Annals of Plant and Soil Research 27(2): 258-267 (2025)
https://doi.org/10.47815/apsr.2025.10463

Assessment of variability and its components among chickpea genotypes, inter-relationships and path coefficients of yield and related traits: An experimental study

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Received: January, 2025; Revised accepted: May, 2025

ABSTRACT

During the Rabi season of October 2023 to April 2024, twenty-three different cultivars of chickpea (Cicer arietinum L.) were cultivated at AKS University in Satna using a Completely Randomized Block Design (CRBD). In order to determine variance, genetic diversity, heritability, genetic progress, interrelationships, and the direct and indirect effects of various quantitative variables on seed yield, eleven quantitative traits were investigated. The experimental design revealed highly significant variations for all variables due to the treatments applied. Still, non-significant differences were found between replications for each character being studied. The analysis of variance revealed significant variance in the genotypes for each character under investigation. For the seed index (g), number of branches per plant, and number of pods per plant, the highest GCV and PCV were noted. High genetic progress and high heritability were found for the seed index, number of pods per plant, number of branches per plant, and pod length (cm), suggesting that additive gene action may play a significant role in determining these traits. Therefore, choosing for these features may be a more effective way to achieve the desired genetic improvement. At both the genotypic and phenotypic levels, the characteristics such as pod length (cm), plant height (cm), number of pods per plant, biological yield per plant (g), and harvest index (%) showed positive and significant associations with seed yield per plant (g). Plant height (cm), 100-seed weight (g), days to 50% flowering, days to maturity, number of secondary branches per plant, and number of seeds per pod are important characteristics to take into account for chickpea seed yield augmentation and selection. These findings were derived using path coefficient analysis.

Keywords: Chickpea, Variance, Variability, Heritability, Correlation and Path Coefficients

INTRODUCTION

Pulses are a vital source of dietary protein for vegetarians in both developing and developed countries. In India, pulse crops play a significant role in the agricultural economy and contribute to nutritional security for impoverished populations (Chaturvedi and Ali, 2002). Chickpea (*Cicer arietinum* L.) is the third most important pulse crop globally, covering an area of 14.84 million hectares and producing 15.08 million tons, with an average yield of 1.01 t/ha in 2020 (FAOSTAT 2021). This yield is significantly lower than the estimated potential of 6 t/ha that can be achieved under optimal conditions (Thudi *et al.,* 2016). Most chickpea production occurs in developing countries, where over 90% of the output is consumed domestically (Jain *et al.,* 2013). The chickpea flower features five sepals, five petals, and ten stamens arranged in a (9+1) diadelphous formation, along with a superior ovary. It is an important protein-rich crop known for its considerable diversity among 44 annual *Cicer* species. The genus *Cicer* also contains alleles and genes that provide tolerance and resistance to various abiotic and biotic stresses, as well as traits related to agronomy and nutrition (Sharma *et al.,* 2013). Within this genus, there are 10 annual and 36 perennial species, with *C. arietinum* being the only domesticated and cultivated annual species worldwide (Toker *et al.,* 2021). Archaeological findings suggest that chickpeas have been present in the Middle East since around 7500–6800 BC (Gayacharan *et al.,* 2020). The Fertile Crescent and the Mediterranean region are identified as primary centers of chickpea origin, while South Asia and Ethiopia serve as secondary centers (Vavilov, 1926; Van der Maesen, 1987).

Germplasm is an invaluable natural resource that provides essential traits for developing superior plant varieties (Hawkes, 1981). Understanding genetic variability and the relationships among different traits within

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germplasm is crucial for selecting and breeding high-yielding, high-quality cultivars, ultimately enhancing production (Siva kumar and Muthaiah, 2000; Priyadarshan, 2017; Thakur *et al.,* 2018). Knowledge of heritability allows plant breeders to predict the behavior of future generations, enabling effective selection and evaluating the potential for genetic improvement (Kumar *et al.,* 2018). Additionally, correlation coefficient studies help identify interrelationships among various plant traits. Path coefficient analysis, which provides standardized partial regression coefficients, measures the direct influence of one variable on another and breaks down the correlation coefficient into components reflecting direct and indirect effects (Nikita and Lal, 2022).

