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Research Paper

Estimation of Genotypic Variability and Path Coefficient in Chickpea

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Abstract:
A total of 35 lines, along with a check, were evaluated in Randomized Complete Block Design.HighseedyieldperplantwasrecordedbyICC-1356.Allthetraitsshowedsignificant variation among the lines. Number of seeds per plant, number of pods per plant, biological yieldshowedhighGenotypicCoefficientofVariation(GCV)andPhenotypicCoefficientof Variation (PCV). Traits exhibiting high heritability coupled with genetic advanceas percent of mean suggest that the traits are governed by additivegene action, equal contribution of additive and non-additive gene action respectively. Correlation at both genotypic and phenotypic level, seed yield per plant exhibited highly significant positive association with biologicalyieldperplant,numberofpodsperplant,numberofseedsperplant,seedindexand number of primary branches per plant. Path analysis revealed that biological yield per plant andharvestindexregisteredhighandpositivedirecteffectonseedyieldperplant.Itindicates true relationship between these traits and direct selection for these traits will be rewarding for yield improvement
Keyword: *Chickpea,Geneticvariability,GCV,PCV,correlationanalysisandpathanalysis*

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I. Introduction:

Chickpea is an integral part of an Indian agriculture since time, because of only its intrinsic value in terms of higher protein content, carbohydrates, minerals, nitrogen fixing ability and and alternative crop for crop diversification. Chickpea occupies a prime position among the pulses in the country with maximum hectare production and its higher nutritive value.

Chickpea is an autogamous diploid (2n=14/16) legume. It belongs to family Fabaceae sub-family Papilionoideae. The genus Cicer includes 43 species, nine of which are annual, 33 are perennial and one with unspecific life cycle.

Chickpea is the second most important pulse crop after dry beans. Genetic improvement in chickpea started since domestication and lot of improvement has been achieved, but crop improvement is a never-ending endeavor. It is an important winter season food legume having extensive geographical distribution. The genus Cicer originated in South-eastern Turkey and migrated to other parts of the world. lt is well adapted to relatively cooler climates; the largest area of adaptation is in the Indian sub- continent.

In recent years its cultivation has spread over an area of 11 m ha. India is one of the major chickpea producing country contributing 11.23 M tons and 44.51% shares oftotal production. Chickpea contributes the single largest share in India’s export basket of pulses registering 70.92% share in total pulse export **(Commodity Profile for Pulses – March, 2019)**.

A major limitation in improving the pulse crop is the restricted genetic variability available for most agronomic characters. At present, genes are readily be transferredfrom (C. reticulatum) into cultivated (C. arietinum) chickpea. But useful genes present in other genus Cicer species cannot be utilized due to the incompatibility barrier. It is hoped that through the development of new techniques such as embryo rescue and somatichybridization, the desirable genes from other Cicer species could be introgressed to the cultivated chickpea **(Altaf and Ahmad, 1990)**.

A chickpea seed contains 17-24% proteins, 41-50.8% carbohydrates and high percentage of other mineral nutrients and unsaturated linoleic and oleic acid and is one of the most important crops for human consumption **(Farshadfar and Farshadfar, 2008)**.

The presence of genetic variability is of utmost importance for any breeding program and due to this reason the plant breeders have emphasized the evaluation of germplasm for the improvement of crop yield as well as for utilization in further breeding programs. Evaluation of plant genetic resources is a prerequisite for which the future breeding work is based **(Reddy *et al*., 2012)**. In addition to genetic variation, heritability of economically important characters is essential for effective breeding programs and selection of specific traits.

Heritability estimates the genetic advance in a population provides information about the expected gain in the following generations.

Correlation coefficient studies helps in determination of interrelationship between various plant characters. The path coefficient is a standardized partial regression coefficient and as such it measures the direct influence of variable upon another and partitioning correlation coefficient into components of direct and indirect effects.

II. Materials and Methods:

The present study consists of 21 chickpea lines and one check variety (table 3.2) which was grown in rabi, 2020-21 at the Field Experimentation Centre, Department of Genetics and Plant Breeding, SHUATS, Prayagraj. The experiment was laid in a randomized block design (RBD) with 21 genotypes in three replications. Data were collected from the experimental field of trial in year 2021-22.

Statistical measure, i.e., mean, standard error of mean, coefficient of variation and range for each quantitative character were computed for the study of phenotypic variability. The analysis of variance for RBD, were done by following methodology advocated by **Panse and Sukhatme (1967). Analysis of Variance:** was done under the fixed effect model given below: $Y_{ij}=\mu+g_i+r_j+e_{ij}$

III. Results and Discussion:

One of the important considerations in any crop improvement is the detailed study of genetic variability. Variability is a measure by estimation of mean genotypic and phenotypic variation, genotypic and phenotypic coefficient of variation, heritability, genetic advance and genetic gain.

Environment plays an important role in the expressionofphenotypicand genotype, fact which are inferred, form phenotypic observation. Hence, variability can be observed throughbiometricparameterslikegenotypicandphenotypicvariationgenotypiccoefficient of variation, heritability (broad sense) and genetic advance. This would be of great help to breeder in evolving a selectionprogramforgenetic improvement of crop plant.

The estimates of variance, coefficient of variation,heritability,genetic advance and genetic advance as percentage mean for all the thirteen characters studied have been boxed in Table 3.1.

3.1 Phenotypicandgenotypicco efficient of variation:

Inthepresentinvestigation,itisdepictedfromtheTable3.1thatingeneral,estimatesof phenotypic coefficient of various was found higher than their corresponding genotypic coefficientofvariation,indicatingthattheinfluenceofenvironmentontheexpressionofthese characters. However, good correspondence was observed genotypic coefficient of variation and phenotypic coefficient in all characters.Theresultof genotypic coefficient of variation and phenotypic coefficient of variation present are summarized as under.

