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Genetic Variability and Character Association for Seed Yield in Farmers' Chickpea (*Cicer arietinum* L.) Varieties grown in Vindhyan Zone of Eastern Uttar Pradesh

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ABSTRACT: The present study was carried out to assess the genetic variability and character association amongst nineteen farmers' chickpea varieties that were examined during *Rabi* 2019-2020 under RBD with three replications. ANOVA showed highly significant differences for all of the characters studied at 1% level of significance except days to maturity. For majority of the characters, PCV was somewhat greater than GCV, indicating that character expression is mostly controlled by genotypes, with just a little contribution of environment. The characters *viz.*, number of pods per plant, number of primary branches per plant, number of secondary branches per plant, biological yield per plant, seed index, harvest index, and seed yield per plant all had high heritability coupled with high GAM, indicating that these characters are driven by additive gene action. Biological yield per plant and harvest index revealed a significant positive association and had a direct effect on seed yield. As a result, these characters may serve as an efficient selection criterion for chickpea yield enhancement.

Keywords: Genetic variability, Chickpea (*Cicer arietinum* L.), Farmers' varieties, Association, Path coefficient analysis.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) commonly called as Gram, Chana or Bengal gram is an chief cool-season food legume. It belongs to the family Leguminaceae and sub-family Papilionaceae. It is a diploid species with chromosome number 2n=16. It is highly self-pollinated crop. Only 0–1% cross pollination is reported which is rare. Amongst all pulses in the world chickpea is third most important pulse crop. Chickpea is widely grown for its nutritious seeds. This light brown coloured pulse is considered to be a good source of fat (4-10%), protein (18-22%), carbohydrate (52-70%), minerals and vitamins (Rathod *et al.*, 2020). "India contributes major share of world's chickpea area (70%) and production (67%) and continues to be the largest chickpea producing nation" (Mohan and Thiyagarajan, 2019). "In India chickpea is grown in an area of 10.17 million hectares with the production of 11.35 million tonnes and productivity of 1116 kilograms per hectare whereas in Uttar Pradesh, chickpea is grown in an area of 0.62 million hectares with the production of 0.85 million tonnes and productivity of 1371 kilograms per hectare" (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare (DAC & FW), 2019-2020). The study of genetic variability including the important yield and the yield attributing characters in chickpea is of utmost importance to judge its potential as base material for genetic improvement (Singh *et al.*, 2021). Heritability act as a predictive tool in expressing the reliability of phenotypic trades, and thus high heritability could aid in effective selection of specific characters and the design of future chickpea breeding programmes (Mohammed *et al.*, 2019). A plant breeder's understanding of heritability coupled with genetic advance is crucial since it indicates the feasibility and extent of improvement through selection (Hasan and Deb, 2017). Grain yield is a complex and polygenic character which is affected by many component characters (Arora *et al.*, 2018). Knowledge of the interrelationships between characters is essential for generating effective selection criteria for improving complex character such as grain yield (Srivastava *et al.*, 2017). Plant breeders need information on correlation and path coefficient analyses to run an effective selection programme and breed genotypes with higher yield potential (Bhanu *et al.,* 2017).

Due to climate change, the world is facing great challenges in terms of low yield and other associated biotic and abiotic stresses. The farmers' varieties are being grown at the farmers' fields since long time. Therefore, they are well acclimatized to the local conditions and carries the genes of interest to mitigate the adverse effect of climate change. Farmers' varieties' genetic variability adds to production system resilience in the face of abiotic and biotic challenges, minimizing the probability of overall crop failure (Altieri and Toledo, 2011). "Farmers' varieties sometimes outperform formal sector improved varieties, especially when deployed in difficult environments, and in systems where farmers' cannot afford inputs that are recommended to boost the performance of formal sector improved materials" (Keneni *et al.,* 2012). Farmers' varieties/landraces are dynamically managed, including their exposure to various production regimes, habitats, farmers' selection, and seed exchange systems, to preserve a reservoir of genetic variability that is always changing. Keeping in view, the present study has been planned to obtain information about genetic variability, the nature and extent of association between different characters influencing yield and cause of association can be better understood which will helps in formulation of the selection criteria for improvement of chickpea yield even in farmers' varieties.

