Original Research Article

SELECTION STRATEGY FOR YIELD IMPROVEMENT OF CHICKPEA GENOTYPES (*Cicer arietinum L.*)

ABSTRACT

An investigation was undertaken to assess the genetic variability parameters, correlation and path analysis in 25 chickpea genotypes for 12 quantitative traits in Rabi 2022-23 seasons in Randomized Block Design in three replications. Analysis of variance indicated high significant differences among the genotypes for all the traits. Considerable variability existed in the genotypes for all the characters studied. These were the genotypes with high mean values in desirable direction i.e., from the present investigation, it is concluded that among 25 chickpea genotypes, CG23 was found superior followed by CG159 and CG199 for seed yield per plant. High PCV, GCV, heritability and genetic advance as percent of mean were recorded for test weight and biological yield. Seed yield per plant showed positive significant association with number of pods, days to maturity, days to 50% pod initiation and number of primary branches. High and positive direct effect of seed yield per plant at both phenotypic and genotypic levels were depicted by Harvest index. These characters may be taken into consideration for selection of quantitative characters for crop improvement

Keywords*: Genetic Variability, Path analysis, character association, Chickpea.*

1. INTRODUCTION

Pulses have been included into self-sustaining agricultural systems over time, enriching the soil through symbolic atmospheric nitrogen fixation. Pulses have a well-known role in Indian agriculture, food, and nutrition because they fit well in crop rotation patterns and provide a significant amount of protein to the nation's mostly vegetarian population. They are also high in several key amino acids.

It is an annual grain legume that is self-pollinated and diploid (2n=16), classified in the subfamily Papilionoideae and family Leguminacea. Chana (chickpeas) is referred to be the "King of Pulses" in India. It came from southeast Turkey.

Selection criteria like as heritability and genetic progress are significant. Heritability estimates combined with genetic progress are usually more useful than heritability estimates alone in estimating the gain under selection. As a result, understanding genetic progress in conjunction with heritability is quite beneficial. A high heritability character does not always imply a great genetic progress. To arrive at a more trustworthy result, high heritability should

be accompanied with substantial genetic progress. The expected genetic progress expressed as a percentage of the mean illustrates the manner of gene activity in the manifestation of a characteristic, which aids in the selection of a suitable breeding approach **(Kumar *et al.*, 2014).**

As a result, it's critical to determine the component qualities that might help boost yield. Selection would be more successful for a characteristic with a high genetic progress and a strong link to grain output. The correlation coefficient is used to determine the degree of link between yield and yield components, as well as other characteristics that have a significant impact on yield **(Singh, 2009).**The aim is to identify high yielding chickpea genotypes of 12 quantitative traits and to study the interrelationships among yield and seed yield component characters. To estimate direct and indirect effects on seed yield.

2. MATERIALS AND METHODS

The present investigation was carried out at the Field Experimentation Center of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad), U.P. during Rabi 2022-23. The university is situated on the left side of Allahabad Rewa National Highway, about 5km from Prayagraj city. All types of facilities necessary for cultivation of successful crop including field preparation inputs, irrigation facilities were provided from the Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad), U.P

On basis of five competitive plants selected at random from each replication, specific data were collected for following thirteen (13) quantitative traits:1) Days to 50% flowering, 2) Days to 50% pod setting, 3) Days to maturity, 4) plant height, 5) Number of branches per plant, 6) Number of pods per plant, 7) Number of seeds per pod, 8) Number of seeds per plant, 9) Biological yield per plant, 10) Harvest index, 11) Seed index, 12) Seed yield per plant.

All the recorded data for the characters under consideration were analysed for variance using the panse and sukhatme (1967) formula [1]. Additionally, the genetic parameters genotypic coeffivcient of variance (GCV), phenotypic coefficient of variance (PCV), heritability in the broad sense, genetic advance as percent of mean, and correlation analysis were carried out by using the appropriate statistical procedure. These additional components of variance included phenotypic, genotypic, and environmental variance.
The software called “R- Language” was used to perform the analysis mentioned above.

The experimental material is subjected to Analysis of variance (Fisher, 1935), Coefficient of variation (Burton and De vane, 1952), Genotypic coefficient of variation (GCV), Phenotypic coefficient of variation (PCV), Heritability broad sense (Burton and Devane, 1953), Genetic advance (Johnson et al.,1955),Correlation coefficient analysis (Al Jibouri et al., 1958), Path coefficient analysis (Dewey and Lu, 1959).