3.1.1 Phenotypicco efficient of variation:

A wide range ofphenotypiccoefficient ofvariation (PCV) was observed for all the traits ranged fromDays to maturity (2.02) to number ofseeds perplant (35.72). Higher magnitudeof PCVwere recorded fornumberofseeds perplant(35.72) followed by number ofpodsperplant(34.65),biologicalyieldperplant(31.58),seedyieldperplant(27.63),seed index (23.00) and number of secondary branches per plant (22.50). Moderate magnitude of PCV was recorded for number of secondary branches per plant (16.59) and harvest index (12.23).LowmagnitudeofPCVwererecordedforplantheight(8.82),daysto50%flowering (4.71),daysto50%podsetting(2.58)anddaystomaturity(2.02)suggestedforalimitedscope of selection for improvement of these trait. Thestudiesonphenotypiccoefficientvariation themagnitudeofPCVwashighestincaseofnumberofseedsperplantandnumberofpodsperplant.

3.1.2 Genotypiccoefficientofvariation:

Awiderangeofgenotypiccoefficientofvariation(GCV)wasobservedforallthetraits ranged from days to maturity (1.64) to number of seeds per plant (27.08).Higher magnitude ofGCVwererecordedfornumberofseedsperplant(27.08),numberofpodsperplant(27.02), biologicalyield(26.92),seedyieldperplant(21.68),seedindex(21.22).Moderatemagnitude ofGCVwererecordedfornumberofsecondarybranchesperplant(14.78),numberofprimary branchesperplant(11.24),harvestindex(9.54)andplantheight(6.95)LowmagnitudeofGCV was recorded for and days to 50% flowering (4.05), days 50% pod setting (2.11) and days to maturity (1.64). The studies on genetic coefficient of variation indicated the magnitude of GCVwashighestincaseofnumberof seeds per plant, number of pods per plant indicating the presence of high amount of variation in these traits.

3.1.3 Heritability(broadsense)

The estimates of genotypic coefficient of variation (GCV) reflectthe total amountof genotypicvariabilitypresentinmaterial.However,theproportionofthisgenotypicvariability which is transmitted from parents toprogenyisreflectedbyheritability. **(Lush 1949)** gave theconceptofbroadsenseheritability.Itdeterminestheefficiencywithwhichwecanutilize thegenotypicvariabilityinabreedingprogramme.Thegenotypicvarianceanditscomponents are influenced by thegene frequencies. Because the frequencies of genes differ from one population to another, estimates of heritabilityalsovaryfromonepopulationtoanotherfora given character.**Burton (1952)** suggested the genetic variation along with heritability estimates would give a better idea about the excepted efficiency of selection thus a character possessinghighGCValongthehighheritabilitywillbevaluableinselectionprogramme.The estimates ofheritability for all 12 characters are presented in Table 3.1.

The perusal of the Table 3.1 revealed the estimates of heritability (%) in broad sensefor12 characters studied, which range from (43.17%) to (85.17%). High heritability was recorded for seed index (85.17%), number of seeds per plant (97.3%),numberof secondary branches (96.9%), days to 50% flowering (73.97%), biological yield per plant(72.65%),daysto50%podsetting(67.13%),daystomaturity(66.04%),plantheight (62.09), seedyieldperplant(61.58),numberofpodsperplant(60.83),harvestindex(60.77%),number ofseedsperplant(57.47%),numberofprimarybranches(45.90%)andnumberofsecondarybranches(43.17%).

Characters exhibiting high heritability may not necessarily give high genetic advance. **Johnson *et al*. (1955)** showed that high heritability should be accompanied by high geneticadvancetoarriveatmorereliableconclusion.Thebreedershouldbecautiousin makingselectionbestonheritabilityasitincludesbothadditiveandnon-additivegeneeffect.

Heritabilityinbroadsensereferstothe functionof thewholegenotypesasunitandis used in context of environmental effect. The heritability estimates in broad sense were classified by **Robinson *et al.* (1951)** as low (70%).

3.1.4 Geneticadvance

A perusal of genetic advance (Table 3.1) revealed that it was high for number of seeds per plant (23.57) followed by number of pods per plant (19.51), biological yieldperplant (10.13). Moderate for harvest index (8.23), seed index(8.18),plantheight (6.67), days to 50%flowering(6.50).Lowfordaysto50%podsetting(3.97),seedyieldperplant(3.95),days to maturity (3.66), number of secondarybranches(1.06)and number of primary branches (0.53).

3.1.5 Geneticadvanceaspercentofmean

Heritability alone provides no indication of the amount of genetic improvementthat wouldresultfromselectionofindividualgenotypes.Henceknowledgeinthemeanofselected families over the base population **(Lush, 1949; Johnson *et al*., 1955)**. It is also expressed as the shift in gene frequency towards the superior side on exercising selection pressure.

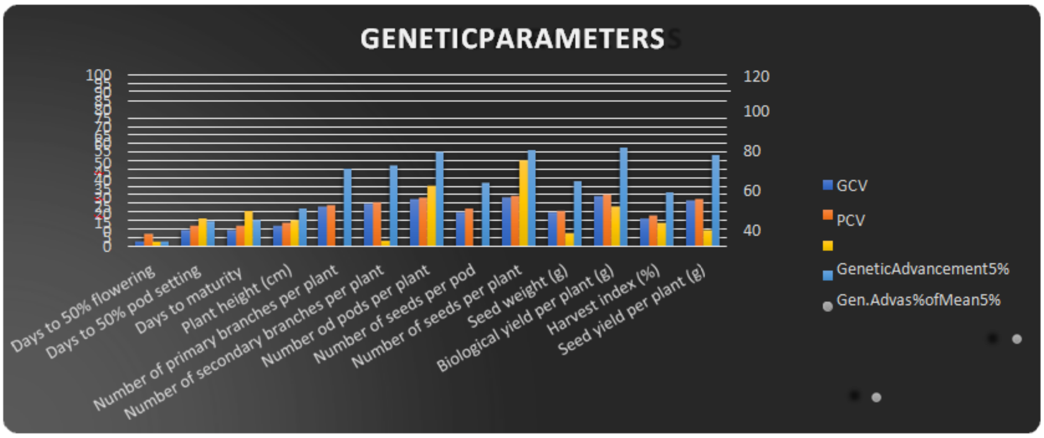
Table 3.1 Genetic parameters of 13 characters ofchickpea germplasm evaluated under field conditions during *Rabi*2020-21, at SHUATS, Prayagraj.