MATERIALS AND METHODS

The study was conducted at the field experimentation center of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh during *Rabi* 2019-2020. The experimental materials for the present study consist of 19 farmers' chickpea varieties which were obtained from Directorate of Research, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj (U.P.). They were grown under Randomized Block Design (RBD) having 3 replications. The gross field area was divided into three sub plots. An irrigation channel of dimension 1 meter ran between adjacent sub plots. These sub plots were used to replicate the genotypes thrice. Each sub plot was divided into 19 units of equal dimensions, 19 farmers' chickpea varieties were grown in these units at a spacing of 30 × 10 cm. To grow a competent crop, recommended agronomic techniques were followed. Observations on number of days to 50% flowering, number of days to maturity and seed index were recorded on plot basis, whereas for characters like plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, biological yield per plant, seed yield per plant and harvest index were recorded from five randomly selected competitive plants from each plot in each replication.

The mean values of five randomly selected observational plants for ten different quantitative characters were used for statistical analysis. The following statistical parameters were calculated for presentation of data on ten different quantitative characters. They are Analysis of Variance (Panse and Sukhatme, 1967), Genotypic and Phenotypic Coefficient of Variation (Burton, 1952), Heritability (Burton and Devane, 1953), Genetic Advance (Lush, 1940), Correlation coefficient Analysis (Falconer, 1964), Path coefficient Analysis (Dewey and Lu, 1959).

RESULTS AND DISSCUSSIONS

Analysis of Variance found that the mean sum of squares due to treatments (genotypes) exhibited high significant differences for all of the traits studied at a 1% level of significance, with the exception of number of days to maturity, which showed a 5% level of significance (Table 1). This revealed that the farmers' chickpea varieties chosen for this study were quite variable, with a significant amount of variability among them, providing a promising potential for improving chickpea traits of interest. As a result, it gives abundant opportunity for the selection of various quantitative characters for chickpea yield development. These results were relatable to the findings of Bhanu *et al.* (2017); Srivastava *et al.* (2017); Bhoite *et al.* (2020).

Table 1: Analysis of Variance for ten quantitative characters in farmers' chickpea varieties.

Sr. No.	Characters	Mean Sum of Squares		
		Replications (df = 2)	Treatments (df = 18)	Error (df = 36)
1.	Number of days to 50% flowering	2.33	116.57 **	20.81
2.	Plant height	89.98	180.35 **	21.18
3.	Number of primary branches per plant	0.35	16.38 **	0.25
4.	Number of secondary branches per plant	2.49	15.44 **	0.66
5.	Number of pods per plant	154.10	2099.06 **	30.81
6.	Number of days to maturity	9.92	44.37 *	17.96
7.	Biological yield per plant	0.84	73.82 **	3.69
8.	Seed yield per plant	1.04	6.66 **	0.4
9.	Harvest Index	9.53	123.60 **	6.44
10.	Seed index	1.01	61.59 **	6.29

*Significance at the 5% level and **Significance at the 1% level ; df: degrees of freedom

The variation in mean values for seed yield per plant varied from 8.73 (CSAB-301) to 13.87 (Tiwari Chana-2) grams with the mean value of 11.35g. The variety Tiwari Chana-2 (13.87g) was found at par with CRCB-447 (13.33g) for seed yield per plant. Thus, these varieties were genetically similar with each other. The mean performance of nineteen farmers' chickpea varieties revealed that the variety Tiwari Chana -2 followed by CRCB - 447, Prakash Chana (8), CRRB – 439 and CDSM -270 were found most promising for seed yield per plant and other traits, as described in Table 2.

Estimation of genetic variability parameters. The parameters of genetic variability for ten quantitative characters of 19 farmers' chickpea varieties are presented in Table 3 and graphical representation of variability parameters are portrayed in Fig. 1. According to Sivasubrahmanian and Menon (1973), variability is characterized as low if coefficient of variation is less than 10 percent, moderate (10 – 20 %) and high (>20%). The results showed that the phenotypic variance was somewhat greater than the genotypic variance for all characters evaluated except days to maturity, indicating that environmental effects contributed less to the phenotypic variance in the characters. Similar observations were also reported by Fasil, (2020). Higher estimates of phenotypic and genotypic variance were recorded for number of pods per plant (720.23, 689.41), followed by plant height (74.24, 53.06), number of days to 50% flowering (52.73, 31.92), harvest index (45.50, 39.05), biological yield per plant (27.07, 23.37), number of days to maturity (26.77, 8.80), seed index (24.72, 18.44), number of primary branches per plant (5.63, 5.38), number of secondary branches per plant (5.59,4.92), and seed yield per plant (2.49, 2.09). Near results were also reported by Bhanu *et al.* (2017); Hasan and Deb, (2017).