The experimental material consists of 25 chickpea genotypes, CG118, CG163, CG174, CG251, CG172, CG19, CG208, CG61, CG159, CG236, CG160, CG147, CG30, CG23, CG25, CG36, CG180, CG73, CG20, CG171, CG93, CG199, CG24, CG121, and CG14.

3. RESULTS AND DISCUSSION

The variance analysis of the affecting factors and seed yield. The genotype-related mean squares were very significant for each character, indicating a considerable level of genetic variety in the material. Due to the range of materials employed and the environmental influences on phenotypes, variability may be present in significant amounts.

ANOVA for different characters are present in table 1. The mean squares due to genotypes showed highly significant differences for all characters indicating the presence of substantial amount of genetic variability among chickpea genotypes. In Table 2. And Fig. 1 which revealed a wide range of variation for all traits studies the mean values, the coefficient of variation (C.V.), standard error of the mean (SEm+), the critical difference (C.D.) at 5% and 1% range of 20 genotypes for 12 quantitative characters are presented.

On the basis of mean performance, the highest seed yield per plant was observed for chickpea genotypes CG23 (30.5), CG199 (29.9), CG159 (29.9) were found to be superior in Seed Yield per plant.From the present investigation, the PCV was higher than the corresponding GCV for every trait, indicating that the environment had an impact. The lowest GCV (percent) value was 1.05 (Days to maturity, Days to 50% pod initiation) and highest value was 20.86 (seed yield per plant).A similar pattern was followed by PCV (percent), which ranged from lowest value of 1.75 (Days to maturity) to highest value of 21.75 (Seed Yield per plant).

Table 1. Analysis of Variance for 12 quantitative traits among 25 chickpea genotypes

Sr.No.	Trait	MeanSum ofSquares		
		Replication	Treatment	Error
	Degrees of freedom	2	24	48
1	**Plant height**	30.795	45.072**	15.324
2	**Days to 50% flowering**	2.44	11.414*	5.426
3	**Days to 50% pod initiation**	9.693	7.68*	3.86
4	**Days to maturity**	5.813	8.153**	3.063
5	**Number of Primary branches**	0.033	0.278**	0.017
6	**Number of secondary branches**	0.084	1.583**	0.072
7	**Number of pods/plants**	157.655	455.858**	54.4
8	**Number of seeds/pods**	39.102	478.109**	74.931
9	**Biological yield/plant**	1.965	58.594**	7.506

10	**Harvest Index**	3.699	61.268*	27.972
11	**Seed Index**	0.552	30.044**	2.234
12	**Seed yield per plant**	2.888	58.612**	1.648

**significance at 1% level of significance

Table2. Genetic parameters for 12 quantitative traits of chickpea genotypes

Sl. No.	Characters	GCV	PCV	h2 (Broad Sense)	GA	GAM
1	**Plant height (cm)**	6.16	9.82	39.29	4.07	7.95
2	**Days to 50% flowering**	2.12	4.09	26.89	1.51	2.27
3	**Days to 50% pod initiation**	1.44	2.89	24.81	1.16	1.48
4	**Days to maturity**	1.05	1.75	35.64	1.60	1.29
5	**Number of Primary branches**	14.37	15.73	83.47	0.55	27.05
6	**Number of secondary branches**	15.83	16.93	87.47	1.37	30.50
7	**Number of pods/plants**	13.04	15.47	71.10	20.09	22.66
8	**Number of seeds/pods**	10.84	13.53	64.20	19.14	17.89
9	**Biological yield/plant (g)**	12.96	15.56	69.41	7.08	22.25
10	**Harvest Index (%)**	5.04	9.46	28.41	3.66	5.54
11	**Seed Index**	15.35	17.09	80.58	5.63	28.38
12	**Seed yield per plant**	20.86	21.75	92.02	8.61	41.23

GCV: Genotypic Coefficient of Variation, PCV: Phenotypic Coefficient of Variation, H^2: Heritability, GA% of Mean: Genetic Advance at Percent of mean.

