Original Research Article

Genetic variability and trait association in *desi* and*kabuli* chickpea

ABSTRACT

Comprehensive assessment of genetic variability necessitates the integration of diverse genetic parameters beyond mere phenotypic observations. Sixty one*desi* and *kabuli* chickpea genotypes were assessed for genetic potential and character associations. High GCV%, PCV%, heritability and genetic advance as percentage of mean was recorded for number of effective pods per plant, seed yield per plant, 100 seed weight, total number of pods per plant, number of secondary branches per plant, harvest index and biological yield per plant. Seed yield per plant exhibited significant and positive correlation as well as highest positive direct effect with harvest index and biological yield per plant. These traits were considered during further selections in chickpea improvement programmes.

Keywords: Association, Chickpea, Path, Variability

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1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the oldest cultivated legumes globally, prized for its nutritional value, adaptability to diverse environments, and crucial role in food security. Particularly in regions where access to animal protein is limited, chickpeas serve as a sustainable and nutritious alternative, contributing to improved dietary diversity and health outcomes. Chickpeas are integral to sustainable agricultural practices due to their ability to fix atmospheric nitrogen through symbiosis with Rhizobium bacteria. As a rotation crop, chickpeas contribute to crop diversification, pest management, and overall agroecosystem resilience.

Chickpea exhibits significant genetic variation across a range of qualitative and quantitative traits, encompassing characteristics such as earliness, height of the plant, more number of branches and effective pods. This inherent variability provides a rich resource for breeders, enabling the development of ideal plant type. Understanding the genetic variability of key traits in chickpea is fundamental for enhancing yield potential. By harnessing genetic variability, researchers aim to develop improved chickpea varieties that meet evolving consumer preferences and contribute to sustainable agricultural intensification.

2. MATERIALS AND METHODS

A total of sixty one chickpea genotypes comprising 52 *desi* and 9 *kabuli* genotypes were evaluated at Seed Breeding Farm, JNKVV, Jabalpur during *rabi* season. Genotypes were sown in three replications using a Randomized Complete Block Design (RCBD) in 4.0m long plots of size 4.8m^2**.** Field experiments were conducted to evaluate a variable set of quantitative traits. Data on traits including flower initiation (FI), days to 50% flowering (50%F), days to maturity (DM), plant height (PH), number of primary branches (NPB), number of secondary branches (NSB), number of nodes (NN), internode length (IL), height at fruit nodes (HFN), stem diameter (SD), total number of pods (TP), effective pods (EP), number of seeds per pod (S/P), 100 seed weight (100SW), biological yield (BY), harvest index (HI), and seed yield per plant (SY) were recorded. Genetic parameters of variability *viz*., mean, ranges, coefficients of variation, heritability, genetic advance and trait associations were estimated using standard statistical methods.

3. RESULTS AND DISCUSSIONS

Assessing genetic variability is pivotal in agricultural and biological sciences to enhance crop yield, and resilience against environmental stresses. Phenotypic variation, influenced by both genetic makeup and environmental conditions, serves as an initial indicator of trait variability. High genotypic (GCV%) and phenotypic (PCV%) coefficient of variance was recorded (Table 1) for number of effective pods per plant, seed yield per plant, 100 seed weight, total number of pods per plant, number of secondary branches per plant, harvest index and biological yield per plant indicated the presence of sufficient variability in the existing material. Similar research conclusion was drawn by previous researchers [1] for number of pods per plant and 100 seed weight [2] for seed yield per plant. Researches for Utilization of these genetic parameters that elucidate the underlying genetic factors shapes the phenotypic expression of chickpea. The previous research [3, 4, 5, 6, 7] explores the role of similar genetic parameters in evaluating genetic variability, emphasizing their utility in supervisory breeding efforts and achieving sustainable agricultural advancements.

Heritability, a fundamental genetic parameter, quantifies the proportion of phenotypic variation attributable to genetic factors. By partitioning total variance into genetic variance, environmental variance, and genotype-environment interactions, researchers gain insights into the relative influence of genes and environment on trait expression. High heritability estimate coupled with high genetic advance as percentage of mean were recorded for 100 seed weight, total number of pods per plant, height of the first fruiting node, number of secondary branches per plant, number of effective pods per plant, biological yield per plant, seed yield per plant and harvest index. This breakdown facilitates decision-making in breeding programs by identifying traits most amenable to genetic manipulation and predicting the success of selection efforts.