S. No.	Characters	GCV	PCV	h^2(Broad Sense)	Genetic Advancement5%	Gen.Advas%of Mean 5%
1	Daysto50%flowering	3.456	7.635	20.489	2.83	3.222
2	Daysto50%pod setting	9.096	11.796	59.465	15.987	14.45
3	Daystomaturity	9.188	11.618	62.533	20.4	14.967
4	Plantheight (cm)	11.963	13.459	79.01	15.039	21.906
5	Numberofprimarybranchesperplant	22.916	23.846	92.354	0.918	45.366
6	Numberofsecondarybranchesperplant	24.493	25.945	89.118	2.661	47.631
7	Numberofpodsperplant	27.518	28.151	95.555	35.606	55.413

8	Numberofseedsperpod	19.848	21.828	82.68	0.579	37.177
9	Numberofseedsperplant	28.169	29.242	92.798	50.271	55.899
10	Seedweight(g)	19.328	20.314	90.525	7.793	37.882
11	Biologicalyieldperplant (g)	28.882	29.9	93.307	23.21	57.471
12	Harvestindex(%)	16.456	17.726	86.179	13.769	31.469
13	Seedyieldperplant(g)	26.648	27.557	93.513	9.174	53.085

GCV-GeneticCoefficientVariance,PCV-PhenotypicCoefficientVariance,H^2-BroadSenseHeritability,GA-GeneticAdvance

Fig:3.1Histogramrepresentationsof12geneticparametersof35chickpeagenotypes



High estimate of genetic advance as percent of mean was recorded for biological yield (47.26), number of pods per plant (43.41), number of seeds per plant (42.28), seed index (40.35), seed yield per plant (35.05) and number of secondary branches per plant (20.01). Moderateestimateofgeneticadvanceaspercentofmeanwasrecordedfornumberofprimary branches per plant (15.69), harvest index (15.31), plant height (11.28) and lowestimateofgeneticadvanceaspercentofmeanwasrecordedfordaysto50%flowering (7.17), days to 50% pod setting (3.57), days to maturity (2.74).

The traits with high heritability estimates showed that variation in these traits predominantly governed by heritable factors, whereas both genetics and environment played equivalent roles in the expression of traits with moderately high heritability indicated that the expressionofthetraitwasmostlyinfluencedbyenvironmentratherthangenetic.Traitswith high heritability estimates in broadsense can be utilized for genetic improvement as they are least influenced by the environmental effects and thus having a potential for large genetic determination.

3.2 Correlationcoefficientsanalysis

Correlation coefficient analysisis astatistical measurewhich is used to find out the degree and direction of relationship between two or more variables crop yield is oneof the complex characters controlled by several interacting genotypic and environmental factors Interrelationship existed between yield and its contributing components can significantly improvetheefficiency of cropbreeding programs throughtheuseofproper selection indices. The correlation coefficient analysis is usefulinselectionofseveral traits simultaneously influencing the yield.

In the present investigation correlation coefficient analysis measure the mutual relationship between various plant character and to determine the component characterson whichselectioncanbeusedforgeneticimprovementinyieldwhileselectingthesuitableplant type,correlationstudieswouldprovidereliableinformationandthedirectionoftheselection especially when the breeder needs to combinehighyield potential with desirable traits and seed quality traits.

In the present investigation the genotypic and phenotypic correlation coefficientof different traits with grain yield per plant and their relationship among themselves are represented in Table 3.2 and 3.3 and are discussed here under following points.

3.2.1 Genotypiccorrelationcoefficientanalysis:

In present investigation, genotypic correlation coefficient of different characters with seedyieldperplantandinterrelationshipamongcomponentcharactersarepresentedinTable 3.2.

Correlationbetweengrainyieldandothercomponentcharacters:

Seed yield perplant showed highly significant and positive association with biological yield (0.940**) followed by number of pods per plant (0.565**), number of secondary branches per plant (527**), seed index (0.461**). It also showed positive but non-significant associationwithplantheight(0.188),daysto50percentflowering(0.173).Whilenegativeand significant association was recorded for harvestindex(- 0.174).

Mutualcorrelationbetweenothercharacters

Days to 50 per cent flowering showed positive and significantassociationwith days to50%podsetting(0.643**),numberofsecondarybranchesperplant(0.559**)plant height (0.477**), days to maturity (0.308**). While positive but non-significant association wasrecordedforseedyieldperplant(0.173),seedindex(0.152),numberofprimarybranches per plant (0.134), number of pods per plant 0.096), biological yield (- 0.082).

Days to 50% pod setting showed positiveand significant association with number of secondarybranchesperplant(0.951**),numberofprimarybranchesperplant(0.436**),plant height(0.420**),daystomaturity(0.375**),seedyieldperplant(0.263**).Whilepositivebut non-significant association wasrecordedforbiological yield (0.036), number of pods per plant(0.186),numberof seedsperplant(0.036).Thenegative and significant association was recorded for harvest index (-0.263**)

Plant height showed positive and significantassociationwithseedindex(0.414**). Positive and non-significant association with seed yield per plant (0.188), daysto maturity (0.079) and number of secondary branches per plant (0.072). While negative and non-significantassociationwasrecordedfornumberofprimarybranchesperplant(-0.194),harvest index(-0.179).Negativeandsignificantassociationwasrecordedfornumberofpodsperplant (-0.455**), number of seeds per plant (-0.402**).

Number of primary branches per plant exhibited positiveandsignificantassociation with number of pods per plant (0.718**), number of secondary branches per plant (0.638**), number seeds per plant (0.472**), biological yield (0.465**), days tomaturity(0.379**).Whilenegativenon-significantassociationwasrecordedforharvestindex (-0.105).