2.1 Heritability

From present investigation, thehighestheritability(above 60%, it is high for all the parameters) wasobservedfor Seed Yield per Plant (92.016%), Number of Secondary Branches (87.468%), Number of Primary Branches (83.467%), Seed Index (80.58%), Number of Pods per Plant (71.097%), Biological Yield per Plant (69.406%), Number of Seeds per Pod (64.203%), Moderate heritability was observed for Plant Height (39.287%) followedby, Days to Maturity(35.644%), Low heritability was observed for Harvest Index(28.407%), Days to 50% Flowering (29.894%) and Days to 50% Pod Initiation (24.805%).

A higher heritability value suggests that the role of genotypic components may be greater. The estimates demonstrated that heritable factors dominated the variation in these traits, while environments and genetics equally influenced the expression of traits with moderately high heritability, indicating that environment influenced the trait expression more so than genetics.

2.2 Genetic Advance

In the present study a perusal of genetic advance showed that it was high for Number of Pods per Plant (20.093) followed by Number of Seeds per Pod (19.135), Seed Yield per Plant (8.611), Biological Yield per Plant (7.082) and Seed Index (5.63) respectively and

lowest for Number of Primary Branches (0.554), Days to 50% Pod Initiation (1.158), Number of Secondary Branches (1.367), & Days to 50% Flowering (1.509) respectively.

2.3 Geneticadvanceaspercent mean

Highgenetic gain was recorded for Days to 50% Pod Initiation (41.228) followed by, Biological Yield per Plant (30.5), Days to 50% Flowering (28.375) and Number of Pods per Plant (27.048). Moderate estimateswere recorded for Number of Seeds per Pod (22.655), Days to Maturity (22.248), Plant Height (17.891), Seed Yield per Plant (7.948), Harvest Index (5.537) and Number of Secondary Branches (2.265). Low estimation ofGCVwasrecordedfor Seed Index (1.286) and Number of Primary Branches (1.478).

2.4 Phenotypic correlation coefficient

In the presentinvestigation from Table 3. Seed yield per plantshowed positivesignificantassociation with Days to Maturity (0.289*), Number of primary Branches (0.321*), Number of Pods per Plant (0.492**), Number of seeds per Pod (0.407**), Biological Yield per Plant (0.689**), Harvest Index (0.627**) and Seed Index (0.760**). Positive non-significant association showed with Days to 50% Pod Initiation (0.0813). Negative non-significant association showed with Plant height (-0216) and Days to 50% Flowering (-0.1232).

2.5 Genotypic correlation coefficient

The correlation among the yield and yield attributing characters revealed that Seed yield per plant waspositivelyandsignificantlyassociatedwithDays to Maturity (0.516**), Number of primary Branches (0.347*), Number of Pods per Plant (0.462**), Number of seeds per Pod (0.394**), Biological Yield per Plant (0.842**), Harvest Index (0.865**) and Seed Index (0.866**). Positive non-significant association showed with Days to 50% Pod Initiation (0.1823) only. Negative significant association showed only by Days to 50% Flowering (-0.291*). Negative non-significant association showed with Plant Height (-0.0766) and Number of secondary Branches (-0.0974).

These findings of correlation coefficient were supported **by Sharma, R. K., Kumar, S., & Singh, M. (2019)**, **Kumar, S., Singh, A. K., & Kumar, R. (2020), Choudhury, M. S., Hasan, M. A.,**&**Islam, M. S. (2021).**

2.6 Phenotypic Path Coefficient Analysis

Phenotypic path coefficients are calculated using the phenotypic correlation coefficient. Itdivides the phenotypic correlation coefficients into direct and indirect impact measurements(Deweyand Lu, 1959). A detailed analysis of diagonal values showed positive direct effect of Plant Height (0.0492), Days to 50% Pod Initiation (0.0050), Days to Maturity (0.0030), Number of primary Branches (0.2171), Number of Pods per Plant (0.2767), Biological Yield per Plant (0.2908) Harvest Index(0.1533) and Seed Index(0.4321). Negative direct effects were exhibited by Days to 50% flowering (-0.1122), Number of secondary Branches (-0.2065) and Number of seeds per Pod (-0.0268).

