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Dissection of Genetic Variability and Character Association to their Implication in Selection for Yield Improvement in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

Forty two genotypes of chickpea were evaluated in timely planting condition during *rabi* 2020-2021. The analysis of variance characterized that the highly significant alterations were reported among the genotypes for all the studied traits in timely planting. The traits seed yield per plant, height of first fruiting node, number of effective pods per plant, biological yield and 100 seed weight had high GCV%, high heritability with genetic advance as percentage of mean and positive and direct effect on seed yield per plant in under timely sown condition. These traits are highly responsible for increasing the seed yield so must be included in selection criteria for yield enhancement of chickpea advance breeding lines under timely planting. The promising lines gives higher seed yield per plant are ICC 191606 (29.45 g), ICC 181108-1 (29.23 g) and JG 36 (18.42 g) and revealed their suitability in better management practices.

Keywords Chickpea, Timely planting, Genetic variability, Positive, Direct effect.

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INTRODUCTION

Chickpea [(*Cicer arietinum* L.) 2n=2x=16] is an annual self-pollinating legume crop with a genome size of ~738.00Mbp. It is originated in the South East Turkey region. The worldwide population is growing with high speed and predicted to go out over nine billion in the year 2050 (Godfray 2010). This speedy growth in population demonstrated danger to the human food and nourishing security. Subsequently, dietary consumption of >50.0% of the human populace suffering from the deficiencies of essential minerals and proteins content (White and Broadley 2009).

Genetic variations play very important role in crop enhancement and delivers robust broad genetic base to the advance breeding lines. Evaluation of genetic variability, heritability along-with genetic advance assisted the plant breeders to improve the inheritance of polygenic characters to start an efficient

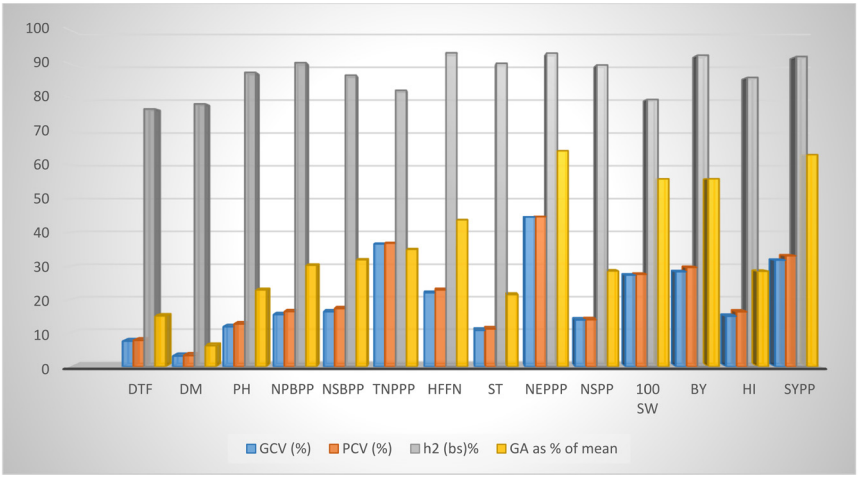

Fig. 1. Genetic parameters of variability for yield and its attributing traits in chickpea.

breeding improvement program. Meanwhile, yield of seed is a multifaceted trait and the selection of parents only established on yield only is not providing correct information for improvement and misleading. To overcome this problem, Information of trait association and their direct and indirect effect on seed yield is ultimate important to plan a breeding strategy for multiple trait enhancement and to formulate selection criterion.

The present examination has been started for yield improvement of *desi* chickpea advance breeding lines. Therefore, the available statistics is very supportive for the documentation of high yielding advance promising genotypes of chickpea.

MATERIALS AND METHODS

Forty two advanced breeding lines of chickpea were studied in timely sowing condition (25th November E-I) during *rabi* season 2020-2021 by applying Randomized Complete Block Design (RCBD) along-with three replications at Seed Breeding Farm, Department of Plant Breeding and Genetics, JNKVV Jabalpur. All the suggested standard practices were implemented for appropriate growth of the crop. Facts were documented for several yield and its assigning traits like, days to 50% flowering, days to maturity, plant height (cm), height of first fruiting node (cm), number of primary branches per plant, number of secondary branches per plant, stem thickness (mm), total number of effective pods per plant, number of seeds per pod, 100 seed weight (g), biological yield (g), harvest index (%) and seed yield per plant (g). Statistical analysis was done by using Window-Stat 9.1 software.