Number of secondary branches per plant exhibited positive and significant association with seed yield per plant (0.527**),biological yield perplant(0.437**), numberof podsper plant(0.422**)anddays tomaturity(0.402**)andnumberofseeds perpod(0.286**). While negative non- significant association was recorded for harvest index (-0.218).

Days to maturity showed positive and significant seed yield per plant (0.371**), seed index (0.354**), biological yield (0.311**). While positive and non-significant number of podsperplant(0.134).Whilenegativebutnon-significantassociationwasrecordedforharvest index (-0.012).

Number of pods per plant exhibited positive and significant associationwith number of seeds per plant (0.981**), biological yield (0.622**), seed yield per plant (0.565**). While negative but significant association was recorded for harvest index (- 0.375), seed index (- 0.357).

Number of seeds per plant showed positive and significant association with biological yield per plant (0.510**) and seed yield per plant (0.415**). While negative significant was observed in seed index (-0.504*) and harvest index (-0.406**).

Biological yield showed positive and significant association with seed yield per plant (0.940**), seed index (0.260*). Negative and significant harvest index (-0.469**).

Seed index showed positive and significant association with seed yield per plant (0.461**) and harvest index (451**).

Harvest index showednegativeand non-significant associationwithseed yield per plant (-0.147).

Table3.2Genotypiccorrelationamongthedifferenttraitsevaluatedinchickpeaduring Rabi2019-20atSHUATS,Prayagraj

	DF50	DP50	DM	PH	NPB	NSB	NPPP	NSP	NSPP	SI	BYPP(g)	HI (%)	SYPP
DF50	**1.0000**	-0.1527	-0.296**	0.1349	-0.309**	0.513**	0.631**	-0.0686	0.683**	-0.347**	0.356**	-0.279**	0.272**
DP50		**1.0000**	-0.196*	-0.0298	-0.1618	0.277**	0.0285	0.335**	-0.0899	0.248*	0.1270	-0.0846	0.1478
DM			**1.0000**	0.635**	0.458**	0.0721	-0.0639	0.447**	0.327**	0.218*	0.1496	0.0991	0.213*
PH				**1.0000**	0.243*	-0.0159	-0.0377	0.1615	0.1562	0.443**	0.219*	0.0690	0.246*
NPB					**1.0000**	-0.0217	0.0652	0.1240	0.1302	0.1201	0.263**	-0.1248	0.1837
NSB						**1.0000**	0.631**	0.407**	0.583**	-0.371**	0.431**	-0.399**	0.224*
NPPP							**1.0000**	-0.0006	0.835**	-0.368**	0.732**	-0.301**	0.578**
NSP								**1.0000**	0.436**	-0.323**	-0.0360	-0.0122	-0.0287
NSPP									**1.0000**	-0.417**	0.614**	-0.1725	0.547**
SI										**1.0000**	0.1596	0.1626	0.294**
BYPP											**1.0000**	-0.420**	0.797**
HI												**1.0000**	0.249*
SYPP													**1.0000**

DF50:Daysto50%flowering,DP50:Daysto50%podsetting,PH:Plantheight(cm),NPB:No.ofprimarybranche sperplant,NSB:No. ofsecondarybranchesperplant,DM:Daystomaturity,NPP:No.ofpodsperplant,NSP:No.ofseedsperplant,BY: BiologicalYield(g), SI:Seed Index(g),HI:Harvestindex(%),SYPP:Seedyieldperplant(g)

3.2.2 Phenotypiccorrelationcoefficientanalysis:

Inpresentinvestigation,phenotypiccorrelationcoefficientofdifferentcharacters with grainyieldperplantandinterrelationshipamongcomponentcharactersarepresentedinTable 3.3.

Correlationbetweenseedyieldandothercomponentcharacters:

Seedyieldperplantshowedhighlysignificantandpositiveassociationwithbiological yield (0.917**) followed by number of pods per plant (0.615**), number of seedsperplant (0.513**), seed index (0.376**) and number of secondary branches perplant(284**).Italso showed positive but non-significant associationwithdaysto maturity (0.218), plant height (0.159),daysto50percentpodsetting(0.115).Whilenegative and non-significant association was recorded for harvest index (-0.011).

Mutualcorrelationbetweenothercharacters

Days to 50 per cent flowering showed positive and significantassociationwith days to 50% pod setting (0.672**), plantheight(0.327**),numberofsecondary branches per plant (0.299**). Whilepositivebutnon-significantassociationwas recorded for days to maturity (0.243), seedindex (0.116),numberofprimary branchesper plant (0.054), seed yieldperplant(0.007). Whilenegativeandnon-significantharvest index(-0.056)andnumber of pods per plant (-0.016).

Days to 50% pod setting showed positiveand significant association with number of secondary branches per plant (0.562**), days to maturity (0.317**). While positive but non- significant association was recorded for plant height (0.223), seed index (0.199),biological yield (0.147),seed yield perplant (0.115),numberofseeds perplant (0.041), numberof pods per plant (0.032).

Plant height showed positive and non-significant association with seed index (0.248), numberofsecondary branches perplant (0.183), biologicalyield(0.159). Negative and non-significantassociationwithnumberofseedsperplant(-0.226),numberofpodsperplant(- 0.199),harvest index (-0.074), number ofprimary branches per plant (-0.048).

Number of primary branches per plant exhibited positiveandsignificant association with number of secondary branches per plant (0.544**), number of pods per plant (0.487**), number seeds per plant (0.431**), biological yield(0.404**),seed yield per plant (0.363**).While negative non-significant association was recorded for harvest index (-0.190).

Numberofsecondarybranchesperplantexhibitedpositiveandsignificantassociation with number of primary branches per plant (0.291**),biological yieldper plant (0.285**), seed yield per plant (0.284**). While negative non-significant association was recorded for harvest index (-0.179). While positive non- significant association was recorded for number of seeds per plant (0.196), days to maturity (0.171) and seed index (0.168).

