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Correlation, Path Analysis and Genetic Divergence of Various Agro-morphological Traits and Traits Suitable for Mechanical Harvesting of Chickpea (*Cicer arietinum* L.) Germplasm

R. V. Charitha Reddy [a], Rumana Khan [a*], Anshuman Singh [a] and S. K. Chaturvedi [a]

[a] Department of Genetics and Plant Breeding, Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh 284003, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Five hundred and forty germplasm lines of chickpea were evaluated along with five checks (RLBGK-1, BG 3062, RVG 204, Phule Vikram, NBeG 47) in augmented design during rabi, 2021–2022 at Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India to study the agro-morphological features and traits appropriate for mechanical harvesting. Correlation, path coefficient analysis and genetic divergence were estimated to find out the extent of association and

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**Corresponding author: E-mail: rumanakhan1@yahoo.com;*

genetic divergence among chickpea germplasm. Plant height, growth habit, the height of the initial podding node, and the angle of the primary branch are characteristics that have been researched to identify lines that are suited for mechanical harvesting. Peduncle length, number of primary branches, number of secondary branches, number of pods per plant, chlorophyll content, leaf area index, chlorophyll fluorescence showed positive correlation with seed yield per plant. Plant height and height of first podding node were showing positive high indirect effects through number of secondary branches on seed yield per plant. Cluster 1 was the largest with 399 germplasm while two clusters number 24 and 37 were smallest with 1 genotype each. Plant height and height of first podding node were exhibiting maximum mean in cluster 32, whereas seed yield per plant was having maximum mean in cluster 14. According to percent contribution of different characters to total divergence obtained, the most significant contributors to the divergence were number of pods per plant and plant height. Correlation analysis indicated that traits suitable for mechanical harvesting are not directly correlated with seed yield, while path coefficient analysis indicated that they have indirect effects on seed yield through number of primary and secondary branches per plant.

Keywords: Correlation; seed yield; germplasm; chickpea; path coefficient.

1. INTRODUCTION

The most prominent and historically significant legume is the chickpea (*Cicer arietinum* L.). It is a diploid (2n=16) pulse crop that self-pollinates. It has a 738 million base pair genome [1]. The Latin term cicer, which refers to the Fabaceae plant family of legumes, is where the name "chickpea" originates. A relatively nutrient-dense pulse crop, chickpeas have modest levels of digestible carbohydrates (40–60%), protein (15–22%), and essential fats (4–8%). Chickpea is the most versatile legume consumed in India, being used for main meals, savoury snacks, and sweets. This is primarily due to its taste. It can be eaten whole, sprouted, immature pods, mature green seed, or ground into dhal and flour. The grain and flour are both further processed into a variety of products. Its flour is fine and quick to prepare. Technology for making ready-to-eat foods such as biscuits, cookies, and fermented foods. Alternative uses for chickpeas include soup mixes made with chickpea flour [2]. They are divided into desi and kabuli categories. The kabuli kinds have higher sugar levels and lower fibre levels than the desi types. The kabuli varieties have larger seeds and have a greater market price than the desi varieties. The price premium in kabuli varieties rises in tandem with the seed size [3]. Mechanical harvestable varieties released in India are NBeG 47 (ICCV 05106), Phule Vikram (ICCV 08108), BG 3062 (1CCV 08112), RVG 204 (ICCV 08102). Traditional varieties are short, semi spreading, height of lower pods 15-20cm from ground, whereas mechanical harvestable varieties are upright and tall, fruiting zone start about 30cm from ground. Total mechanization of harvesting is cost effective and quicker, reducing the risk of ripened crops exposure to untimely rain or other extreme weather conditions. The canopy structure of mechanical harvestable varieties leads to high photosynthetic efficiency, low humidity which helps in reducing foliar diseases. Mechanical harvesting is labour friendly, save time, save money. Mechanical harvesting is better for the health of labourers especially women, as handling the crop causes painful dermatitis due to its high acid content [4]. These varieties are developed to address the issue of labour shortage on farms and reduce drudgery. The yield of these varieties is on par and in some conditions better than existing varieties, other disease resistance traits are also on par. Improves resource use efficiency and also developing mechanical harvestable varieties is needed to enhance area and production for reaching country's goal of self-sufficiency in pulse production. The present investigation helps to find out inter-relationships among various quantitative traits especially traits suitable for mechanical harvesting towards seed yield in chickpea and estimation of genetic divergence helps in selection of parents for utilizing in hybridization programme aimed at combining characters related to mechanical harvesting and yield attributes.