The phenotypic coefficient of variation (PCV) was somewhat greater than the genotypic coefficient of variation (GCV), indicating that the expression of the traits is mostly influenced by the genotypes themselves, with only a minor impact from environment. Similar findings were also reported by Rathod *et al.* (2020); Singh *et al.*, (2021). Higher magnitudes of PCV and GCV were recorded for number of pods per plant (41.57, 40.67), followed by number of primary branches per plant (30.17, 29.49), and number of secondary branches per plant (23.22, 21.80), while low for number of days to maturity (3.92, 2.24), and days to 50% flowering (8.74, 6.80) which reveals that the genotypes used in this study have a lot of genetic variation, and it shows the possibility of genetic improvement through selection for those characters. These findings suggest that selection can be successful based on phenotypic along with equal probability of genotypic values. These results were in accordance of Srivastava *et al.* (2017); Talekar *et al.* (2017); low GCV and PCV for number of days to 50% flowering and maturity were similar with the results of Hasan and Deb (2017); Bhoite *et al.* (2020).

Estimation of Heritability and Genetic Advance as percent of Mean (GAM): According to Johnson *et al.* (1955) the range of heritability was classified as low (<30%), medium (30-60%), and high (>60%). Table 3 displays the heritability estimates derived from the current study. The traits *viz.*, number of pods per plant (95.7%), number of primary branches per plant (95.5%), number of secondary branches per plant (88.1%), biological yield per plant (86.4%), harvest index (85.8%), and seed yield per plant (83.7%) had higher broad sense heritability values, indicating that they were less influenced by the environment and were highly heritable, allowing for effective selection of traits based on phenotypic expression using a simple selection method. Bhoite *et al.*, (2020); Kumar *et al.*, (2020); Kumar *et al.*, (2019) all found similar findings.

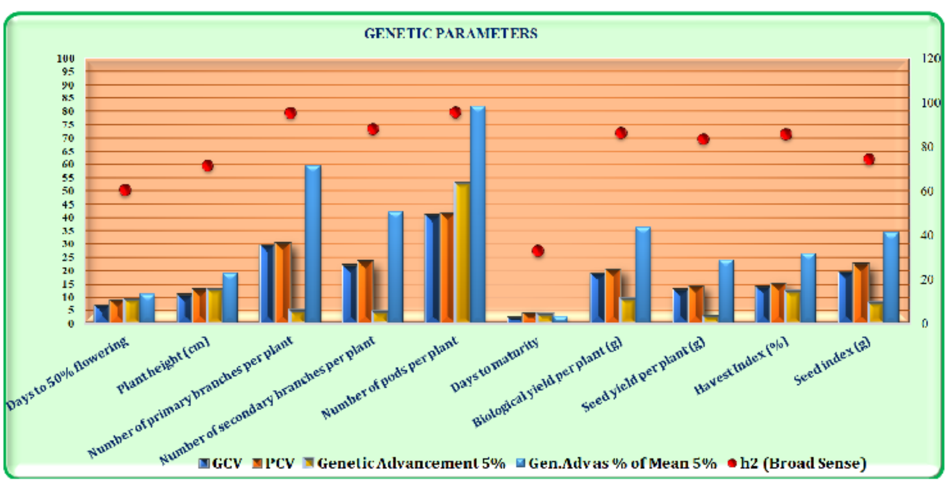

Fig: 1. Graphical representation of Genotypic Coefficient of Variation (GCV), Phenotypic Coefficient of Variation (PCV), Heritability, Genetic advance at 5% and Genetic advance as percent of mean at 5% for ten quantitative traits in farmers' chickpea varieties.

Table 2: Mean performance of nineteen farmers' chickpea varieties for ten quantitative characters.