Daystomaturityshowedpositiveandsignificantseedindex(0.256**).Whilepositive and non - significant seed yield per plant (0.218),biologicalyield(0.161), number of pods per plant (0.058), harvest index (0.044). While

negative butnon- significant association was recorded for number of seeds per plant (-0.085).
Number of pods per plant exhibited positive and significant associationwith number of seeds per plant (0.866**), biological yield (0.629**), seed yield per plant (0.615**). While negative but significant association was recorded for seed index(- 0.274*). While negative but non-significant association was recorded for harvest index (- 0.235)
Number of seeds per plant showed positive and significant association with biological yield per plant (0.568**) and seed yield per plant (0.513**). While negative significant was observed in seed index (-0.367*) and harvest index (-0.296**).
Biological yield showed positive and significant association with seed yield per plant (0.917**), seed index (0.255*). Negative and significant harvest index (-0.361**).
Seed index showed positive and significant association with seed yield per plant (0.376**) and harvest index (287**).
Harvest index showednegativeand non- significant associationwithseed yield per plant (-0.011).

Table3.3PhenotypiccorrelationamongthedifferenttraitsevaluatedinchickpeaduringRabi2020-21atSHUATS,Prayagraj

Trait	DF50	DP50	DM	PH	NPB	NSB	NPPP	NSP	NSPP	SI	BYPP(g)	HI (%)	SYPP
DF50	**1.0000**	-0.0222	-0.0516	0.0195	-0.1371	0.224*	0.294**	0.0212	0.285**	-0.1011	0.1572	-0.0680	0.0918
DP50		**1.0000**	-0.205*	-0.0250	-0.1295	0.1764	0.0293	0.208*	-0.0833	0.1466	0.0920	-0.0874	0.0763
DM			**1.0000**	0.482**	0.312**	0.1011	-0.0373	0.405**	0.223*	0.1787	0.1464	0.0857	0.196*
PH				**1.0000**	0.1808	-0.0145	-0.0317	0.0913	0.1387	0.370**	0.212*	0.0368	0.224*
NPB					**1.0000**	-0.0339	0.0597	0.0986	0.1262	0.1097	0.235*	-0.1099	0.1669
NSB						**1.0000**	0.588**	0.348**	0.520**	-0.317**	0.410**	-0.338**	0.210*
NPPP							**1.0000**	-0.0017	0.771**	-0.344**	0.694**	-0.269**	0.531**
NSP								**1.0000**	0.378**	-0.251**	-0.0333	-0.0143	-0.0038
NSPP									**1.0000**	-0.388**	0.582**	-0.1558	0.516**
SI										**1.0000**	0.1488	0.1663	0.288**
BYPP											**1.0000**	-0.382**	0.748**
HI												**1.0000**	0.214*
SYPP													**1.0000**

DF50: Days to 50% flowering, DP50: Days to 50% pod setting, PH: Plant height (cm), NPB: No. of primary branches per plant, NSB:No. of secondary branches per plant, DM: Days to maturity, NPP: No. of pods per plant, NSP: No. of seeds per plant, BY: BiologicalYield(g),SI:SeedIndex(g),HI:Harvestindex(%),SYPP:Seedyieldperplant(g)

Correlationstudiesinthebreedingmaterialwillhelpindevelopingaselectionscheme, which would help in enhancing the genetic potential of a crop. It also provides basiccriteria for selection and directional model based on yield and its components infieldexperiments. Genotypicandphenotypiccorrelationcoefficienttellsustheassociationbetweenandamong two or morecharacters.Asignificantassociation suggests that such characters could be improvedsimultaneously.However,suchonimprovementdependsonphenotypiccorrelation, additivegeneticvarianceand heritability**.**
In the present investigation, results showed that the genotypiccorrelation coefficient ingeneralwerehigherthanthephenotypiccorrelationcoefficient.Theinterrelationshipswere; therefore,stronglyinherentandlowphenotypicexpressionwereduetoenvironmentalfactors. The phenotypic expression of correlationcoefficient, however appeared to be depressed in somecasesduetoenvironmentalinfluencethusselectionbasedonphenotypemaybeeffective.
The yield related traits displaying positive and significant association with grain yield per plant suggested that grain yieldcanbeimprovedthroughsimultaneous selection for thesetraits.Selectionisgenerallybasedonphenotypicexpressionoftraits.Henceselectionfor the traits exhibiting positive significant genotypic and positive significant phenotypic correlationwouldbeofmajoruseinindirectanddirectselectionforgrainyieldrespectively.

3.3 Pathcoefficientanalysis

Correlation is not sufficient to explain the true associationas itdoes not indicate the cause-and-effect relationship, hence the correlated traits have to be further analyzedfortheir direct effects of specific yield components on yield and also indirect effects via other yield components on grain yield**.**

The path coefficient analysis suggested by specified theeffectivemeasureof direct and indirect causes of association and also depicts the relative importance of each factor involved in contributing tothe final product i.e.,yield.In order to findout the cause-and-effect relationshipbetweenseedyieldanditsrelatedcharacters,pathanalysistakeninthepresent investigation.Pathcoefficient analysisallowsseparatingdirecteffect and indirect effects through other attributes by partitioning correlation.

Genotypic path coefficient analysis permits the separationofCorrelation coefficient intothedirectandindirecteffects. Itisbasicallyastandardizedpartialregressionanalysisand deals with a closed system of variables that are linearly related. Such information provides realistic basis for allocation of appropriate weightageto various yield components. The results obtained have been presented in the Table 3.4.

3.3.1 Genotypicpathcoefficientanalysis

Daysto 50%floweringhadpositivedirect effect(0.1728)ongrainyieldperplant. It exhibited positive indirect effect on biologicalyield (0.1063),number ofseeds per plant (0.0169), number of secondary branches per plant (0.3192), days to maturity (0.0028) and harvest index (0.033) and showed negative indirectonseedindex(-0.0322), number of primarypodsperplant(-0.0563),numberofprimarybranchesperplant(-0.0002),plantheight (-0.0248), days to 50 pod setting (-1.1789).