2. MATERIALS AND METHODS

The field experiment was conducted at Block-D3, University Seed and Research Farm, Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India, during Rabi, 2021–2022, with 540 germplasm, including 5 checks in augmented design. Each germplasm was grown in a single row plot of 2 metres long, with a 30 cm between-row distance and a 10 cm plant-to-plant distance. All agronomic package of practices were followed to grow the crop. Five plants from each germplasm were randomly chosen and the observations were then recorded. Data were recorded on quantitative characteristics such days to 50% flowering, the length of the peduncle, the number of primary branches, the number of secondary branches, days to maturity, the number of pods per plant, and the number of seeds per pod, 100 seed weight, seed yield per plot, plant height, height of first podding node, chlorophyll content, leaf area index and chlorophyll fluorescence. Coorelation coefficient was calculated as per Fisher, [7] and Al- Jibouri *et al.,* [6], path coefficient analysis was done as per Wright [7], Li, [8] and Dewey and Lu, [9] and genetic divergence analysis as per Mahalanobis, [10] .

3. RESULTS AND DISCUSSION

Information on the type of character associations with economic yield is crucial for the selection procedure. The correlation coefficient, denoted by the symbol r, has a value that can be between -1 and +1. When these numbers (r) diverge significantly from zero, only then does the correlation coefficient's range apply. In any case, the values point to a lack of association. Correlation studies were done to know correlation between different traits and seed yield per plant. Peduncle length, number of primary branches, number of secondary branches, number of pods per plant, chlorophyll content, leaf area index and chlorophyll fluorescence have shown positive correlation with seed yield per plant. Whereas days to 50% flowering, days to maturity, number seeds per pod, plant height, height of first podding node have shown negative correlation with seed yield per plant (Table 1).

In path coefficient analysis the residual effect (R = 0.3823) indicated that 38.23 per cent variability of seed yield per plant was explained by other traits. The direct effect was maximum for days to 50% flowering (6.4209) and days to maturity (-6.4209) followed by height of first podding node (2.3450), plant height (-2.3429), number of secondary branches (1.3229), number of primary branches (-1.3180), leaf area index (-1.0758), chlorophyll content (0.2623), number of pods per plant (0.2497), 100 seed weight (-0.2114), number of seeds per pod (0.0556). The indirect effect was also in the same order through these characters (Tables 2 & 3).

Equilibrium distance was carried out using 14 characters *viz*., days to 50% flowering, peduncle length, no of primary branches, no of secondary branches, days to maturity, number of pods per plant, number of seeds per pod, 100 seed weight, plant height, height of first podding node, chlorophyll content, leaf area index, chlorophyll fluorescence, seed yield per plant having significant difference between genotypes. The 540 genotypes were grouped in 37 clusters. The number of germplasms in different clusters ranged from 1 to 399. Cluster- 1 was the largest with 399 germplasm followed by cluster- 2 (20), Cluster- 5 (17), Cluster- 6 (14), Cluster- 4 (12), Cluster- 6 (10), Cluster- 9 (8), Cluster- 10 (7), Cluster- 3, 8 (6 each), Cluster-14 (4), Cluster-13,15,16,18 (3 each), Cluster-11,12,17,19,20,21,22,23 (2 each) and Cluster-24 to Cluster 37 (1 each).

The most significant contributors to the divergence were the parameters no. of pods per plant and plant height. The analysis of variance revealed significant difference between cluster means for days to 50% flowering, peduncle length, no of primary branches, no of secondary branches, days to maturity, number of pods per plant, number of seeds per pod, 100 seed weight, plant height, height of first podding node, chlorophyll content, leaf area index, chlorophyll fluorescence, seed yield per plant. The accessions having traits suitable for mechanical harvesting were grouped in cluster 32 and high seed yielding accessions were grouped in cluster 14. Vishnu *et al.* (2020) viewed most divergence in clusters IV & V in both rainfed and irrigated conditions. Mastamaradi *et al.* (2020) grouped genotypes into different clusters and observed that genotypes from cluster II & I have suitable traits for machine harvesting, whereas genotypes of cluster IV & III shown good yield (Table 4).