MATERIAL AND METHODS

The current study was carried out in the research farm, Genetics and Plant Breeding, AKS University, Sherganj, Satna, Madhya Pradesh, during the Rabi season of 2023–24. Twenty three strains and varieties of chickpea (*Cicer arietinum* L.) germplasm, comprising native genotypes, were used in the experiment and were assessed using a completely randomized block design. There were 23 plots in each of the three equal blocks that made up the experimental field. Every plot has four, six-meter-long rows with 30-centimeter row spacing and 15-centimeter plant spacing. For the best possible crop growth, recommended cultural measures were put into place.

Day count to 50% blooming (D50%F), days to maturity (DM), length of pod (cm) (LP), height of plant (cm) (PH), number of pods per plant (NPPP), number of seeds per pod (NSPP), number of branches per plant (NBPP), biological yield per plant (g) (BYPP), seed index (100 seeds) (SI), harvest index (%) (HI), and seeds yield per plant (g) (SYPP) were the eleven observations that were noted. Five competitive plants were chosen at random from each plot to collect data for each of the twelve quantitative features. Plot-based measurements were made of these plants.

The process described by Panse and Sukhatme (1967) was followed in order to do the analysis of variance for the experiment's design. According to Burton and de Vane's (1953) formula, the genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), and environmental coefficient of variation (ECV) were computed. The formula proposed by Burton and de Vane (1953) was used to determine heritability in the wide sense (h2b). The Johnson *et al.,* (1955) approach was used to calculate genetic progress.

As formula stated by Searle (1961), the basic relationships between various features at the genotypic and phenotypic levels were determined. Path coefficient analysis was performed using the (Dewey & Lu 1959) formula.

RESULTS AND DISCUSSION

Analysis of variance (ANOVA) for the design of experiment

The Analysis of Variance (ANOVA) is a crucial instrument for measuring the amount of variation found in the germplasm. The experiment design comprising 23 chickpea strains/varieties, as shown in Table 1 and Figure 1, was subjected to an analysis of variance. The experiment's design revealed statistically significant variations for every character that was assessed. The biological yield per plant (g) (BYPP) had the most replication-related variation (339.78), BYPP is also expressed the largest treatment-related variants (598.52). The findings indicate that there is plenty of scope to improve crop output and its contributing features in breeding programs by adopting the promising genotypes. These results are accordance to results reported by Aroosa and Ahmed 2024; Deshmukh *et al.,* 2024; Kalyar *et al.,* 2024; Kumar *et al.,* 2024; Prathyusha *et al.,* 2024; Rasheed *et al.,* 2024; Sanjay *et al.* 2024; Soni *et al.* (2024); Tamatam and Pandey 2024; Janghel *et al.,* 2023; Lambani *et al.,* 2023; Verma *et al.,* 2023; Balpande *et al.,* 2022; Dhopre *et al.,* 2022; Gulwane *et al.,* 2022; Kandwal *et al.,* 2022; and Mushtaq *et al.,* 2013.

Table 1: Analysis of variance for eleven quantitative characters in Chickpea

S.No.	Traits	Replicate (df=2)	Treatments (df=22)	Error (df=44)
1	D50%F	15.23	65.92**	3.50
2	DM	16.80	61.25**	4.40
3	PL	0.01	0.18**	0.01
4	PH	14.14	18.88**	7.31
5	NPPP	33.28	184.78**	6.49
6	NSPP	0.03	0.09**	0.02
7	NBPP	3.46	32.13**	1.62
8	BYPP	339.78	598.52**	218.22
9	SI	0.05	171.46**	1.30
10	HI	121.62	112.09**	71.64
11	SYPP	91.68	39.76**	20.53

**Significant at 5% probability level, **Significant at 1% probability level*

Mean, Range and Variability Performance of chickpea genotypes

The mean performance of 23 genotypes of chickpea were presented in Table 3 and Figure 2 the genotypes showing very high performance in desirable direction for various characters listed in Table 2 can serve as suitable donors for improving the traits. As per recorded mean performance the varieties viz., RVG 202, JG 63, JG 6, JG 315, Kabuli Small, and JG 14 showing high seed yield per plant (g). so as per the data observed for these varieties are recommended for the cultivation in Satna district of M.P.