Daysto50%podsettinghadpositivedirecteffect(0.2629)ongrainyieldperplant.It exhibited positive indirect effect on number of secondary branches per plant (0.5433), biological yield per plant (0.314), days to maturity (0.0028) and number ofseedsperplant (0.0169). And showed negative indirect on number of pods per plant (- 0.1091), number of primary branches per plant (-0.0006), seed index (-0.0633), harvest index (-0.1253).

Plant height exhibited positive direct effect (0.1882) on grain yield per plant, it exhibited positive indirect effect onseed yieldthroughnumberofsecondary branchesper plant (0.0408), number of pods per plant(0.2669),biologicalyieldperplant (0.3267), number of primary branches per plant (0.0003), days to maturity (0.0007) and exhibited negative indirect effect on grain yield through number of seeds per plant (- 0.0991), harvest index (-0.0502), days to 50% pod setting (-0.1214) and seed index (- 0.0033).

Numberofprimarybranchesperplantexhibitedpositivedirecteffect(0.4937)onseed yield per plant, it exhibited positive indirect effect on number of seeds per plant (0.1164), biologicalyield(0.5989),daystomaturity(0.0034),numberofsecondarybranchesperplant (0.3641) and plantheight (0.0101) and exhibited negative indirect Effect on seed yield through harvestindex (0.0502),seed index(-0.0033),number of pods per plant (-0.4212) and days to 50% pod setting (-0.1214).

Number of secondary branches per plantexhibitedpositiveindirecteffect (0.5266) on seed yield per plant, it exhibited positiveindirecteffect on number of seedsperplant (0.0706), days to maturity (0.0036) and exhibited negative indirect effect onseed yield through number of pods per plant (-0.2474), days to 50% flowering (-0.0072)and days to50% pod setting (-0.2647).

Days to maturity exhibited positive direct effect (0.3708) on seed yield per plant,it exhibited positive indirect effect on number of secondary branches (0.2295), biological yield (0.4004), number of seeds per plant(0.0045) and exhibited negative indirecteffecton seed yield through days to 50% flowering (-0.004), plant height (-0.0041) and days to 50% pod setting -0.1044).

Number of pods per plantexhibited positivedirect effect (0.5654) on seed yield per plant, it exhibited positive indirect effect on biological yield (0.8008), seed index (0.0758), plant height (0.0237) and exhibited negative indirect effectonseedyield through harvest index(-0.1787),numberofprimarybranchesperplant(-0.0011)anddaysto50%podsetting (-0.0517).

Number of seeds per plant exhibited positive direct effect (1.4146) on seed yield,it also showed positiveindirect effect on seed yield through biologicalyield (0.6564), plant height (0.0209), number of secondary branches per plant (0.1633) and exhibited negative indirect effect on number of pods per plant (-0.5753), harvest index (-0.1933), number of primary branches (-0.0007), days to 50% flowering (-0.00097).

Biologicalyieldexhibitedpositivedirecteffect(0.9396)ongrainyield,italsoshowed positive indirect effect on seed yield through number of seeds per plant (0.1258), days to maturity(0.0028),numberofsecondarybranchesperplant(0.2494),daystomaturity(0.0028) andexhibitednegativeindirecteffectongrainyieldthroughdaysto50%flowering (-0.0011), seedindex(-0.044),plantheight(-0.0132)anddaysto50% podsetting (-0.0678).

Seed index exhibited positive indirect effect (0.4613) on grainyield,italso showed positive indirect effect on grain yield through number of pods per plant (0.2091), days to maturity (0.0032), number of secondary branches (0.1428),biologicalyield (0.335) and exhibited negative indirect effect on grain yield through days to 50% pod setting (-0.0828), days to 50% flowering (-0.0019) and plant height (-0.0215).

Harvest index exhibited negative direct effect (-0.1471) on grain yield, it also showed positive indirect effect on seed yield through number of pods per plant (0.2201), plant height (0.0093)anddaysto50%podsetting(0.0732)andexhibitednegativeindirecteffectongrain yield through seed index (-0.0958), biological yield (-0.6046), number of seedsperplant (- 0.1002),number of secondary branches (-0.1245)anddays to maturity (-0.0001).

Table3.4Genotypicdirect(inbold)andindirecteffectsof12traitsonseedyieldinchickpeaevaluatedinRabi2020-21

Trait	DF50	DP50	DM	PH	NPB	NSB	NPPP	NSP	NSPP	SI	BYPP(g)	HI (%)
DF50	**0.3045**	-0.0465	-0.0900	0.0411	-0.0940	0.1561	0.1920	-0.0209	0.2079	-0.1056	0.1084	-0.0851
DP50	-0.1022	**0.6689**	-0.1309	-0.0199	-0.1082	0.1855	0.0191	0.2243	-0.0601	0.1662	0.0849	-0.0566
DM	-0.1108	-0.0733	**0.3746**	0.2378	0.1716	0.0270	-0.0239	0.1674	0.1224	0.0816	0.0560	0.0371
PH	-0.0253	0.0056	-0.1192	**-0.1879**	-0.0456	0.0030	0.0071	-0.0303	-0.0294	-0.0832	-0.0411	-0.0130
NPB	-0.0512	-0.0269	0.0761	0.0403	**0.1660**	-0.0036	0.0108	0.0206	0.0216	0.0199	0.0437	-0.0207
NSB	0.0632	0.0342	0.0089	-0.0020	-0.0027	**0.1233**	0.0778	0.0502	0.0718	-0.0457	0.0531	-0.0492
NPPP	-0.7800	-0.0353	0.0790	0.0466	-0.0807	-0.7807	**-1.2371**	0.0008	-1.0329	0.4555	-0.9050	0.3729
NSP	0.0587	-0.2869	-0.3824	-0.1382	-0.1061	-0.3486	0.0005	**-0.8556**	-0.3729	0.2762	0.0308	0.0105
NSPP	0.4703	-0.0619	0.2251	0.1076	0.0897	0.4015	0.5752	0.3002	**0.6889**	-0.2872	0.4231	-0.1188
SI	0.1876	-0.1344	-0.1178	-0.2396	-0.0650	0.2005	0.1992	0.1746	0.2256	**-0.5410**	-0.0863	-0.0880
BYPP	0.4918	0.1755	0.2066	0.3021	0.3634	0.5956	1.0108	-0.0498	0.8486	0.2205	**1.3818**	-0.5802
HI	-0.2347	-0.0711	0.0832	0.0580	-0.1048	-0.3355	-0.2532	-0.0103	-0.1449	0.1366	-0.3527	**0.8400**
SYPP	0.272**	0.1478	0.213*	0.246*	0.1837	0.224*	0.578**	-0.0287	0.547**	0.294**	0.797**	0.249*