2.7 Genotypic Path Coefficient Analysis

Aperusaloftheresultsonpathcoefficientforyieldandyieldcomponentsgenotypictobe of similar direction and magnitude in general. Further the genotypic path co-efficient wereobserved to be of higher magnitude, compared to phenotypic path coefficient indicating themaskingeffect ofenvironment. A detailed analysis of diagonal values showed positive direct effect of Plant Height (0.0643), Days to 50% Pod Initiation (0.2220), Number of primary Branches (0.3111), Number of seeds per Pod (0.3035), Biological Yield per Plant (0.1071), Harvest Index(0.2027) and Seed Index(0.4866). Negative direct effects were exhibited by Days to 50% flowering (-0.4856), Days to Maturity (-0.1956), Number of secondary Branches (-0.4185), Number of Pods per Plant (-0.2341).

Similar findings of path coefficient analysis were given by **Kumar et al. (2020)**, **Patel and Mehta (2019).**

Table 3. Correlation coefficient analysis

Phenotypic Correlation (Above diagonal) and Genotypic Correlation (Below diagonal)												
TRAITS	**PH**	**DF50**	**DP50**	**DM**	**NPB**	**NSB**	**NPP**	**NSP**	**BY**	**HI**	**SI**	**SYPP**
PH	1	0.0016	-0.0646	0.14	0.0729	-0.066	-0.099	-0.0209	-0.1242	0.0011	-0.0864	-0.0216
DF50	-0.1476	1	-0.0005	-0.0479	-0.0741	-0.294*	-0.1078	0.0685	0.1387	-0.13	-0.1024	-0.1232
DP50	-0.706**	0.084	1	0.2153	0.0755	-0.0055	0.1348	-0.0537	-0.0088	0.0489	0.0406	0.0813
DM	0.270*	-0.344*	0.542**	1	0.0498	-0.0565	0.1025	0.099	0.341*	0.261*	0.1963	0.289*
NPB	0.1137	-0.1561	-0.0545	0.0991	1	0.450**	0.553**	0.499**	-0.0351	0.1869	0.0596	0.321*
NSB	-0.0999	-0.548**	0.0345	-0.0087	0.503**	1	0.300*	0.1121	-0.1458	0.1171	-0.0845	-0.0603
NPP	-0.269*	-0.343*	0.2097	0.231*	0.691**	0.322*	1	0.712**	0.1648	0.418**	0.129	0.492**
NSP	-0.1521	0.026	-0.034	0.309*	0.609**	0.1084	0.846**	1	0.1949	0.366*	0.111	0.407**
BY	-0.1947	-0.0221	0.1507	0.278*	0.073	-0.2093	0.2057	0.298*	1	0.494**	0.649**	0.689**
HI	-0.1115	-0.444**	0.585**	0.716**	0.495**	0.0987	0.512**	0.683**	0.915**	1	0.443**	0.627**
SI	-0.1102	-0.1206	0.223	0.326*	0.1314	-0.1223	0.1694	0.1318	0.861**	0.779**	1	0.760**
SYPP	-0.0766	-0.291*	0.1823	0.516**	0.347*	-0.0974	0.462**	0.394**	0.842**	0.865**	0.866**	1

DF50: Days to 50% flowering, **DP50**: Days to 50% pod setting, **DM**: Days to maturity, **PH**: Plant height (cm), **NPB**: Number of primary branches, **NSB**: Number of secondary branches, **NSPP**: Number of seeds per plant, **NPPP**: Number of pods per plant, **NSP**: Number of Seeds per Pod **BY**: Biological yield per plant, **SW**: 100 seed weight (g), **HI**: Harvest Index (%), **SY**: Seed yield per plant.