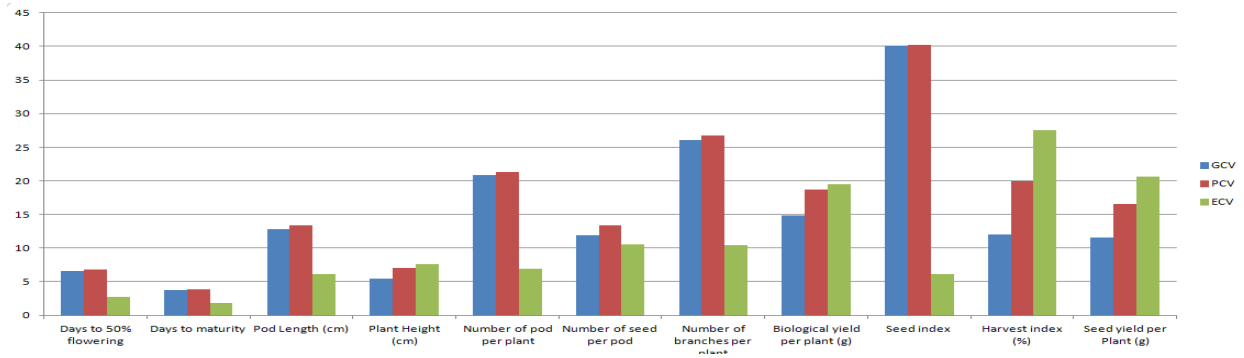
Table 2: Most desirable chickpea genotypes identified for different traits

Traits	Genotypes
D 50%F	Vijay, Jaki 9218, JG 412, JG 63, JG 218, JG 322, and RVG 202.
DM	JG 63, Jaki 9218, Vijay, JG 412, JG 16, Dhanshree, and JG 218.
PL	JK 5 (Kabuli), Kabuli Small, JG 6, Local, JG 130, Narendra 2, and RVG 202.
PH	Safed Chana, Narendra 2, JG 12, Jyoti 5, Vijay, and Dhanshree.
NPPP	Raj 128, JG 63, JG 14, JG 412, Safed Chana, and JG 11.
NSPP	Kala Chana, Dhanshree, JG 14, JG 6, JG 130, and JG 218.
NBPP	JG 16, JG 14, JG 11, Kala Chana, Narendra 2, and Raj 128.
BYPP	JG 63, Narendra 2, Raj 128, RVG 202, JG 12, and JG 412.
SI	JK 5 (Kabuli), Kabuli Small, Jaki 9218, Local, JG 6, and Narendra 2.
HI	Safed Chana, Kabuli Small, JG 322, JG 130, JG 6, and JG 315.
SYPP	RVG 202, JG 63, JG 6, JG 315, Kabuli Small, and JG 14.

The GCV and PCV of 11 traits of chickpea were presented in Table 4 and Figure 3 From the greatest seed index (g.) (40.08%) to the lowest days to maturity (3.71%), the GCV differed in range. The seed index (g.) (40.08%), number of branches per plant (26.09%), and number of pods per plant (20.89%) showed the highest genotypic coefficient variation. The following characters had moderate and low GCV: days to 50% flowering (6.60%), plant height (cm) (5.48%), days to maturity (3.71%), number of seeds per pod (11.92%), biological yield per plant (g) (14.87%), pod length (cm) (12.86%), harvest index (%) (11.96%). This suggests that certain personalities are less susceptible to changes in their surroundings; hence these qualities should be prioritized more.

The harvest index (%) (19.91), number of branches per plant (26.78), number of pods per plant (21.26), and seed index (40.23) all had the highest PCV values. From the greatest seed index (g) (40.23%) to the lowest days to maturity (3.85%), there was a variance in the magnitude of PCV. High phenotypic coefficient of variance characteristics suggested more environmental factor effect. Since of this, care must be taken throughout the selection process since environmental fluctuations have an unpredictable character and might cause findings to be misinterpreted.

These results are accordance to results reported by Kumar *et al.,* (2024) observed maximum GCV and PCV for plant population, number of secondary branches, number of pods per plant, seed yield per plant and biological yield per plant. Tamatam and Pandey (2024) observed highest Genotypic & phenotypic coefficient of variance for the trait SY whereas,



Comparative study and GCV, PCV, and ECV

moderate estimates for NSP, TW, HI, NUFP and BY. Janghel *et al.,* (2023) observed maximum GCV and PCV for seed yield per plant, number of seeds per pod, plant height (cm), number of pods per plant and days to maturity. Ram *et al.,* (2023) observed highest Genotypic & phenotypic coefficient of variance for the traits viz., 100 seed weight and plant-level seed yield. Verma *et al.,* (2023) observed highest Genotypic & phenotypic coefficient of variance for the traits viz., number of nodules per plant, number of pods per plant and number of seeds per pod. Balpande *et al.,* (2022) reported high GCV and PCV in case of hundred seed weight, followed by pod length, harvest index, seed yield/plant and number of seeds/pod.

