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Variability and Character Association for Yield and Quantitative Traits under Late Sown Conditions in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

Background: Among all the pulses, chickpea is the most important *rabi* crop with high acceptability and wider use in India. More availability of quality seed of improved varieties being made available to the famers is one of the most important factors contributing to better harvest of chickpea in recent years. Therefore, there is urgent need for developing high yielding varieties of chickpea employing sound and effective breeding strategies. The study of variability, correlation and path coefficient analysis for seed yield with other yield contributing characters is of immense importance to get information regarding exercising selections for genetic improvement in chickpea.

Methods: A total of 40 genotypes of chickpea were undertaken for present study and these genotypes evaluated in randomized block design (RBD) with three replications at Rajasthan Agricultural Research Institute (SKNAU), Jaipur Rajasthan, India under late sown conditions during *rabi* 2019-20. The experimental unit was four row plots of 4 m long and spacing between row to row was kept to 30 cm and plant to plant was 10 cm. The genetic parameters *viz*., mean GCV, PCV, broad sense heritability, genetic advance (GA), correlation coefficient and path analysis were estimated.

Result: Genotypes revealed significant wide genetic variation for almost all the quantitative traits. Number of pods plant^{-1} exhibited highest PCV and GCV. The highest broad sense heritability (h_2b) was recorded for days to maturity followed by days to 50% flowering and 100-seed weight. The 100-seed weight, number of pods plant^{-1}, number of seeds pod^{-1} and primary branches plant^{-1} had positive genotypic correlation with grain yield. Path coefficient analysis depicted that among the 9 causal (independent) traits; number of seeds pod^{-1}, number of pods plant^{-1}, number of primary branches plant^{-1}, plant height from ground to first pod (cm) and days to 50 % flowering had positive and directly influence on grain yield. Therefore these traits can be taken into consideration while exercising selection for grain yield in chickpea.

Key words: Chickpea, Correlation coefficient, GCV, Path-analysis, PCV.

INTRODUCTION

Among the food crops, pulses are an important group which occupies a unique position in the world of agriculture by virtue of their high protein content. Pulses occupy a key position in Indian diet and meet about 30 per cent of the daily protein requirement (Singh, 2019). Among all pulse crops, gram gave highest production of 11.23 Mt from an area of 10.56 Mha (Dharbale *et al*., 2019). India is the largest chickpea producing country (72.0%) in the world followed by Australia (6.0%), Turkey and USA (4.0%). It also covered highest area under cultivation (73.0%) followed by Australia (7.0%) and Pakistan (6.0%) (FAOSTAT, 2019). In India, chickpea is usually grown throughout the country covering North Hill (dry and cool), North East Hills (wet and mild hot), North West plains (wet and cool), North East plains (humid/ wet and cool) and Central and Southern part (dry and hot) of India. Due to expansion of irrigated area for wheat cultivation in some of the states like Punjab, Haryana, Uttar Pradesh and Bihar have lost area of chickpea which is compensated by other states like Madhya Pradesh, Andhra Pradesh, Maharashtra, Karnataka (Arya *et al*., 2019). Among all the pulses, chickpea is the most important *rabi* crop with high acceptability and wider use in India. More availability of quality seed of improved varieties being made available to the famers is most important contributing factor to better harvest of chickpea in recent years. Therefore, there is an urgent need for developing high yielding varieties of chickpea employing sound and effective breeding strategies. The study of variability, correlation and path coefficient analysis of grain yield with other yield contributing characters is of immense importance to get information regarding exercising selection for genetic improvement in chickpea. Studies on character association are useful to the breeder in identifying the suitable genotypes for utilizations in

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breeding programme. The present study was undertaken to determine the variability and character association with respect to yield and its components in chickpea.