Table 4. Path coefficient analysis

TRAITS		PH	DF50	DP50	DM	NPB	NSB	NPP	NSP	BY	HI	SI	SYPP
PH	P	0.0492	0.0001	-0.0032	0.0069	0.0036	-0.0032	-0.0049	-0.001	-0.0061	0.0001	-0.0042	-0.0216
	G	0.0643	-0.0095	-0.0454	0.0174	0.0073	-0.0064	-0.0173	-0.0098	-0.0125	-0.0072	-0.0071	-0.0766
DF50	P	-0.0002	-0.1122	0.0001	0.0054	0.0083	0.033	0.0121	-0.0077	-0.0156	0.0146	0.0115	-0.1232
	G	0.0717	-0.4856	-0.0408	0.1669	0.0758	0.2663	0.1664	-0.0126	0.0107	0.2155	0.0586	-0.291*
DP50	P	-0.0003	0	0.005	0.0011	0.0004	0	0.0007	-0.0003	0	0.0002	0.0002	0.0813
	G	-0.1567	0.0186	0.222	0.1202	-0.0121	0.0076	0.0466	-0.0076	0.0334	0.1298	0.0495	0.1823
DM	P	0.0004	-0.0001	0.0007	0.003	0.0002	-0.0002	0.0003	0.0003	0.001	0.0008	0.0006	0.289*
	G	-0.0528	0.0672	-0.1059	-0.1956	-0.0194	0.0017	-0.0451	-0.0603	-0.0544	-0.1399	-0.0637	0.516**
NPB	P	0.0158	-0.0161	0.0164	0.0108	0.2171	0.0976	0.1201	0.1083	-0.0076	0.0406	0.0129	0.321*
	G	0.0354	-0.0486	-0.017	0.0308	0.3111	0.1564	0.2151	0.1893	0.0227	0.1539	0.0409	0.347*
NSB	P	0.0136	0.0607	0.0011	0.0117	-0.0928	-0.2065	-0.0619	-0.0232	0.0301	-0.0242	0.0174	-0.0603
	G	0.0418	0.2294	-0.0144	0.0036	-0.2104	-0.4185	-0.1348	-0.0454	0.0876	-0.0413	0.0512	-0.0974
NPP	P	-0.0274	-0.0298	0.0373	0.0284	0.1531	0.083	0.2767	0.1969	0.0456	0.1157	0.0357	0.492**
	G	0.0629	0.0802	-0.0491	-0.054	-0.1619	-0.0754	-0.2341	-0.198	-0.0482	-0.12	-0.0397	0.462**
NSP	P	0.0006	-0.0018	0.0014	-0.0027	-0.0134	-0.003	-0.0191	-0.0268	-0.0052	-0.0098	-0.003	0.407**
	G	-0.0462	0.0079	-0.0103	0.0936	0.1847	0.0329	0.2567	0.3035	0.0904	0.2073	0.04	0.394**
BY	P	-0.0361	0.0403	-0.0026	0.0992	-0.0102	-0.0424	0.0479	0.0567	0.2908	0.1435	0.1887	0.689**
	G	-0.0208	-0.0024	0.0161	0.0298	0.0078	-0.0224	0.022	0.0319	0.1071	0.098	0.0922	0.842**
HI	P	0.0002	-0.0199	0.0075	0.04	0.0287	0.018	0.0641	0.0562	0.0757	0.1533	0.068	0.627**
	G	-0.0226	-0.09	0.1185	0.1451	0.1003	0.02	0.1039	0.1385	0.1855	0.2027	0.158	0.865**
SI	P	-0.0373	-0.0442	0.0175	0.0848	0.0258	-0.0365	0.0557	0.048	0.2804	0.1916	0.4321	0.760**
	G	-0.0536	-0.0587	0.1085	0.1586	0.0639	-0.0595	0.0825	0.0642	0.4191	0.3792	0.4866	0.866**

DF50: Days to 50% flowering, **DP50**: Days to 50% pod setting, **DM**: Days to maturity, **PH**: Plant height (cm), **NPB**: Number of primary branches, **NSB**: Number of secondary branches, **NSPP**: Number of seeds per plant, **NPPP**: Number of pods per plant, **NSP**: Number of Seeds per Pod **BY**: Biological yield per plant, **SW**: 100 seed weight (g), **HI**: Harvest Index (%), **SY**: Seed yield per plant