DF50: Days to 50% flowering, DP50: Days to 50% pod setting, PH: Plant height (cm), NPB: No. of primary branches per plant, NSB:No. of secondary branches per plant, DM: Days to maturity, NPP: No. of pods per plant, NSP: No. of seeds per plant, BY: Biological Yield (g), SI: Seed Index (g), HI: Harvest index (%), SYPP: Seed yield per plant (g)

Phenotypic path coefficient analysis permits the separation of Correlationcoefficient intothedirectandindirecteffects. Itisbasicallyastandardizedpartialregressionanalysisand deals with a closed system of variables that are linearly related. Such information provides realistic basis for allocation of appropriate weightageto various yield components. The results obtained have been presented in the Table 3.5.

3.3.2 Phenotypicpath coefficient analysis

Days to 50% flowering had positive direct effect (0.1023)ongrainyieldperplant. It exhibitedpositiveindirecteffectonbiologicalyieldperplant(0.0549),plantheight(0.0029), number of secondary branches per plant (0.0949), number of podsper plant (0.0068) and exhibitednegativeindirect onseedindex(-0.0023),numberofprimary branches (-0.0094), number of seeds per plant (-0.0049).

Daysto50%podsettinghadpositivedirecteffect(0.1979)ongrainyieldperplant.It exhibited positive indirect effect on plant height (0.0029), number of secondary branches (0.0949), biological yield (0.2113) and number of pods perplant(0.0169) showed negative indirectonnumberofprimarybranchesperplant(-0.0364),daysto50%flowering(-0.0161) and number of seeds per plant (-0.003).

Plant height exhibited negative indirect effect (0.1751) on grain yield per plant, it exhibited positiveindirect effecton seedyield through daysto 50%podsetting (0.0066),number of pods per plant (0.0119), number of primary branches per plant (0.0119) and exhibited negative indirect effect on grain yield through number of pods per plant (- 0.0484), seed index (-0.0057) and harvest index (-0.0516).

Number of primary branches per plant exhibited positiveindirect effect(0.4291) on seed yield per plant, it exhibited positive indirect effect on biological yield (0.4512), days to maturity (0.0046), number of pods per plant (0.0074), biological yield per plant (0.4512) and exhibited negative indirect effect on seed yield through harvest index (- 0.0575), plant height (-0.0011), seed index (-0.0003), number of seedsperplant(- 0.0352).

Number of secondary branches per plant exhibited positive direct effect (0.4054)on seed yield per plant, it exhibited positive indirect effect on biological yield (-0.3764), number of pods per plant (0.0507), days to maturity (0.0051), plant height (0.0011) and exhibited negativeindirecteffectonseedyieldthroughnumberofseedsperplant(-0.0187),plantheight (0.0011) and days to 50% pod setting (0.015).

Days to maturity exhibited positive indirect effect (0.3034)onseedyieldperplant, it exhibitedpositiveindirecteffectondaysto50%podsetting(0.0069),numberofpodsperplant (0.0143), and exhibited negative indirect effect on seed yield through seed index (-0.0052), number of primary branches per plant (-0.0252) and days to50% flowering (-0.0069).

Number of pods per plantexhibited positivedirect effect (0.5877) on seed yield per plant, it exhibited positive indirect effect on biological yield(0.6493),daysto maturity (0.0018), number of secondary branches per plant (0.0445)andexhibited negativeindirect effect on seed yield through harvest index (-0.1225), plant height (-0.003)andnumberof primary branches per plant (-0.0587), number of seeds per plant (- 0.724).

Number of seeds per plant exhibited positive direct effect (0.4593) on seed yield,it also showed positive indirect effect on seed yield throughnumberofsecondary branches (0.003), number of pods per plant (0.1321), days to 50% pod setting (0.0008),andexhibited negative indirect effect on harvest index (-0.1396), number of primarybranches per plant (- 0.0438), plant height (-0.0028), days to maturity (-0.0005).

Biological yield exhibited positive direct effect (0.929) on grain yield, it alsoshowed positive indirect effect on seed yield through plant height (0.003), number of secondary branchesperplant(0.0262)andexhibitednegativeindirecteffectongrainyield through days to 50% flowering (-0.0034), number of pods per plant (0.0458), daysto 50% flowering (- 0.0013).

Seed index exhibited positive direct effect (0.4251) on grain yield, it also showed positive indirect effect on grain yield through harvestindex(0.1501),plantheight (0.003), and days to 50% pod setting (0.0051) and exhibited negative indirect effect on grain yield throughnumberofprimarybranches (-0.0019)anddaysto50%flowering(-0.0034), number of pods per plant (-0.0458).

Harvest index exhibited negative direct effect (0.0861) on grain yield, it also showed positiveindirecteffectonseedyieldthroughdays tomaturity(0.0002),numberofseeds per plant (0.0277), days to maturity (0.0002), number of primary branches per plant (0.0142) and exhibited negative indirect effect on grain yield through plant height (-0.0011), number of secondarybranchesperplant(-0.0247),plantheight(-0.0011)andbiologicalyieldperplant(- 0.4392).

In the present investigation theresults ofpath coefficient analysis indicated that, the traitshavingdirecteffectsongrainyieldareunderstoodtobestronglyassociatedwithit.The path analysis results showed that positive and direct on grain yield was exhibited by number of primary branch per plant, number of seedsper pod, biological yield, and harvest index.