MATERIALS AND METHODS

A total of 40 genotypes of chickpea were undertaken for present study collected from different centers of All India Coordinated Improvement Project of Chickpea. The present study was conducted in randomized block design (RBD) with three replications at Rajasthan Agricultural Research Institute (SKNAU), Durgapura, Jaipur, Rajasthan, India, during *rabi* 2019-20. The genotypes were sown in first week of December under late sown conditions. The experimental unit was four row plots of 4 m length with keeping the row to row spacing of 30 cm and plant to plant spacing of 10 cm. Uniform dose of 20 kg N and 40 kg P_2O_5/ha through urea and SSP was drilled at the time of sowing. The data were recorded from 5 randomly selected plants for each genotype. The considered traits are days to 50% flowering, total plant height (cm), height from ground to first pod (cm), days to maturity, number of primary branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, 100-seed weight (g) and grain yield kg ha^{-1}. The genetic parameters *viz*., mean, genotypic variance, phenotypic variance, broad sense heritability and genetic advance (GA) were estimated by applying formula followed by Burton and Devane (1953). Further, genotypic and phenotypic correlation coefficient for the undertaken traits were calculated as per the method of Al-Jibouri *et al.* (1958). Path analysis was done as per method given by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Significant genetic variation was observed for almost all the quantitative traits among the given 40 genotypes of chickpea under late sown conditions (Table 1). Higher value of phenotypic variance than genotypic variance for the given traits was recorded. The genetic constants for the characters revealed that the magnitude of phenotypic coefficient of variation (PCV) was higher than the corresponding genotypic coefficient of variation (GCV) for all the traits denoting environmental factors influencing their expression to some degree or other (Table 2). Highest PCV was recorded by number of pods plant^{-1} (26.705%) followed by 100-seed weight (23.95%) and number of seeds pod^{-1} (19.46%) given in Table 2. Highest GCV (23.59%) value was noted for 100-seed weight followed by number of pods plant^{-1} (22.94%) and plant height from ground to first pod (18.07%). While the lowest GCV and PCV (7.44 and 7.46%) were noted for days to maturity. Similarly a good deal of genetic variability for different yield and yield traits was reported by various scientists (Jeena *et al*., 2005; Ali *et al*., 2011; Jha *et al*., 2015; Gul *et al*., 2013). Wide differences between PCV and GCV implied their susceptibility to environmental fluctuation, whereas narrow differences between PCV and GCV suggested their relative resistance to environmental alterations. The estimate of GCV and PCV alone is not much helpful in determining the heritable portion. The amount of advance to be expected from selection can be achieved by estimating heritability along with coefficient of variability. Burton (1952) also suggested that GCV and heritability estimates would gave better information about the efficiency of selection. The heritability in broad sense was observed to be medium to high 45.84 to 99.52 per cent for all the traits which had significant differences among the accessions. Highest broad sense heritability (h^2b) was recorded for days to maturity (99.52%) followed by days to 50% flowering (99.19%), 100-seed weight (97.02%) number of seeds pod^{-1} (79.96%), plant height from ground to first pod (75.85%) and number of pods plant^{-1} (73.80%). The high degree of heritability estimates for most of the traits suggested that the characters are under genotypic control. While, the value of genetic advance (GA) calculated in this study ranged from 0.37% to 229.07% having highest for grain yield kg ha^{-1} (229.07%) followed by number of pods plant^{-1} (25.11%). Likewise, the present study high variability parameters for pods/ plant and grain yield were reported by Jha *et al*. (2015). High heritability coupled with high genetic advance and GCV were noticed for grain yield, number of pods plant^{-1} and 100-seed weight. From the study of heritability and genetic advance it is inferred that simple selection among germplasm accessions can bring about significant improvement in these traits as the heritability and estimated genetic advance were high. The present studies are akin with Vaghela *et al*. (2015) and Yucel (2020).

The genotypic and phenotypic correlation coefficients worked out among different characters revealed that in general the genotypic correlation coefficient were similar to phenotypic correlation coefficient (Table 3). In some cases the genotypic correlation was slightly higher than the phenotypic correlation coefficients, which may be a result

Table 1: Analysis of variance for yield and other quantitative characters in chickpea under late sown conditions.