RESULTS AND DISCUSSION

The analysis of variance (ANOVA) signified that the highly significant alterations were reported among the advanced breeding lines for all the studied traits in timely planting. This specified that high range of variability was attained for the traits like, (Table 1) days to 50% flowering (55-74 days with mean value 63.9), days to maturity (107-120 days, mean with 114.9), plant height (41.9-71.5 cm average 57.5 cm), number of primary branches per plant (2.1–4.0, with 2.8 mean), number of secondary branches per plant (10.7–21.1 with 16.0 mean), total number of pods per plant ranged from 33.0–145.8 with 72.8 mean, height of first fruiting node (14.2–30.9 cm with general mean 22.5 cm), stem thickness (2.6–4.2 mm, average 3.9 mm), total number of effective pods per plant (18.4–150.0 with 67.8 mean), number of seeds per pod (2.7–4.9, 3.45 is value of mean), 100 seed weight (3.7–34.9 g and mean 22.7 g), biological yield ranged from 24.2–76.85 g with 40.7 g mean, harvest index (32.5-59.6% and 42.6% mean) and seed yield per plant (8.7–32.7 g with mean value 17.3 g). Ex-

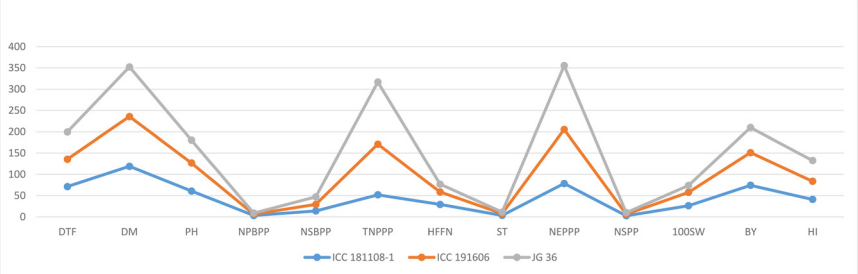

Fig. 2. Dependence of seed yield per plant on yield and its attributing traits in chickpea.

tensive assortment of predictability were prominent for all the studied traits under timely sown planting.

The genotypic coefficient of variation (GCV%) gives information about the extent of genetic variability available in various polygenic traits (Table 1, Fig. 1). The genotypic coefficient of variation was found slightly lower than phenotypic coefficient of variation (PCV%) for all the studied traits. It discovered that the minute influence of environment was present on the appearance of these traits. This are in the arrangement with the results of Sharma *et al.* (2019) and Kumar *et al.* (2021).

The high GCV% was noted for number of effective pods per plant (44.5%), followed by total number of pods per plant (36.6%), seed yield per plant (31.8), biological yield (28.3%), 100 seed weight (27.3%) and height of first fruiting node (22.0%) (Table 1). The outcomes were also supported by Kumar *et al.* (2018) for seed yield per plant, 100 seed weight and biological yield, Jida and Alemu(2019) for seed yield per plant, biological yield and total number of pods per plant and Kumar *et al*. (2021) for seed yield per plant. High amount of GCV% and PCV% designated that these traits have quantifiable inheritance and highly affected by environmental influences. Lowest value of GCV% was recorded for days to maturity (3.15%) followed by days to 50% flowering (7.5%). Similar findings were also renowned by Jida and

Table 1. Genetic parameters of variability for yield and its attributing traits in chickpea. Here, DTF= Dayas to 50% flowering, DM= Days to maturity, PH = Plant height (cm), NPBPP = Number of primary branches per plan, NSBPP = Number of secondary branches per plant, TNPPP = Total number of pods per plant, HFFN = Height of first fruiting node (cm), ST= Stem thickness (mm), NEPPP = Number of effective pods per plant, NSPP = Number of seeds per pod, 100SW = 100 seed weight (g), BY = Biological yield (g), HI= Harvest index (%), SYPP = Seed yield per plant (g).