Table 1. Estimation of the phenotypic (below diagonal) and genotypic (above diagonal) correlation coefficient between fourteen characters in chickpea 2021-2022

	Character	DF	PL	NPB	NSB	DM	NPPP	NSPP	SW100	PH	HFPN	CC	LAI	CF	SYPP
1	DF		-0.02	-0.03	-0.03	1.00	-0.15**	-0.10*	-0.18**	0.03	0.03	0.04	-0.51**	0.16**	-0.50**
2	PL	-0.01		0.70**	0.70**	-0.02	-0.89**	0.87**	0.61	-0.10*	-0.11*	-0.62**	-0.14**	-0.44**	0.51**
3	NPB	-0.02	0.08		1.00	-0.03	0.18**	-0.08	-0.57**	0.04	0.04	-0.18**	0.30**	-0.15**	0.39**
4	NSB	-0.02	0.08	1.00		-0.03	0.18**	-0.08	-0.58**	0.04	0.04	-0.18**	0.30**	-0.15**	0.39**
5	DM	1.00	-0.01	-0.02	-0.02		-0.15**	-0.10*	-0.18**	0.03	0.03	0.04	-0.51**	0.16**	-0.50**
6	NPPP	-0.09*	-0.04	0.14**	0.14**	-0.09*		-0.00	0.09*	0.09*	0.09*	0.10*	0.23**	-0.24**	0.35**
7	NSPP	-0.06	-0.01	-0.01	-0.01	-0.06	0.01		0.99	-0.17**	-0.17**	0.12**	-0.03	-0.16**	-0.09*
8	SW100	-0.07	0.00	-0.02	-0.02	-0.07	-0.00	-0.00		0.88**	0.88**	-0.19	0.60**	-0.10	0.10
9	PH	0.05	-0.00	0.05	0.05	0.05	0.08	0.00	0.03		1.00	0.15**	0.22**	-0.03	-0.13**
10	HFPN	0.05	-0.00	0.05	0.05	0.05	0.08	0.00	0.03	1.00		0.15**	0.22**	-0.03	-0.13**
11	CC	-0.03	-0.06	-0.02	-0.02	-0.03	-0.02	0.01	0.02	-0.04	-0.04		0.00	0.24**	0.34**
12	LAI	-0.32**	0.01	0.24**	0.24**	-0.32**	0.21**	0.01	0.08	0.16**	0.16**	0.04		-0.34**	0.13**
13	CF	0.02	0.03	-0.09*	-0.09*	0.02	-0.13**	-0.03	-0.14**	0.07	0.07	0.15**	-0.21**		0.22**
14	SYPP	-0.18**	-0.04	0.25**	0.25**	-0.18**	0.28**	0.02	0.07	-0.01	-0.01	0.01	0.09*	0.03	

** and ** correlation is significant at the 0.05 and 0.01 level.*

Table 2. Genotypic path analysis direct effects (diagonal) and indirect effects (off-diagonal) of different traits on Seed yield per plant

S. N	Character	DF	NPB	NSB	DM	NPPP	NSPP	SW100	PH	HFPN	CC	LAI	r
1	DF	**6.4209**	4.0422	-4.0198	-6.4209	-0.0362	-0.0058	0.4617	-7.6817	7.7140	0.0098	0.5520	-0.4995**
2	NPB	-1.9692	**-1.3180**	1.3229	1.9692	0.0448	-0.0043	0.1208	-9.6424	9.7074	-0.0481	-0.3233	0.3872**
3	NSB	-1.9511	-1.3180	**1.3229**	1.9511	0.0448	-0.0042	0.1220	-9.7356	9.8006	-0.0483	-0.3232	0.3881**
4	DM	6.4209	4.0422	-4.0198	-**6.4209**	-0.0362	-0.0058	0.4617	-7.6817	7.7140	0.0098	0.5520	-0.4995**
5	NPPP	-9.3122	-2.3654	2.3739	9.3122	**0.2497**	0.0000	-0.0182	-2.1149	2.1184	0.0263	-0.2450	0.3545**
6	NSPP	-6.7128	1.0089	-1.0010	6.7128	-0.0001	**0.0556**	-0.4207	4.0946	-4.0981	0.0311	0.0361	-0.0922*
7	SW100	-1.4024	7.5331	-7.6351	1.4024	0.0215	0.1107	**-0.2114**	-2.0628	2.0607	-0.3132	-0.6436	1.0963
8	PH	2.1052	-5.4244	5.4970	-2.1052	0.0225	-0.0097	-0.1861	**-2.3429**	2.3450	0.0398	-0.2321	-0.1347**
9	HFPN	2.1122	-5.4561	5.5288	-2.1122	0.0226	-0.0097	-0.1857	-2.3429	**2.3450**	0.0398	-0.2323	-0.1347**
10	CC	2.3917	2.4151	-2.4342	-2.3917	0.0250	0.0066	0.2524	-3.5534	3.5581	**0.2623**	-0.0023	0.3418**
11	LAI	-3.2943	-3.9612	3.9737	3.2943	0.0569	-0.0019	-0.1264	-5.0541	5.0639	0.0006	-**1.0758**	0.1327**

** and ** correlation are significant at the 0.05 and 0.01 level; Residual = 0.3823*

Table 3. Phenotypic path analysis direct effects (diagonal) and indirect effects (off-diagonal) of different traits on Seed yield per plant