Sr. No.	Varieties	Number of days to 50% flowering	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Number of pods per plant	Number of days to maturity	Biological yield per plant (g)	Seed yield per plant (g)	Harvest Index (%)	Seed index (g)
1	CRAV-205	82.33	76.20	7.87	11.93	55.40	126.67	21.40	10.40	48.61	26.53
2	CJRB-303	84.67	66.00	8.53	10.67	57.20	135.00	23.53	11.27	47.89	23.20
3	CRSM-209	87.33	73.70	4.87	9.67	51.07	132.00	21.13	10.50	49.69	26.73
4	Sunitha Chana (192)	85.67	75.60	8.27	8.70	62.73	134.00	25.87	11.69	45.19	26.07
5	CJRA-208	86.67	65.60	4.20	9.33	54.80	136.00	27.47	9.87	35.93	26.00
6	CDSM-270	84.67	63.77	7.53	8.93	54.47	128.00	31.27	12.53	40.09	22.87
7	CRRB-439	80.67	56.83	12.33	12.60	119.70	133.33	30.87	12.70	41.14	15.94
8	CKRB-440	75.67	54.20	5.73	8.13	42.20	126.67	16.53	9.80	59.27	16.47
9	Jagvanthi Chana (475)	74.67	61.57	7.40	10.27	50.93	126.33	25.20	11.34	44.99	18.07
10	CBCM-206	74.33	69.20	6.20	10.60	58.13	131.67	29.40	11.53	39.22	20.73
11	CSLM-441	76.33	60.33	7.73	9.20	48.47	125.33	22.67	8.80	38.82	19.93
12	CSAB-301	75.67	60.10	6.67	8.40	38.54	135.00	20.40	8.73	42.81	18.60
13	CRSM-271	75.33	77.00	6.73	7.13	48.60	133.67	26.20	11.50	43.89	27.40
14	CRRB-442	82.00	72.20	7.27	10.34	84.13	135.66	21.20	12.33	58.18	22.93
15	CCRA-207	87.66	67.40	5.67	11.27	50.67	133.33	20.60	10.07	48.87	26.00
16	Prakash Chana (8)	90.00	63.00	8.93	7.27	60.00	137.00	36.33	13.20	36.33	22.93
17	CRCB-447	90.67	62.60	13.13	16.80	143.14	136.33	31.80	13.33	41.92	12.70
18	Tiwari Chana-2	92.66	71.00	9.80	12.80	63.20	128.33	28.17	13.87	49.23	22.33
19	Munish Chana	91.33	84.20	10.53	9.40	83.07	133.33	25.77	12.20	47.34	29.80
	Mean	83.07	67.40	7.86	10.18	64.55	131.98	25.57	11.35	45.23	22.38
	C.V.	5.49	6.83	6.39	8.00	8.60	3.21	7.51	5.61	5.61	11.21
	S.E.	2.63	2.66	0.29	0.47	3.21	2.45	1.11	0.37	1.47	1.45
	C.D. 5%	7.56	7.62	0.83	1.35	9.19	7.02	3.18	1.05	4.20	4.15
	C.D. 1%	10.13	10.22	1.12	1.81	12.33	9.41	4.27	1.41	5.64	5.57
	Range Lowest	74.33	54.20	4.20	7.13	38.54	125.33	16.53	8.73	35.93	12.70
	Range Highest	92.66	84.20	13.13	16.80	143.14	137.00	36.33	13.87	59.27	29.80

Table 3: Genetic variability parameters of ten quantitative traits of nineteen farmers' chickpea varieties.

Sr. No.	Characters	Variance			Coefficient of variation		Heritability in broad sense (h^2)	Genetic advance (5%)	Genetic advance as percent of mean (5%)
		Phenotypic	Genotypic	Environmental	GCV	PCV			
1	Number of days to 50% flowering	52.73	31.92	20.81	6.80	8.74	60.50	9.05	10.90
2	Plant height (cm)	74.24	53.06	21.18	10.80	12.78	71.50	12.68	18.82
3	Number of primary branches per plant	5.63	5.380	0.250	29.49	30.17	95.50	4.66	59.37
4	Number of secondary branches per plant	5.590	4.920	0.660	21.80	23.22	88.10	4.29	42.16
5	Number of pods per plant	720.230	689.410	30.810	40.67	41.57	95.70	52.91	81.98
6	Number of days to maturity	26.77	8.8	17.97	2.24	3.92	32.90	3.50	2.65
7	Biological yield per plant (g)	27.07	23.37	3.69	18.90	20.34	86.410	9.25	36.20
8	Seed yield per plant (g)	2.49	2.09	0.41	12.72	13.90	83.70	2.72	23.99
9	Harvest Index (%)	45.5	39.05	6.45	13.81	14.91	85.80	11.92	26.36
10	Seed index (g)	24.73	18.44	6.29	19.18	22.21	74.60	7.63	34.12