Table 3: Mean performance of 11 characters of chickpea genotypes

Genotypes	D50%F	DM	PL	PH	NPPP	NSPP	NBPP	BYPP	SI	HI	SYPP
JG 6	70.00	118.00	1.99	35.27	28.07	1.47	12.53	69.57	22.80	37.48	25.96
JG 130	69.33	124.00	1.91	37.60	41.27	1.47	13.20	61.68	18.80	38.06	23.48
Jyoti 5	72.33	118.00	1.66	33.67	40.27	1.27	8.80	75.98	16.28	31.28	23.38
JG 218	66.00	114.00	1.67	35.53	37.13	1.47	13.20	68.43	14.59	31.66	20.34
Jaki 9218	58.33	110.00	1.81	35.20	29.67	1.33	6.27	82.69	28.92	25.72	21.00
Vijay	57.67	112.00	1.74	33.80	39.33	1.27	14.40	62.26	17.87	30.06	17.84
Narendra 2	71.67	119.67	1.90	32.80	40.67	1.47	15.00	105.79	20.18	22.95	24.52
JG 12	71.33	116.67	1.73	32.93	40.60	1.07	13.53	87.61	11.16	18.55	16.16
JG 412	61.33	112.00	1.71	35.53	43.33	1.27	10.87	84.56	19.04	27.94	23.48
JG 63	65.33	108.67	1.78	36.47	45.47	1.07	13.13	108.70	15.34	24.91	26.92
Raj 128	72.67	118.00	1.77	37.47	46.27	1.07	14.87	97.01	20.12	20.68	20.44
JG 315	73.67	118.67	1.86	35.93	37.53	1.20	12.67	71.72	13.84	35.94	25.88
RVG 202	68.67	117.33	1.87	38.47	38.67	1.27	13.40	90.92	19.93	32.63	28.99
Kabuli Small	73.67	119.00	2.44	39.73	23.00	1.47	7.20	69.12	30.60	39.53	25.32
Safed Chana	74.00	122.67	1.74	31.47	41.80	1.47	7.20	68.96	7.78	40.30	24.12
Kala Chana	73.67	122.33	1.63	35.40	39.53	1.67	15.47	65.19	13.31	29.16	16.57
JG 14	69.00	117.67	1.74	36.00	45.27	1.53	16.47	70.19	16.54	35.73	24.54
JG 11	68.67	122.00	1.83	34.60	41.40	1.13	15.53	70.31	17.04	30.11	20.45
JK 5 (Kabuli)	70.67	115.67	2.71	42.47	22.73	1.40	5.07	72.98	43.02	30.83	21.76
JG 16	70.00	112.67	1.85	39.13	39.80	1.33	16.60	68.08	11.68	28.85	18.56
Dhanshree	70.00	113.00	1.77	33.80	39.73	1.60	12.40	65.31	18.16	31.42	19.96
JG 322	67.67	121.00	1.67	34.27	29.80	1.27	11.87	53.36	11.50	38.65	20.65
Local	74.00	125.33	1.95	36.53	17.60	1.07	11.47	70.67	23.70	23.65	15.23

Day count to 50% blooming (D50%F), Days to maturity (DM), Length of pod (cm) (LP), Height of plant (cm) (PH), Number of pods per plant (NPPP), Number of seeds per pod (NSPP), Number of branches per plant (NBPP), Biological yield per plant (g) (BYPP), Seed index (100 seeds) (SI), Harvest index (%) (HI), and Seeds yield per plant (g) (SYPP)

Heritability and Genetic Advance

Heritability, h^2 (Broad Sense)%, Genetic Advancement @ 5%, and Genetic Advance as % of Mean 5% was estimated for all the characters and has been presented in Table 4.