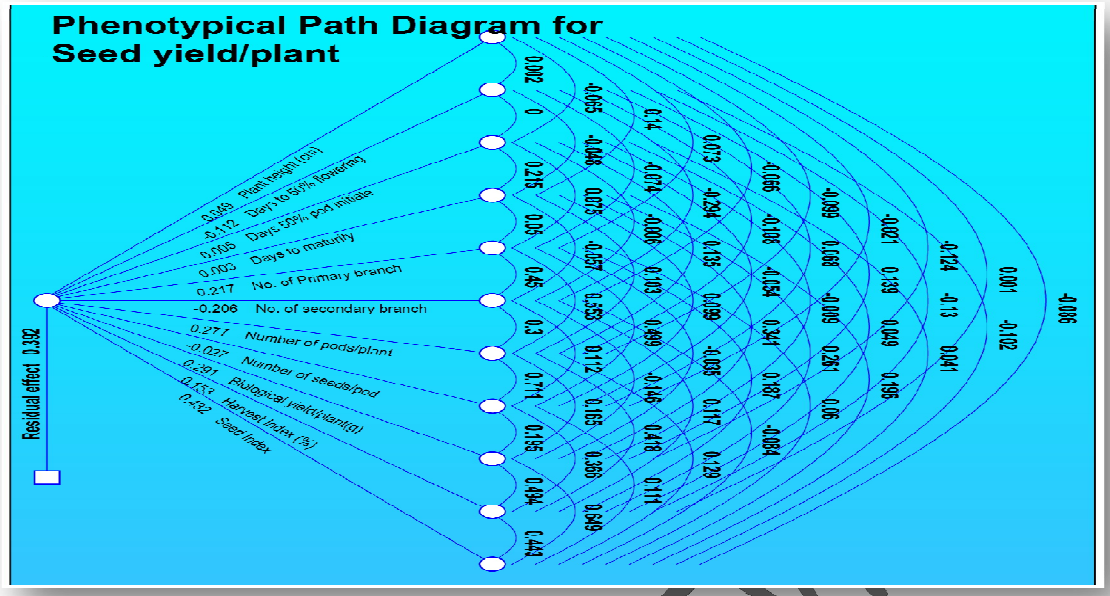

Figure 2. Phenotypic Path diagram

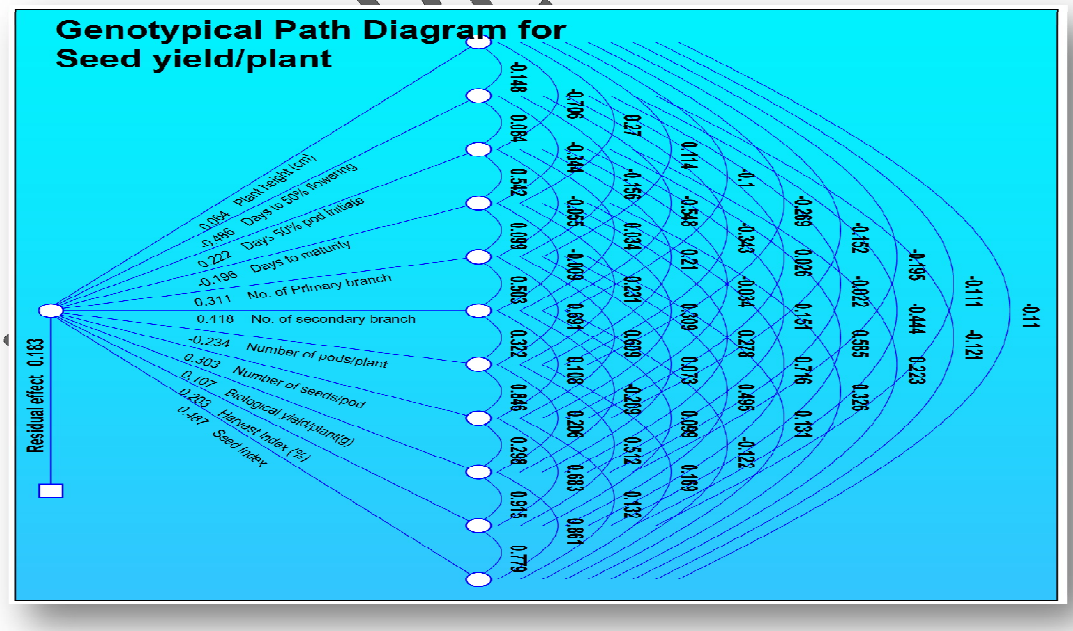

Figure 3. Genotypic Path diagram

3. CONCLUSION

Based on the current study, it was determined that out of 25 genotypes of chickpeas, CG23 had the highest seed yield per plant, followed by CG159 and CG199. For Seed Yield and biological yield, high PCV, GCV, heritability, and genetic advancement as a percentage of mean were noted. The number of pods, days to maturity, days to 50% pod initiation, and number of major branches all positively and significantly correlated with the amount of seed produced per plant. The Harvest index showed a strong and favourable direct effect of seed yield per plant at both the genotypic and phenotypic levels. When choosing quantitative characters for crop development, these characteristics could be taken into account.

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