According to Johnson *et al.* (1955), GAM is characterized as low (less than 10%), moderate (10-20%), and high (greater than 20%) (Table 3). In predicting the resultant effect of selection, combining heritability estimates and genetic advance as a percent of mean would provide a better judgement than heritability alone. For the traits *viz.*, number of pods per plant (81.98%, 95.7%), number of primary branches per plant (59.37%, 95.5%), number of secondary branches per plant (42.16%, 88.1%), biological yield per plant (36.2%, 86.4%), seed index (34.12%, 74.60%), harvest index (26.36%, 85.8%), and seed yield per plant (23.99%, 83.7%) high genetic advance as percent of mean was observed, along with high heritability. The findings of this study revealed that additive gene effects governed the majority of the characters. As a result, direct selection of these characters based on phenotypic expression using a simple selection method would be effective, as more additive genes would accumulate, leading to further improvement. These findings are consistent with those of Srivastava *et al.* (2017); Mohan and Thiyagarajan, (2019); Bhoite *et al.* (2020).

Estimation of correlation coefficient between yield and its component traits: Correlation coefficient at the phenotypic level revealed that seed yield per plant was highly significant and positively associated with biological yield per plant (0.66**), and harvest index (0.54**), while seed index (0.12), number of days to 50% flowering (0.06), plant height (0.07), and number of primary branches per plant (0.01) were non-significant and positively associated. In contrast, the number of pods per plant (-0.25), number of secondary branches per plant (-0.09), and number of days to maturity (-0.09) all had a negative and non-significant correlation with seed yield per plant as can be seen in Table 4.

Correlation coefficient at the genotypic level revealed that seed yield per plant had a significant positive correlation with biological yield per plant (0.72**), and harvest index (0.52**), while seed index (0.14), number of days to 50% flowering (0.11), plant height (0.06), and number of primary branches per plant (0.02) were non-significant but positively associated. In contrast, the number of pods per plant (-0.27*) had a significant but negative correlation with seed yield per plant, but the number of secondary branches per plant (-0.09), and number of days to maturity (-0.07) had a negative and non-significant association with seed yield per plant as can be seen in Table 4.

In the current study, correlation analysis between yield and its contributing characters revealed that the majority of character pairs at both genotypic and phenotypic associations were in the same direction, and the genotypic correlation coefficient was in most cases higher than the phenotypic correlation coefficient, implying that the traits studied have a strong inherent association and that phenotypic selection may be beneficial. In some situations, the phenotypic correlation coefficients were higher than the genotypic correlation coefficients, indicating that the environment can affect the expression of traits at the phenotypic level. These findings closely resemble to the results of Bhanu *et al.* (2017); Hasan and Deb (2017); Kumar *et al.* (2019).

At both the genotypic and phenotypic levels, the characters *viz.*, biological yield per plant, and harvest index were shown to have a positive significant correlation with seed yield per plant which indicates that the direct selection for these traits would improve the grain yield in chickpea. Further, it has been suggested that any positive increase in such characters may promote chickpea seed yield. As a consequence, it can be assumed that selection based on these traits in combination will result in the identification of high yielding genotypes. Identical results were also reported by Bhanu *et al.* (2017); Hasan and Deb (2017); Agrawal *et al.* (2018); Kumar *et al.* (2019); Singh *et al.* (2021).

Estimation of Path Coefficient analysis: The direct and indirect effects (path coefficient analysis) at the phenotypic level, with seed yield per plant as the dependent variable, revealed that biological yield per plant (0.797) had the greatest positive direct effect, followed by harvest index (0.726), number of primary branches per plant (0.029), number of days to 50% flowering (0.029), plant height (0.026), seed index (0.014), and number of pods per plant (0.003), whereas number of days to maturity (-0.074), and number of secondary branches per plant (-0.055) had negative direct effect on seed yield per plant as illustrated in Table 5.