S. N	Character	DF	NPB	NSB	DM	NPPP	NSPP	SW100	PH	HFPN	CC	LAI	r
1	**DF**	**7.46896**	-2.16180	2.14680	-7.46896	-0.02680	-0.00170	6.04485	-6.03859	0.00190	-0.00530	0.00090	-0.1797**
2	**NPB**	-1.25389	**1.28767**	-1.28519	1.25389	0.04200	-0.00040	6.17353	-6.17762	0.00140	0.00410	-0.00560	0.2512**
3	**NSB**	-1.24760	1.28767	**-1.28519**	1.24760	0.04210	-0.00040	6.16441	-6.16851	0.00150	0.00410	-0.00560	0.2512**
4	**DM**	7.46896	-2.16180	2.14680	**-7.46896**	-0.02680	-0.00170	6.04485	-6.03859	0.00190	-0.00530	0.00090	-0.1797**
5	**NPPP**	-6.77177	1.83376	-1.83120	6.77177	**0.29520**	0.00040	9.08912	-9.09421	0.00150	0.00350	-0.00790	0.2845**
6	**NSPP**	-4.43500	-1.61480	1.60000	4.43500	0.00430	**0.02810**	4.98600	-4.99330	-0.00060	0.00010	-0.00180	0.02120
7	**SW100**	4.01451	7.06850	-7.04440	-4.01451	0.02390	0.00010	**1.12464**	-1.12469	0.00310	0.00270	0.00430	-0.00570
8	**PH**	4.01015	7.07280	-7.04880	-4.01015	0.02390	0.00010	1.12464	**-1.12469**	0.00310	0.00270	0.00430	-0.00570
9	**HFPN**	-1.94760	-2.53900	2.55110	1.94760	-0.00620	0.00020	-4.80158	4.80839	**-0.07350**	0.00070	0.00910	0.01500
10	**CC**	-2.36227	3.13730	-3.13080	2.36227	0.06230	0.00020	1.84752	-1.84847	-0.00320	**0.01660**	-0.01270	0.0938*
11	**LAI**	1.17674	-1.21481	1.21287	-1.17674	-0.03930	-0.00090	8.21707	-8.21171	-0.01120	-0.00360	**0.05920**	0.03200

** and ** correlation are significant at the 0.05 and 0.01 level; Residual = 0.8795*

Table 4. Percent contribution of different characters to total divergence

Method	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14
Eigen %	3.63	1.51	0.30	0.00	0.00	75.12	0.02	0.56	10.49	0.00	0.09	0.06	0.00	8.21

4. CONCLUSION

From the results of present investigation, it is clear that, traits responsible for mechanical harvesting has indirect effects through number of primary branches and secondary branches per plant towards seed yield, so seed yield might be improved by selecting for more number of primary branches and secondary branches per plant. For selection of parents having mechanical harvestable ability and parents for high seed yield for utilization in hybridization, germplasm in cluster 32 and cluster 14 are selected as plant height and height of first podding node were showing maximum mean in cluster 32, whereas seed yield per plant maximum mean was in cluster 14.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Varshney RK, Song C, Saxena RK, Azam S, Yu S, Sharpe AG, Cook DR. Draft genome sequence of chickpea (*Cicer arietinum*) provides a resource for trait improvement. Nature biotechnology. 2013;31(3):240-246.
2. Geervani P. Utilization of chickpea in India and scope for novel and alternative uses. Uses of Tropical Grain Legumes. 1989; 27:47.
3. Gaur PM, Tripathi S, Gowda CL, Ranga Rao GV, Sharma HC, Pande S, Sharma M. Chickpea seed production manual; 2010.
4. Singh S, Sasidharan N, Kalyanrao. Assessment of Genetic Diversity in Chickpea (*Cicer arietinum* L.) through Morphological Characterization. Plant Archives. 2018;18(1):167-172.
5. Fisher RA. Statistical methods of research workers. 12th Edition. Biological Monograph and Manuals. 1954;5:130-131.
6. Al-Jibouri HA, Miller PA, Robinson HF. Genotypic and environmental variances and covariances in upland cotton of inter-specific origin. Agron. J. 1958;50:633-637.
7. Wright S. Correlation and causation. J. Agric. Res. 1921;20:557-585.
8. Li CC. The concept of path coefficient and its impact on population genetics. Biometrics. 1956;12(2):190-210.
9. Dewey DR, Lu KH. A correlation and path-coefficient analysis of components of crested wheatgrass seed production. Agron. J. 1959;51:515-518.
10. Mahalanobis PC. On generalized distance in statistics. Proceeding National institute of Science India. 1936;2:49-55.

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