Table 1: Genetic parameters of variability for yield and its components in chickpea genotypes

S. No.	Traits	Mean	Range		PCV (%)	GCV (%)	h^2b (%)	GA as % of mean
			Min.	Max.				

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								5%
1	FI	43.0	20.0	60.0	10.1	9.7	93.9	19.4
2	50% F	51.7	37.0	70.0	16.2	15.9	97.6	32.4
3	DM	118.0	105.0	126.0	3.2	2.9	87.8	5.7
4	PH	60.0	44.6	80.7	12.9	11.9	84.6	22.5
5	NPB	2.1	1.6	3.3	12.1	5.3	18.9	4.7
6	NSB	5.5	2.6	17.0	38.0	35.5	87.2	68.3
7	NN	28.2	21.7	38.3	8.8	6.5	55.6	10.0
8	IL	2.1	1.5	2.3	12.6	10.4	68.1	17.6
9	HFN	21.9	10.3	31.3	21.2	20.0	88.9	38.8
10	SD	0.3	0.2	0.6	15.5	12.1	59.9	19.2
11	TP	58.1	16.5	118.7	37.7	36.6	93.9	73.0
12	EP	33.7	4.5	91.2	46.0	42.8	86.4	81.9
13	S/P	1.2	0.4	3.5	29.4	9.8	11.0	6.6
14	100SW	22.7	3.2	59.5	39.6	39.1	97.1	79.3
15	BY	28.6	8.3	66.7	30.5	28.3	86.0	54.0
16	HI	18.4	5.1	48.0	34.9	30.1	74.4	53.5
17	SY	5.2	0.7	16.2	45.7	42.4	85.6	80.7

Classes of Heritability (%): High >70 %, Medium 50-70%, Low < 50 %

Classes of Genetic Advance (%): High >35 %, Medium 25-35%, Low < 25 %

Note: FI=Flower initiation, 50%F= days to 50% flowering, DM= days to maturity, PH= plant height (cm), NPB= number of primary branches, NSB= number of secondary branches, NN= number of nodes, IL= internode length (cm), HFN= height at fruit nodes (cm), SD= stem diameter (mm), TP= total number of pods, EP= number of effective pods, S/P= number of seeds per pod, 100SW= 100 seed weight (g), BY= biological yield (g), HI= harvest index, and SY= seed yield per plant (g)

3.1 Character association

The seed yield in almost all the crops is a complexcharacter, which manifests from multiplicative interaction of several other characters that are termed as yield components. The genetic architecture of grain yield inchickpea as well as other crops is based on the balanceor overall net effect produced by various yield componentsdirectly or indirectly by interacting with one another.Therefore,selection for yieldper se alone would notmatter much as such unless accompanied by the selectionfor various component characters.

The seed yield in agricultural crops such as chickpea is intricately tied to a multitude of interacting factors known as yield components. These components collectively influence the overall grain yield, highlighting the complexity of yield determination. Consequently, prioritizing the enhancement of total yield alone may not suffice without concurrent improvement of specific component traits responsible for yield formation. Selective breeding strategies aimed at optimizing these individual traits are essential for maximizing seed yield and enhancing agricultural productivity in crops like chickpea.

Seed yield per plant exhibited significant and positive correlation (Table 2) with harvest index, biological yield per plant, total number of pods per plant, number of effective pods per plant, number of secondary branches per plant, number of primary branches per plant, stem diameter, number of damage pods per plant, internode length and days to maturity. Hence for genetic improvement of yield, these characters should be given prime importance. Similar assumptions were made by previous chickpea researchers [8, 9, 10,]. However research on *kabuli* chickpea [11] reviled nonsignificant and positive correlation between the harvest index and seed yield per plant.