Table 4: Mean, Range, GCV, PCV, ECV, and C.D. for 11 quantitative characters in chickpea

Characters	Grand mean	Range		GCV	PCV	C.D. 5%	h²b %	GA 5%	GA as 5% Mean
		Min.	Max.						
D50%F	69.12	57.67	74.00	6.60	6.78	3.08	94.70	9.14	13.23
DM	117.32	108.67	125.33	3.71	3.85	3.45	92.80	8.64	7.36
PL	1.86	1.63	2.71	12.86	13.34	0.19	93.00	0.48	25.55
PH	35.83	31.47	42.47	5.48	7.00	4.45	61.30	3.17	8.84
NPPP	36.91	17.60	46.27	20.89	21.26	4.19	96.50	15.60	42.26
NSPP	1.33	1.07	1.67	11.92	13.38	0.23	79.30	0.29	21.86
NBPP	12.22	5.07	16.60	26.09	26.78	2.10	94.90	6.40	52.37
BYPP	75.70	53.36	108.70	14.87	18.66	24.31	63.50	18.49	24.42
SI	18.79	7.78	43.02	40.08	40.23	1.88	99.20	15.46	82.25
HI	30.70	18.55	40.30	11.96	19.91	3.91	36.10	4.54	14.80
SYPP	21.98	15.23	28.99	11.52	16.56	7.46	48.40	3.63	16.51

Day count to 50% blooming (D50%F), Days to maturity (DM), Length of pod (cm) (LP), Height of plant (cm) (PH), Number of pods per plant (NPPP), Number of seeds per pod (NSPP), Number of branches per plant (NBPP), Biological yield per plant (g) (BYPP), Seed index (100 seeds) (SI), Harvest index (%) (HI), and Seeds yield per plant (g) (SYPP)

The seed index (g.) (99.20%), number of pods per plant (96.50%), number of branches per plant (94.90%), days to 50% blooming (94.70%), pod length (cm) (93.00%), and days to maturity (92.80%) were shown to have high heritability estimates. pointed to the characteristics' least susceptibility to external influences and demonstrated the phenotypic expression's reliance on the genotype of the strains' capacity to pass on the gene to their offspring. Nonetheless, low heredity (<40%) was calculated for the harvest index (%) (36.10%), while moderate heritability (>40% to <80%) was noted for the number of seeds per pod (79.30%), biological yield per plant (g) (63.50%), plant height (cm) (61.30%), and seed yield per plant (g) (48.40%).

Table 5: Genotypic and Phenotypic correlation coefficient for 11 quantitative traits in chickpea

Traits		D50%F	DM	PL	PH	NPPP	NSPP	NBPP	BYPP	SI	HI	SYPP
D50%F	Gen	1.000	0.691**	0.235*	0.123	-0.131	0.102	0.044	-0.016	-0.095	0.186	0.050
	Phe	1.000	0.685**	0.228*	0.104	-0.132	0.109	0.026	-0.046	-0.089	0.134	0.024
DM	Gen		1.000	0.056	-0.147	-0.232*	0.081	0.080	-0.420**	-0.128	0.520**	-0.120
	Phe		1.000	0.061	-0.096	-0.222	0.098	0.067	-0.340**	-0.120	0.298*	-0.107
PL	Gen			1.000	0.957**	-0.673**	0.088	-0.556**	-0.061	0.879**	0.389**	0.361**
	Phe			1.000	0.727**	-0.640**	0.107	-0.522**	-0.029	0.844**	0.279*	0.298*
PH	Gen				1.000	-0.472**	-0.163	-0.335**	-0.027	0.836**	0.151	0.348**
	Phe				1.000	-0.385**	-0.012	-0.275*	-0.008	0.651**	0.083	0.260*
NPPP	Gen					1.000	-0.028	0.578**	0.435**	-0.647**	-0.303**	0.327**
	Phe					1.000	-0.031	0.559**	0.341**	-0.634**	-0.276*	0.267*
NSPP	Gen						1.000	-0.078	-0.506**	0.098	0.942**	0.240
	Phe						1.000	-0.068	-0.414**	0.080	0.518**	0.117
NBPP	Gen							1.000	0.061	-0.578**	-0.376**	-0.293*
	Phe							1.000	0.081	-0.562**	-0.247*	-0.277*
BYPP	Gen								1.000	0.101	-0.681**	0.545**
	Phe								1.000	0.086	-0.654**	0.338**
SI	Gen									1.000	-0.073	0.156
	Phe									1.000	-0.043	0.116
HI	Gen										1.000	0.324**
	Phe										1.000	0.462**
SYPP	Gen											1.000
	Phe											1.000