From the above results and discussions, it is evident that considerable amount of variation was present in 21 genotypes of chickpea at Prayagraj climatic condition, whichis pre-requisite to begin any breeding programme.

The presentexperiment possessed considerablevariability and highheritability for many quantitative traits revealing the scope for improvement by selection and hybridization.

Table3.5Phenotypicdirect(inbold)andindirecteffectsof13traitson seedyieldinchickpeaevaluated inRabi2020-21

Traits	DF50	DP50	DM	PH	NPB	NSB	NPPP	NSP	NSPP	SI	BYPP(g)	HI (%)
DF50	**-0.0468**	0.0010	0.0024	-0.0009	0.0064	-0.0105	-0.0138	-0.0010	-0.0134	0.0047	-0.0074	0.0032
DP50	-0.0006	**0.0292**	-0.0060	-0.0007	-0.0038	0.0051	0.0009	0.0061	-0.0024	0.0043	0.0027	-0.0026
DM	0.0009	0.0036	**-0.0175**	-0.0084	-0.0054	-0.0018	0.0007	-0.0071	-0.0039	-0.0031	-0.0026	-0.0015
PH	-0.0010	0.0013	-0.0243	**-0.0503**	-0.0091	0.0007	0.0016	-0.0046	-0.0070	-0.0186	-0.0106	-0.0019
NPB	-0.0001	-0.0001	0.0002	0.0001	**0.0006**	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	-0.0001
NSB	-0.0011	-0.0009	-0.0005	0.0001	0.0002	**-0.0051**	-0.0030	-0.0018	-0.0027	0.0016	-0.0021	0.0017
NPPP	0.0154	0.0015	-0.0020	-0.0017	0.0031	0.0309	**0.0525**	-0.0001	0.0405	-0.0181	0.0364	-0.0141
NSP	0.0003	0.0026	0.0051	0.0011	0.0012	0.0043	0.0000	**0.0125**	0.0047	-0.0031	-0.0004	-0.0002
NSPP	0.0556	-0.0162	0.0434	0.0271	0.0246	0.1014	0.1504	0.0737	**0.1951**	-0.0757	0.1136	-0.0304
SI	-0.0192	0.0278	0.0339	0.0703	0.0208	-0.0602	-0.0653	-0.0476	-0.0736	**0.1899**	0.0283	0.0316
BYPP	0.1245	0.0729	0.1159	0.1675	0.1864	0.3244	0.5494	-0.0264	0.4613	0.1179	**0.7920**	-0.3022
HI	-0.0360	-0.0463	0.0454	0.0195	-0.0582	-0.1790	-0.1427	-0.0076	-0.0826	0.0881	-0.2022	**0.5299**
SYPP	0.0918	0.0763	0.196*	0.224*	0.1669	0.210*	0.531**	-0.0038	0.516**	0.288**	0.748**	0.214*

DF50: Days to 50% flowering, DP50: Days to 50% pod setting, PH: Plant height (cm), NPB: No. of primary branches per plant, NSB:No. of secondary branches per plant, DM: Days to maturity, NPP: No. of pods per plant, NSP: No. of seeds per plant, BY: BiologicalYield(g),SI:SeedIndex(g),HI:Harvestindex(%),SYPP:Seedyieldperplant(g)

IV. Summary and Conclusion:

4.1 Summary:

Broad sense heritability was range from (43.17%) to (85.17%). High heritability was recorded for seed index (85.17%), number of seedsper plant (97.3%), number of secondary branches (96.9%), days to 50% flowering (73.97%), biological yield per plant (72.65%), days to 50% pod setting (67.13%), days to maturity (66.04%). And high genetic advance was found in number of seeds per plant (23.57) followed by number of pods per plant (19.51), biological yield per plant (10.13).

Genotypic correlation coefficient analysis revealed that seed yield per plant showed highly significant and positive association with biological yield (0.940**).

Phenotypic correlation coefficient analysis revealed that seed yield per plant showed significant and positive association with biological yield (0.917**), number pods per plant (0.615**) and number of seeds per plant (0.513**).

Genotypic path coefficient analysis indicated that, the traits having direct effects on grain yield are understood to be strongly associated with it. The path analysis results showed that positive and direct on grain yield was exhibited by biological yield, number of pods per pod, number of secondary branches and number of primary branches.

Phenotypic path coefficient analysis indicated that, the traits having direct effects on grain yield are understood to be strongly associated with it. The path analysis results showed that positive and direct on grain yield was exhibited by biological yield, number of pods per pod, number of secondary branches and number of primary branches.

4.2 Conclusion:

It is concluded from the result of the present experiment that the characters number of seeds per plant, number of pods per plant, biological yield, seed yield per plant and seed index exhibited high genotypic coefficient variation (GCV), phenotypic coefficient of variation (PCV) and high heritability is coupled with genetic advance as percent of mean. The seed yield per plant exhibited a significant and positive correlation with biological yield paves the way of indirect selection of the traits for seed yield. Path analysis showed that the highest contribution to the seed yield was biological yield and number of pods per plant, hence biological yield should be given utmost importance. The genotype selected here is evaluated further for consistency in performance.

References:

[1]. Reddy, A. T., Gowda, J., Jayalakshmi, V., Ahammed, K., Kamakshi, N., Vijayabharathi,A., and Lakshmipathy, T. (2017). Variability Studies for Morphological Traits in the F2 Population of chickpea (Cicerarietinum L.). Trends in Biosciences 10(48): 9583-9586.

[2]. Burton, G. W., and Devane, D. E. (1953). Estimating heritability in tall fescue (Festuca arundinacea) from replicated clonal material. Agronomy Journal, 45(10):478-481.

[3]. Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimates of genetic and environmental variations in Soybean.AgronomyJournal,47: 314-318.

[4]. Robinson, H. F., Comstock, R. E. and Harvey, P. H. (1951).Genotypic and phenotypic correlations in corn and their implications in selection.Agron. J., 43: 282-287.