The direct and indirect effects (path coefficient analysis) at the genotypic level, with seed yield per plant as the dependent variable, revealed that number of pods per plant (2.752), harvest index (1.381), biological yield per plant (1.102), seed index (0.037), number of days to 50 percent flowering (0.349), and plant height (0.087) had positive direct effects, while number of primary branches per plant (-1.219), number of days to maturity (-1.260), and number of secondary branches per plant (-1.617) had negative direct effect on seed yield per plant as illustrated in Table 5.

In the present study, path analysis showed that, at both the phenotypic and genotypic levels, characters *viz.*, number of days to 50% flowering, plant height, number of pods per plant, biological yield per plant, harvest index, and seed index exhibited positive direct effects on seed yield per plant which indicates that the selection for these traits will directly reward for selection in seed yield per plant. As a result, these traits might be regarded as primary components of selection in a breeding programme aimed at increasing chickpea seed yield. These results are in agreement with Bhanu *et al.* (2017); Thakur *et al.* (2018); Singh *et al.* (2021). Further, studies for direct effect on seed yield for biological yield per plant, and harvest index were recorded by Tadesse *et al.* (2016); Kumar *et al.* (2019).

Table 4: Phenotypic and Genotypic Correlation Coefficient for grain yield and its component traits in farmers' chickpea varieties.

Characters		Number of days to 50% flowering	Plant height	Number of primary branches per plant	Number of secondary branches per plant	Number of pods per plant	Number of days to maturity	Biological yield per plant	Harvest Index	Seed index	Seed yield per plant
Number of days to 50% flowering	P	**1**	0.31*	0.30*	0.30*	0.32*	0.38**	0.03	0.04	0.26	0.06
	G	**1**	0.40**	0.41**	0.40**	0.43**	0.39**	0.07	0.07	0.37**	0.11
Plant Height	P		**1**	-0.03	-0.04	-0.03	0.14	0.06	-0.02	0.63**	0.07
	G		**1**	-0.03	-0.1	-0.04	0.19	0.07	-0.08	0.95**	0.06
Number of primary branches per plant	P			**1**	0.57**	0.81**	0.11	-0.09	0.12	-0.34*	0.01
	G			**1**	0.62**	0.82**	0.2	-0.11	0.15	-0.43**	0.02
Number of secondary branches per plant	P				**1**	0.71**	0.08	-0.40**	0.35**	-0.38**	-0.09
	G				**1**	0.76**	0	-0.43**	0.41**	-0.48**	-0.09
Number of pods per plant	P					**1**	0.28*	-0.28*	0.01	-0.38**	-0.25*
	G					**1**	0.50**	-0.30*	0.03	-0.45**	-0.27*
Number of days to maturity	P						**1**	0.04	-0.09	0.12	-0.09
	G						**1**	0.08	-0.13	0.14	-0.07
Biological yield per plant	P							**1**	-0.22	0.28*	0.66**
	G							**1**	-0.23	0.30*	0.72**
Harvest index	P								**1**	-0.19	0.54**
	G								**1**	-0.24	0.52**
Seed index	P									**1**	0.12
	G									**1**	0.14
Seed yield per plant	P										**1**
	G										**1**

P: Phenotypic Correlation Coefficient G: Genotypic Correlation Coefficient

Table 5: Direct (diagonal) and indirect effects of different traits on grain yield in farmers' chickpea varieties at both the phenotypic and genotypic level.