**Significant at 5% probability level, **Significant at 1% probability level*

Day count to 50% blooming (D50%F), Days to maturity (DM), Length of pod (cm) (LP), Height of plant (cm) (PH), Number of pods per plant (NPPP), Number of seeds per pod (NSPP), Number of branches per plant (NBPP), Biological yield per plant (g) (BYPP), Seed index (100 seeds) (SI), Harvest index (%) (HI), and Seeds yield per plant (g) (SYPP)

In terms of genetic advance, a high estimate of 5% (more than 20%) was found for the seed index (82.25%). This was followed by the number of branches (52.37%), pods (42.26%), length of the pod (cm) (25.55%), biological yield (g) (24.42%), and number of seeds per pod (21.86%) per plant. While a substantial genetic progress was noted for seed yield per plant (g) (16.51%), harvest index (%) (14.80%), and days to 50% blooming (13.23%), as a percentage of mean (5%) (between 10% and 20%). For plant height (cm) (8.84%) and days to maturity (7.36%), low estimates of predicted genetic progress (less than 10%) were discovered. High genetic advancement and high heritability were found for the seed index (SI), number of pods per plant (NPPP), number of branches per plant (NBPP), and pod length (cm) (LP), suggesting that additive gene action may play a significant role in determining these traits. Therefore, choosing these features might have a greater impact on the intended genetic improvement. It is supported by similar findings of noted by Aroosa and Ahmed (2024); Deshmukh *et al.,* (2024); Kalyar *et al.,* (2024); Kumar *et al.,* (2024); Prathyusha *et al.,* (2024); Sanjay *et al.,* (2024); Soni *et al.* (2024); Tamatam and Pandey (2024); Janghel *et al.,* (2023); Verma *et al.,* (2023); Balpande *et al.,* (2022); Gulwane *et al.,* (2022); and Kandwal *et al.,* (2022) in their respective studies.

Table 6: Direct and indirect effect for different characters on seed yield per plant at genotypic level in chickpea

Traits	D50%F	DM	PL	PH	NPPP	NSPP	NBPP	BYPP	SI	HI
D50%F	-0.253	-0.175	-0.060	-0.031	0.033	-0.026	-0.011	0.004	0.024	-0.047
DM	0.029	0.042	0.002	-0.006	-0.010	0.003	0.003	-0.018	-0.005	0.022
PL	0.154	0.037	0.654	0.626	-0.441	0.057	-0.364	-0.040	0.575	0.255
PH	-0.018	0.021	-0.140	-0.146	0.069	0.024	0.034	0.004	-0.122	-0.022
NPPP	-0.020	-0.036	-0.105	-0.073	0.155	-0.004	0.090	0.068	-0.101	-0.047
NSPP	0.001	0.001	0.001	-0.002	0.000	0.011	-0.001	-0.006	0.001	0.010
NBPP	0.002	0.004	-0.030	-0.013	0.031	-0.004	0.053	0.003	-0.031	-0.020
BYPP	-0.017	-0.465	-0.068	-0.029	0.481	-0.559	0.068	1.104	0.112	-0.752
SI	0.023	0.030	-0.209	-0.199	0.154	-0.023	0.138	-0.024	-0.238	0.017
HI	0.150	0.420	0.315	0.122	-0.245	0.761	-0.304	-0.550	-0.059	0.808

Note: R Square = 0.9495, Residual Effect = 0.2247, Diagonal Bold = Direct path

Correlation and Path Coefficient Analysis

The results of correlation were shown in Table 5. Using path coefficient analysis, the genotypic and phenotypic correlation coefficient of seed yield with the remaining features under investigation were further divided into direct and indirect impacts, as shown in Table 6 and Table 7, respectively.

The characters that showed a positive and significant correlation with the seed yield per plant (g) at both the genotypic and phenotypic levels were: pod length (cm) (0.361 and 0.298), plant height (cm) (0.348 and 0.260), number of pod per plant (0.327 and 0.267), number of branches per plant (-0.293 and -0.277), biological yield per plant (g) (0.545 and 0.338), and harvest index (%) (0.324 and 0.462). Accordingly, the number of seeds produced per plant rises as each of these features increases. This correlation is statistically significant both at the genotypic and phenotypic levels. Increased seed yield per plant is essentially correlated with longer pod length, greater plant height, more pods per plant, better biological yield, and a higher harvest index.