Source of variation	DF	Grain yield	Days to 50% flowering	Days to maturity	Plant height	Plant height from ground to first pod	Number of primary branches plant^{-1}	Number of pods plant^{-1}	Number of seed pod^{-1}	100-seed weight
Replication	2	26,842.25	0.25	1.51	25.35	11.05	0.01	174.31	0.10	11.85
Treatment	39	77,211.51**	162.08**	210.68**	194.03**	96.60**	0.29*	675.83**	0.33**	78.99**
Error	78	14,462.89	0.43	0.33	27.16	9.26	0.08	71.49	0.03	0.79
SE		98.19	0.54	0.47	4.25	2.48	0.23	6.90	0.13	0.73

**Significant at 1% level; *Significant at 5% level.

of modifying effect of environments on the association of the characters. The grain yield showed significant positive correlation with 100-seed weight and number of pods plant^{-1}. In addition, its association with number of seeds pod^{-1} and primary branches plant^{-1} was positive but non-significant both at genotypic and phenotypic levels. The 100-seed weight had positive and significant correlation with days to 50% flowering, plant height, plant height from ground to first pod, number of primary branches plant^{-1}, number of pods plant^{-1}. The number of seeds pod^{-1} showed significant positive correlation with days to maturity, plant height, plant height from ground to first pod and number of pods plant^{-1}. The days to 50 % flowering showed significant positive correlation with days to maturity, plant height, plant height from ground to first pod, number of pods plant^{-1} and number of seed pod^{-1}. The associations of grain yield with other quantitative traits observed in the present study have also been reported in chickpea by earlier researchers (Meena and Kumar 2012; Jha *et al.* 2012; Gul *et al.* 2013; Paneliya *et al.* 2017). Present results indicating that these traits had good association with seed yield in chickpea and therefore, was important trait for bringing genetic improvement in seed yield. Johanson *et al.* (1955) emphasized that these correlated yield attributes can serve as indicator characters for improving grain yield. Breeders can also concentrate their attention either on number of branches plant^{-1} or number of

Table 2: Variability parameters for grain yield and other quantitative characters under late sown conditions in chickpea.

Variability parameters	Grain yield	Days to 50% flowering	Days to maturity	Plant height	Plant height from ground to first pod	Number of primary branches plant^{-1}	Number of pods plant^{-1}	Number of seeds pod^{-1}	100-seed weight
Mean	947.408	66.208	112.49	57.196	29.846	2.238	61.858	1.821	21.642
Variance	25737.0	54.024	70.228	64.667	32.204	0.098	225.279	0.109	26.296
SD	160.429	7.35	8.38	8.042	12.32	0.313	15.009	0.33	5.128
Range	600.00	48.33	92.33	41.17	5.675	2.00	31.00	1.00	15.20-
	-1366.67	-82.67	-130.33	-79.83	-19.17	-3.00	-95.83	-2.00	36.99
Heritability (broad sense) (%)	59.12	99.19	99.52	67.19	75.85	45.84	73.80	79.96	97.02
Genotypic coefficient of variation	15.26	11.08	7.44	13.04	18.07	11.85	22.94	17.40	23.59
Phenotypic coefficient of variation	19.85	11.13	7.46	15.91	20.75	17.51	26.70	19.46	23.95
Genetic advance	229.07	15.06	17.21	12.59	9.68	0.37	25.11	0.58	10.36
Expected genetic advance % of mean	24.17	22.74	15.29	22.01	32.43	16.54	40.60	32.06	47.87

Table 3: Phenotypic correlation coefficient values between different characters under late sown conditions in chickpea.