Characters		Number of days to 50% flowering	Plant height	Number of primary branches per plant	Number of secondary branches per plant	Number of pods per plant	Number of days to maturity	Biological yield per plant	Harvest Index	Seed index
Number of days to 50% flowering	P	**0.029**	0.009	0.009	0.009	0.009	0.011	0.001	0.001	0.007
	G	**0.349**	0.139	0.144	0.138	0.149	0.135	0.024	0.024	0.129
Plant Height	P	0.008	**0.026**	-0.001	-0.001	-0.001	0.004	0.002	-0.001	0.016
	G	0.034	**0.087**	-0.003	-0.008	-0.004	0.017	0.006	-0.007	0.082
Number of primary branches per plant	P	0.009	-0.001	**0.029**	0.017	0.024	0.003	-0.003	0.004	-0.01
	G	-0.503	0.036	**-1.219**	-0.751	-1.004	-0.242	0.129	-0.186	0.528
Number of secondary branches per plant	P	-0.017	0.002	-0.032	**-0.055**	-0.039	-0.004	0.022	-0.02	0.021
	G	-0.639	0.157	-0.997	**-1.617**	-1.226	-0.006	0.691	-0.654	0.782
Number of pods per plant	P	0.001	-0.0001	0.003	0.002	**0.003**	0.001	-0.001	0.365	-0.001
	G	1.174	-0.117	2.268	2.087	**2.752**	1.374	-0.823	0.069	-1.242
Number of days to maturity	P	-0.028	-0.01	-0.009	-0.006	-0.021	**-0.074**	-0.003	0.007	-0.009
	G	-0.486	-0.244	-0.25	-0.005	-0.629	**-1.26**	-0.096	0.157	-0.177
Biological yield per plant	P	0.026	0.047	-0.072	-0.312	-0.227	0.031	**0.797**	-0.175	0.222
	G	0.076	0.076	-0.117	-0.471	-0.33	0.084	**1.102**	-0.256	0.329
Harvest index	P	0.027	-0.017	0.091	0.257	0.004	-0.065	-0.159	**0.726**	-0.137
	G	0.093	-0.109	0.211	0.559	0.034	-0.172	-0.32	**1.381**	-0.326
Seed index	P	0.004	0.009	-0.005	-0.005	-0.005	0.002	0.004	-0.003	**0.014**
	G	0.014	0.035	-0.016	-0.018	-0.017	0.005	0.011	-0.009	**0.037**
Seed yield per plant	P	0.059	0.065	0.014	-0.094	-0.252	-0.092	0.660**	0.540**	0.124
	G	0.112	0.06	0.022	-0.086	-0.274*	-0.067	0.724**	0.518**	0.141
Residual R2	P	0.002	0.002	0.0004	0.005	-0.0009	0.007	0.526	0.392	0.002
	G	0.039	0.005	-0.026	0.14	-0.754	0.084	0.798	0.716	0.005

P: direct and indirect effects at Phenotypic level G: direct and indirect effects at genotypic level

According to the path analysis study, biological yield per plant, and harvest index had a positive direct effect and showed a positive and significant association with seed yield per plant, suggesting that improving grain yield in chickpea is connected to these characters and that selecting these characters may have a favorable influence on seed yield per plant. As a result, while breeding for increased production in chickpea, these traits should be prioritized. Near results were also reported by Hasan and Deb (2017); Thakur *et al.* (2018).

Given the overall result, it is clear that the knowledge obtained here will be useful in the future for enhancing existing farmers' chickpea varieties. The traits listed above as important direct and indirect yield components demand careful attention in developing a chickpea selection strategy for selecting high yielding varieties.

CONCLUSION

The analysis of variance for all the varieties revealed significant differences for all of the traits under investigation. Based on mean performance, the farmers' chickpea varieties Tiwari Chana-2, followed by CRCB-447, were identified to be the most propitious for seed yield per plant and other traits. characters such as the number of pods per plant, number of primary branches per plant, and the number of secondary branches per plant had high GCV, PCV, and Heritability, indicating that the environment had little impact on the expression of these characters. Number of pods per plant, number of primary branches per plant, number of secondary branches per plant, biological yield per plant, seed index, harvest index, and seed yield per plant, all had high heritability coupled with high GAM, showing that these characters are driven by additive gene action. Characters such as biological yield per plant and harvest index shown a significant positive correlation and had a direct influence on seed yield/plant. As a result, in farmers' chickpea varieties development programme, greater focus should be placed on these traits during selection for increased yield.

The farmers' chickpea varieties Tiwari Chana-2 followed by CRCB-447 and Prakash Chana (8) were found best in terms of yield and its contributing characters in Vindhyan Zone of Eastern Uttar Pradesh. Therefore, we can recommend these varieties for further improvement and breeding programmes.

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Conflict of Interest. None.

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