3.2 Path Coefficient Analysis

Path analysis revealed that the internode length showed highest positive direct effect on seed yield per plant, followed by number of nodes per plant, harvest index and biological yield per plant. Hence, for enhancement of yield and for developing plant type these characters are selected directly. Similar conclusion was drawn[1, 8, 9]. In contrast plant height showed highest negative defect effect on seed yield succeeded by days to 50% flowering, number of secondary branches, stem diameter, number of seeds per pod, 100 seed weight and damage pods. The most substantial positive indirect effect on seed yield was illustrated by total number of pods, biological yield and harvest index. At the genotypic level, residual effect on seed yield per plant was 0.1264 which suggested that the current study needs to be incorporated with additional yield attributing traits. A study suggests addition of more number of independent variables concerning the dependent variable may reduce the residual effect [12].

4. CONCLUSION

Continued advancements in genetic parameter estimation promise to further refine our understanding of genetic variability and its application in addressing global agricultural challenges. The study revealed significant genetic variability, as indicated by high GCV% and PCV%, across several important yield traits in chickpea. Traits such as number of effective pods per plant, seed yield per plant, 100 seed weight, total number of pods per plant, number of secondary branches per plant, harvest index, and biological yield per plant exhibited substantial genetic variability, suggesting ample scope for genetic improvement through selective breeding. By leveraging heritability, components of variance, coefficient of variation, and genetic advance, helped to unravel the complex interplay between genes and environment, thereby optimizing breeding strategies for sustainable agricultural productivity.

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Table 2: Phenotypic correlation coefficient analysis for yield and its contributing traits in chickpea

Traits	FI	50%F	DM	PH	NPB	NSB	NN	IL	HFN	SD	TP	EP	DP	S/P	100SW	BY	HI	SY
FI	1	0.172*	0.255***	-0.216**	0.157*	0.147*	0.106	-0.322***	-0.005	-0.241**	-0.026	0.137	-0.014	-0.049	-0.177*	-0.143	-0.103	-0.179
50%F		1	0.210**	0.102	0.269***	0.437***	0.129	0.012	0.294***	-0.14	0.471***	0.358***	0.348***	-0.108	-0.416***	0.153*	0.031	0.094
DM			1	-0.098	0.075	0.190**	-0.029	-0.091	-0.400***	0.069	-0.029	-0.156*	0.342***	0.106	0.243***	0.249***	0.032	0.155*
PH				1	0.032	0.039	0.387***	0.756***	0.342***	0.549***	-0.043	-0.062	-0.187*	0.158*	0.231**	0.363***	-0.165*	0.099
NPB					1	0.386***	0.035	-0.002	0.136	-0.067	0.437***	0.412***	0.069	-0.016	-0.217**	0.240**	0.182*	0.289***
NSB						1	0.018	0.201	0.192**	-0.077	0.597***	0.530***	0.172*	-0.14	-0.262***	0.325***	0.186*	0.348***
NN							1	-0.300***	0.341***	0.104	0.038	0.057	-0.188*	-0.105	-0.275***	0.008	-0.155*	-0.118
IL								1	0.123	0.486***	-0.706	-0.11	-0.064	-0.083	0.439-***	0.361***	-0.057	0.187*
HFN									1	0.011	0.291***	0.346***	-0.128	-0.233**	-0.344***	0.039	-0.002	0.042
SD										1	-0.074	-0.066	-0.102	-0.177*	0.297***	0.455***	0.001	0.273***
TP											1	0.889***	0.288***	-0.196**	-0.530***	0.368***	0.401***	0.575***
EP												1	0.108	-0.298***	-0.509***	0.293***	0.439***	0.570***
DP													1	0.118	-0.139	0.162*	0.139	0.191**
S/P														1	0.012	-0.191**	-0.018	-0.128
100SW															1	0.158*	-0.111	0.008
BY																1	0.017	0.620***
HI																	1	0.766***

Note: FI=Flower initiation, 50%F= days to 50% flowering, DM= days to maturity, PH= plant height (cm), NPB= number of primary branches, NSB= number of secondary branches, NN= number of nodes, IL= internode length (cm), HFN= height at fruit nodes (cm), SD= stem diameter (mm), TP= total number of pods, EP= number of effective pods, S/P= number of seeds per pod, 100SW= 100 seed weight (g), BY= biological yield (g), HI= harvest index, and SY= seed yield per plant (g)

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Table 3: Genotypic path coefficient analysis for yield and its component characters in chickpea