Characters		Grain yield	Days to 50% flowering	Days to maturity	Plant height	Plant height from ground to first pod	Number of primary branches plant^{-1}	Number of pods plant^{-1}	Number of seeds pod^{-1}
Days to 50% flowering	r_g	-0.264**							
	r_p	-0.193*							
Days to maturity	r_g	-0.382**	0.737**						
	r_p	-0.298**	0.731**						
Plant height	r_g	-0.111^{NS}	0.197*	0.154^{NS}					
	r_p	0.023^{NS}	0.158^{NS}	0.127^{NS}					
Plant height from ground to first pod	r_g	-0.131^{NS}	0.450**	0.289**	0.767**				
	r_p	-0.067^{NS}	0.386**	0.249**	0.662**				
Number of primary branches plant^{-1}	r_g	0.047^{NS}	-0.093^{NS}	0.117^{NS}	0.128^{NS}	-0.023^{NS}			
	r_p	0.094^{NS}	-0.057^{NS}	0.080^{NS}	0.098^{NS}	0.001^{NS}			
Number of pods plant^{-1}	r_g	0.262**	0.260**	0.316**	-0.050^{NS}	-0.051^{NS}	-0.051^{NS}		
	r_p	0.255**	0.226*	0.276**	-0.059^{NS}	-0.074^{NS}	-0.047^{NS}		
Number of seeds pod^{-1}	r_g	0.043^{NS}	0.227*	0.258**	0.222*	0.138^{NS}	-0.152^{NS}	0.229*	
	r_p	0.058^{NS}	0.208*	0.230*	0.149^{NS}	0.076^{NS}	-0.104^{NS}	0.180*	
100-seed weight	r_g	0.324**	-0.111^{NS}	-0.245**	0.241**	0.230*	0.180*	-0.188*	-0.425**
	r_p	0.228*	-0.111^{NS}	-0.239**	0.209*	0.199*	0.115^{NS}	-0.158^{NS}	-0.374**

**Significant at 1% level; *Significant at 5% level.

Table 4: Direct (diagonal) and indirect (non diagonal) effects of different characters on grain yield under late sown conditions in chickpea.

Characters	Days to 50% flowering	Days to maturity	Plant height	Plant height from ground to first pod	Number of primary branches plant^{-1}	Number of pods plant^{-1}	Number of seeds pod^{-1}	100-seed weight
Days to 50% flowering	**0.03985**	-0.23293	-0.05888	-0.00002	-0.00941	-0.05134	0.09900	-0.05039
Days to maturity	0.02937	**-0.31608**	-0.04615	-0.00001	0.01178	-0.06243	0.11230	-0.11088
Plant height	0.00785	-0.04878	**-0.29906**	-0.00004	0.01295	0.00977	0.09671	0.10912
Plant height from ground to first pod	0.01794	-0.09150	-0.22950	**-0.00005**	-0.00233	0.01001	0.05990	0.10410
Number of primary branches plant^{-1}	-0.00371	-0.03685	-0.03832	0.00000	**0.10108**	0.00998	-0.06612	0.08144
Number of pods plant^{-1}	0.01037	-0.10001	0.01481	0.00000	-0.00511	**0.19731**	0.09993	-0.08509
Number of seeds pod^{-1}	0.00906	-0.08150	-0.06641	-0.00001	-0.01535	-0.04527	**0.43550**	-0.19276
100-seed weight	-0.00443	0.07735	-0.07203	-0.00001	0.01817	0.03706	-0.18528	**0.45306**

Residual are 0.63425.

pods plant^{-1} to achieve higher seed yield while selection of individual plant in segregating materials of chickpea. Vaghela *et al*. (2009) and Meena and Kumar (2012) also reported the similar results for fixed homozygous material. Correlation co-efficient indicates only the general associations between any two traits without tracing any possible causes of such associations. In such situations, the path coefficient analysis at phenotypic level is done to partition the correlation coefficients in to direct and indirect effects (Table 4). Grain yield was taken as dependent variable while computing the path coefficient. The path coefficient analysis revealed that the characters like 100-seed weight (0.45306) followed by number of seeds pod^{-1} (0.43550), number of pods plant^{-1} (0.19731) and number of primary branches plant^{-1} (0.10108) which had positive significant association with grain yield also exerted positive and high direct effects on grain yield (Table 4). The positive and high direct effects of 100-seed weight, number of seeds pod^{-1}, number of pods plant^{-1} and number of primary branches plant^{-1} on grain yield was also observed by earlier workers in chickpea (Thakur and Sirohi 2009; Shafique *et al*. 2016; Mohammed and Fikre 2018). This confirms the role of these traits in determining the grain yield and therefore, their values in constructing the selection criterion.

CONCLUSION

Thus, the conclusion that can be reached from the variability, correlations and path coefficient is that, number of pods plant^{-1}, number of seeds pod^{-1} and 100-seed weight are the most important component traits and these traits can be taken into consideration while exercising selection for seed yield in chickpea.

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