Character	Range Min	Range Max	Mean	GCV (%)	PCV (%)	h^2 (bs)%	GA as % of mean
DTF	55.66	74.66	63.94	7.59	7.82	76.5	15.15
DM	107.33	120.66	114.90	3.15	3.29	78.0	6.22
PH	41.90	71.56	57.50	11.90	12.73	87.3	22.91
NPBPP	2.19	4.04	2.83	15.55	16.44	90.2	30.30
NSBPP	10.77	21.12	16.05	16.40	17.35	86.5	31.94
TNPPP	33.08	145.84	72.84	36.63	36.85	82.0	35.02
HFFN	14.24	30.96	22.57	22.05	22.92	93.1	43.72
ST	2.60	4.29	3.24	10.83	11.24	90	21.51
NEPPP	18.40	150.04	67.82	44.54	44.65	93	64.2
NSPP	2.73	4.96	3.45	13.94	14.01	89.5	28.57
100 SW	3.77	34.92	22.72	27.35	27.58	79.3	55.87
BY	24.23	76.85	40.72	28.36	29.65	92.4	55.89
HI	32.59	59.68	42.67	15.05	16.37	85.8	28.51
SYPP	8.71	32.70	17.37	31.84	33.14	92	63.02

Table 2. Phenotypic correlation coefficient analysis for yield and its attributing traits in chickpea. *, ** and *** significant at 5%, 1% and 0.1% level of probability, respectively.

Character	DTF	DM	PH	NPBPP	NSBPP	TNPPP	HFFN
DTF	1	0.5754 ***	0.2886**	0.3937 ***	-0.1837 *	0.1720	0.6270***
DM		1	0.2376 **	0.3158 **	-0.1779 *	-0.0370	0.4367***
PH			1	0.4745***	-0.3801***	0.0083	0.5224***
NPBPP				1	-0.0781	0.2260*	0.5101***
NSBPP					1	0.2490**	-0.2239*
TNPPP						1	0.0563
HFFN							1
ST							
NEPPP							
NSPP							
100 SW							
BY							
HI							

Table 2. Continued.

Character	ST	NEPPP	NSPP	100SW	BY	HI	SYPP
DTF	0.1452	0.2305 **	-0.4849 **	0.2504**	0.2610 **	-0.1885 *	0.1375
DM	0.0712	0.0138	-0.2528 **	0.3998 **	0.1850 *	-0.0470	0.1503
PH	0.1930*	0.1872*	-0.2058*	0.3584***	0.3664***	0.0378	0.3091
NPBPP	0.0271	0.3073***	-0.4323***	0.1895*	0.3776***	0.0990	0.3434**
NSBPP	-0.0994	0.2331**	0.0526	-0.3552***	-0.1337	0.0837	-0.0669
TNPPP	0.0395	0.8759 ***	-0.0752	-0.2323**	0.4354***	0.1140	0.4438***
HFFN	0.3703***	0.1405	-0.3444***	0.2122*	0.3009***	-0.1066	0.1958
ST	1	0.0592	-0.0411	0.3261***	0.4053***	-0.0052	0.3514**
NEPPP		1	0.1241	-0.1871*	0.5519***	0.0578	0.5187***
NSPP			1	-0.3224***	-0.1487	0.0059	0.1184
100 SW				1	0.2620**	0.1784*	0.3214**
BY					1	-0.0076	0.8696***
HI						1	0.4768***

Alemu (2019) for days to flowering and days to maturity. Low amount GCV% is present in these traits so breeder should search high variability source for further improvement of these traits.