Traits	FI	50% F	DM	PH	NPB	NSB	NN	IL	HFN	SD	TP0	EP	DP	S/P	100 SW	BY	HI
FI	0.0085	0.0015	0.0022	-0.0021	0.0028	0.0014	0.0009	-0.0032	0	-0.0028	-0.0002	0.0013	-0.0001	-0.001	-0.0015	-0.0013	-0.0011
50%F	-0.0244	-0.141	-0.0309	-0.0152	-0.086	-0.0666	-0.0229	-0.0024	-0.0454	0.0261	-0.069	-0.0556	-0.0517	0.0509	0.0602	-0.023	-0.0048
DM	0.0316	0.0267	0.1217	-0.013	0.0264	0.0244	-0.0065	-0.012	-0.0535	0.0078	-0.0048	-0.0218	0.0487	0.0382	0.0332	0.0342	0.0035
PH	0.3317	-0.1465	0.1454	-1.3609	-0.0104	-0.0458	-0.6595	-1.1434	-0.5124	-0.9476	0.064	0.0853	0.3126	0.5754	-0.3376	-0.5585	0.2311
NPB	0.0103	0.0186	0.0066	0.0002	0.0305	0.0244	0.0129	-0.0089	0.0118	-0.0104	0.0295	-0.0292	0.0044	-0.0325	-0.0151	0.0125	0.0137
NSB	-0.0103	-0.0288	-0.0122	-0.0021	-0.0488	-0.061	-0.0006	-0.0014	-0.0138	0.005	-0.038	-0.0356	-0.0123	0.0428	0.0171	-0.0208	-0.0131
NN	0.0777	0.1127	-0.0372	0.3367	0.2947	0.0073	0.6949	-0.0421	0.289	0.0732	0.0244	0.0328	-0.1776	-0.0836	-0.2404	-0.0062	-0.1701
IL	-0.5128	0.023	-0.1324	1.1294	-0.39	0.0305	-0.0814	1.3442	0.2341	0.9795	-0.1137	-0.1464	-0.1407	-0.5381	0.689	0.6329	-0.0548
HFN	0	0.004	-0.0055	0.0047	0.0048	0.0028	0.0052	0.0022	0.0124	0.0007	0.004	0.005	-0.0016	-0.0099	-0.0045	0.0006	-0.0001
SD	0.0159	0.0089	-0.0031	-0.0334	0.0163	0.0039	-0.005	-0.0349	-0.0026	-0.0479	0.0051	0.007	0.0074	0.0206	-0.0187	-0.0276	0.0007
TP	-0.0011	0.0236	-0.0019	-0.0023	0.0466	0.0301	0.0017	-0.0041	0.0156	-0.0052	0.0482	0.0441	0.0151	-0.0306	-0.0268	0.0191	0.0213
EP	0.0167	0.0421	-0.0191	-0.0067	0.1021	0.0622	0.005	-0.0116	0.0428	-0.0155	0.0976	0.1067	0.0133	-0.0884	-0.0606	0.032	0.0515
DP	0.0001	-0.0011	-0.0012	0.0007	-0.0004	-0.0006	0.0008	0.0003	0.0004	0.0005	-0.001	-0.0004	-0.0031	-0.0009	0.0005	-0.0006	-0.0005
S/P	0.0025	0.0078	0.0067	0.0091	0.0229	0.0151	0.0026	0.0086	0.0171	0.0092	0.0136	0.0178	-0.0059	-0.0215	-0.0007	0.0145	0.0072
100SW	0.0176	0.0419	-0.0267	-0.0243	0.0485	0.0274	0.0339	-0.0502	0.0359	-0.0382	0.0544	0.0556	0.0142	-0.003	-0.0979	-0.016	0.0132
BY	-0.0822	0.0865	0.1487	0.2173	0.2172	0.1802	-0.0047	0.2493	0.0256	0.3051	0.2097	0.159	0.1086	-0.3567	0.0863	0.5295	0.0548
HI	-0.0817	0.021	0.0176	-0.1054	0.278	0.1334	-0.1519	-0.0253	-0.003	-0.0088	0.2732	0.2994	0.0987	-0.209	-0.0838	0.0642	0.6202
SY	-0.2	0.1007	0.1652	0.133	0.5552	0.3689	-0.1746	0.2652	0.0539	0.3307	0.5972	0.5836	0.2299	-0.6471	-0.0013	0.6853	0.7727

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