plant height, primary branches plant^{-1} and seed yield (kg ha^{-1}).

Recommendations

On the basis of conclusions given above the following recommendations can be made:

ICC-19181 took less days for flower initiation and has shorter plant height which is desirable in chickpea breeding. Therefore, it is recommended for these traits and should be used in further breeding programs. The population of C_1 (ICC-19181 x NDC-4-20-4) showed better results for yield contributing traits which is one of the goal of plant breeder, so it is recommended that the population of C_1 (ICC-19181 x NDC-4-20-4) should be used in future breeding programmes to obtain good yield. Seed yield plant^{-1} showed positive and significant correlation with harvest index, secondary branches plant^{-1}, pods plant^{-1} and biological yield plant^{-1}. So, these traits should be considered during chickpea breeding.

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