The high heritability was reported for all the studied characters. High genetic advance as percentage of mean was documented for all the studied whereas the minimum genetic advance as percentage of mean was found for days to maturity (6.2%) followed by days to 50% flowering (15.1%). High heritability attached with high amount genetic advance as percentage of mean was noted for all the traits except days to maturity (78.0%, 6.2%) followed by days to 50% flowering (76.5%, 15.1% respectively) (Table 1). These above discussed results are comparable with the findings of Chopdar *et al.* (2017), Hussain *et al*. (2017), Shengu *et al.* (2018), Hailu (2020) and Kumar *et al.* (2021). Heritability is the most significant indicator for increasing selection efficiency which is mainly based on phenotypic expression of individual trait.

High values of GCV%, high heritability coupled along-with high genetic advance as percentage of mean was reported for total number of pods per plant, height of first fruiting node, number of effective pods per plant, 100 seed weight, biological yield and seed yield per plant in timely planting. Similar results were also obtained by Tiwari and Babbar (2016) for total number of pods per plant, 100 seed weight, biological yield per plant, seed yield per plant, Desai *et al.* (2015) for number of seeds per pod. The statistics

Table 3. Genotypic path coefficient analysis for yield and its attributing traits in chickpea. RSQUARE=0.9930RESIDUALEFFECT=0.0835.

Character	DTF	DM	PH	NPBPP	NSBPP	TNPPP	HFFN	ST	NEPPP	NSPP	100SW	BY	HI	SYPP
DTF	**-0.0015**	-0.0008	-0.0004	-0.0006	0.0003	-0.0003	-0.0009	-0.0002	-0.0003	0.0007	-0.0004	-0.0004	0.0003	0.1375
DM	0.0115	**0.0201**	0.0048	0.0063	-0.0036	-0.0007	0.0088	0.0014	0.0003	-0.0051	0.0080	0.0037	-0.0009	0.1503
PH	-0.0096	-0.0079	**-0.0334**	-0.0159	0.0127	-0.0003	-0.0175	-0.0065	-0.0063	0.0069	-0.0120	-0.0122	-0.0013	0.3091
NPBPP	-0.0169	-0.0136	-0.0204	**-0.0430**	0.0034	-0.0097	-0.0219	-0.0012	-0.0132	0.0186	-0.0081	-0.0162	-0.0043	0.3434
NSBPP	0.0000	0.0000	0.0001	0.0000	**-0.0003**	-0.0001	0.0001	0.0000	-0.0001	0.0000	0.0001	0.0000	0.0000	-0.0669
TNPPP	-0.0025	0.0005	-0.0001	-0.0033	-0.0036	**-0.0145**	-0.0008	-0.0006	-0.0127	0.0011	0.0034	-0.0063	-0.0017	0.4438
HFFN	0.0056	0.0039	0.0047	0.0046	-0.0020	0.0005	**0.0090**	0.0033	0.0013	-0.0031	0.0019	0.0027	-0.0010	0.1958
ST	-0.0011	-0.0005	-0.0014	-0.0002	0.0007	-0.0003	-0.0027	**-0.0074**	-0.0004	0.0003	-0.0024	-0.0030	0.0000	0.3514
NEPPP	0.0102	0.0006	0.0083	0.0136	0.0103	0.0388	0.0062	0.0026	**0.0443**	-0.0055	-0.0083	0.0245	0.0026	0.5187
NSPP	-0.0013	-0.0007	-0.0006	-0.0012	0.0001	-0.0002	-0.0010	-0.0001	-0.0003	**0.0028**	-0.0009	-0.0004	0.0000	-0.1184
100 SW	0.0061	0.0098	0.0087	0.0046	-0.0087	-0.0057	0.0052	0.0080	-0.0046	-0.0079	**0.0244**	0.0064	0.0044	0.3214
BY	0.2283	0.1618	0.3204	0.3303	-0.1170	0.3808	0.2631	0.3545	0.4827	-0.1301	0.2291	**0.8746**	-0.0067	0.8696
HI	-0.0915	-0.0228	0.0184	0.0480	0.0406	0.0553	-0.0518	-0.0025	0.0281	0.0029	0.0866	-0.0037	**0.4854**	0.4768

associated with amount of parental traits and their involvement for progeny is highly imperative and quantified that the selection can be done on these traits to determine more promising lines and involved to prepare a selection criteria in chickpea improvement breeding program.