The results of path coefficient analysis showed that the number of pods per plant (0.155 and 0.028), number of branches per plant (0.053 and 0.166), harvest index (%) (0.808 and 1.390), and biological yield per plant (g) (1.104 and 1.064) had the greatest positive direct effects on seed yield at both the genotypic and phenotypic levels, respectively. Conversely, plant height (cm) (-0.146 and -0.029) showed a direct negative impact on seed production at the genotypic and phenotypic levels, respectively. At the genotypic and phenotypic levels, the harvest index (%) utilizing days to 50% blooming, days to maturity, pod length (cm), plant height (cm), and number of seeds per pod showed the strongest positive indirect influence on seed

Table 7: Direct and indirect effect for different characters on seed yield per plant at phenotypic level in chickpea

Traits	D50%F	DM	PL	PH	NPPP	NSPP	NBPP	BYPP	SI	HI
D50%F	0.121	0.083	0.028	0.013	-0.016	0.013	0.003	-0.006	-0.011	0.016
DM	-0.111	-0.163	-0.010	0.016	0.036	-0.016	-0.011	0.055	0.020	-0.049
PL	-0.064	-0.017	-0.280	-0.204	0.179	-0.030	0.146	0.008	-0.236	-0.050
PH	-0.003	0.003	-0.021	-0.029	0.011	0.000	0.005	0.000	-0.019	-0.002
NPPP	-0.004	-0.006	-0.018	-0.011	0.028	-0.001	0.016	0.010	-0.018	-0.005
NSPP	-0.017	-0.015	-0.017	0.002	0.005	-0.155	0.010	0.064	-0.012	-0.080
NBPP	0.004	0.011	-0.087	-0.029	0.093	-0.011	0.166	0.014	-0.094	-0.041
BYPP	-0.048	-0.362	-0.031	-0.009	0.363	-0.441	0.087	1.064	0.091	-0.696
SI	-0.041	-0.055	0.384	0.296	-0.289	0.036	-0.256	0.039	0.455	-0.020
HI	0.187	0.415	0.249	0.115	-0.245	0.720	-0.344	-0.910	-0.060	1.390

Note: R Square = 0.9734, Residual Effect = 0.1630, Diagonal & Bold = Direct path

yield per plant, respectively. Additionally, at the genotypic and phenotypic levels, this feature has the greatest indirect negative impact on seed yield per plant as measured by the number of pods, branches, and biological yield per plant (g) on each plant.

The results obtained for correlation and path coefficient analysis are accordance to Deshmukh *et al.,* (2024); Srikanth *et al.,* (2024); Jain *et al.,* (2023); Kiran *et al.,* (2023); Lambani *et al.,* (2023); Ram *et al.,* (2023); Kandwal *et al.,* (2022); Meena *et al.,* (2021); Farshadfar *et al.,* (2013); Mushtaq *et al.,* (2013), Yucel *et al.,* (2010), and Malik *et al.,* (2010).

CONCLUSION

The experiment's design revealed statistically significant variations for every character that was assessed. As per recorded mean performance the varieties viz., RVG 202, JG 63, JG 6, JG 315, Kabuli Small, and JG 14 showing high seed yield per plant (g). so as per the data observed for these varieties are recommended for the cultivation in Satna district of M.P. the traits viz., seed index (g.), number of branches per plant, and number of pods per plant showed the highest GCV and PCV. High genetic advancement and high heritability were found for the SI, NPPP, NBPP, and LP, suggesting that additive gene action may play a significant role in determining these traits. Therefore, choosing these features might have a greater impact on the intended genetic improvement. Increased seed yield per plant is essentially correlated with longer pod length, greater plant height, more pods per plant, better biological yield, and a higher harvest index. Therefore, these characters should be considered for yield improvement in chickpea breeding programme.

ACKNOWLEDGEMENT

This paper and the research behind it would not have been possible without the exceptional support of my supervisor, Mr. Rajbeer Singh Gaur. I acknowledge to all the faculty of Department of Genetics and plant breeding and AKS University, Satna (M.P.) for providing the essential facilities during the research.

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