The correlation coefficient indicated the nature of implication in the midst of the different characters and contributes to give an idea that how one intricate character namely, seed yield of chickpea may be enhanced (Table 2). The seed yield per plant revealed significant positive phenotypic interrelation with biological yield (0.8696) followed by number of effective pods per plant (0.5187), harvest index (0.4768), total number of pods per plant (0.4438), stem thickness (0.3514), number of primary branches per plant (0.3434) and 100 seed weight (0.3214). The similar findings were also detected by Chopdar *et al.* (2017) for harvest index, primary branches per plant, number of pods per plant, biological yield, and 100-seed weight, Shengu *et al.* (2018) for 100-seed weight, Jida and Alemu (2019) for biological yield, number of effective pods per plant and number of primary branches per plant, Kousar *et al.* (2019) for number of primary branches per plant, number of pods per plant, 100 seed weight and harvest index, Aktar *et al.* (2020) for stem thickness and primary branches per plant and Kumar *et al.* (2021) for number of pods per plant, 100 seed weight, number of primary branches per plant. The phenotypic correlation decides the environmental differences coupled with non-additive gene interactions. Considerate of traits association among numerous yield and its contributing traits is significantly important for scheduling a sound breeding program for yield improvement.

Path coefficient analysis is the average regression measurement and find out the straight impression of one variable on the other characters. Traits depicting positive and direct effect on seed yield per plant at genotypic level (Table 3) viz., biological yield (0.8746) followed by harvest index (0.4854), number of effective pods per plant (0.0443). These traits might be taken in selection priority for concurrently betterment for seed yield per plant in chickpea. These results are in accordance with the outcomes of Dhuria and Babbar (2015) for number of effective pods per plant and height of first fruiting node, Chopdar *et al.* (2017) for days to maturity, biological yield, harvest index and number of seeds per pod, Kumar *et al.* (2021) for number of seeds per pod, number of effective pods per plants and seed index.

The traits, seed yield per plant, height of first fruiting node, number of effective pods per plant, biological yield and 100 seed weight had high GCV%, high heritability with genetic advance as percentage of mean and positive and direct effect on seed yield per plant under timely sown condition. These traits

Table 4. Dependence of seed yield per plant on yield yield and its attributing traits in chickpea.

Character	DTF	DM	PH	NPBPP	NSBPP	TNPPP	HFFN	ST	NEPPP	NSPP	100SW	BY	HI
						Timely planting							
ICC 181108–1	71.33	119.00	60.90	3.29	13.94	51.93	29.45	3.46	78.59	2.91	26.24	74.36	41.14
ICC 191606	64.33	116.67	65.80	3.19	15.44	119.13	29.23	4.29	126.81	3.46	31.56	76.85	42.60
JG 36	64.00	116.67	53.57	2.40	17.64	145.84	18.42	3.52	150.05	3.63	16.20	58.68	48.74

are highly responsible for increasing the seed yield so must be included in selection criteria for yield enhancement of chickpea advance breeding lines under timely sown condition.

Promising advance breeding lines for timely sown planting- In current exploration research, chickpea is grow in timely sown condition (Table 4, Fig. 2). Based on the inclusive mean performance on seed yield and its accrediting traits number of pods per plant, number of effective pods per plant, number of seeds per pod, 100 seed weight, biological yield, harvest index and seed yield per plant. The promising lines gives higher seed yield per plant are ICC 191606 (29.45 g), ICC 181108-1 (29.23 g) and JG 36 (18.42 g) and revealed their suitability in better management practices.

CONCLUSION

The foremost goal of a plant breeder is to strengthen the yield potential of crop to obtain higher economic returns and reduce cost of cultivation. In accomplishing this aim, it is desirable to gather the facts highly interconnected with seed yield and its component traits, concerning variability, heritability, genetic advance, correlation and their cause of association with seed yield. The information attained on these traits will be extremely valuable to frame the suitable selection scheduling for genetic expansion and higher seed yield in chickpea. This investigation documented a group of most favorable chickpea accessions that can be definitely utilized in several breeding enhancement programs for improving yield ability of chickpea advance breeding lines.

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