Assessment of Genetic Variability, Heritability and Genetic Advance Studies for Yield and Quality Traits in Elite Genotypes of Chickpea (*Cicer arietinum* L.)

ABSTRACT: The present investigation has been entitled Assessment of Genetic Variability, Heritability and Genetic Advance Studies for Yield and Quality Traits in Elite Genotypes of Chickpea (*Cicer arietinum* L.). The experiment was laid out in Randomized Block Design (RBD). The experiment was carried out during the Rabi 2020-2021. The analysis has been done with 10 characters having plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, pod length, days to 50% flowering, 100- seed weight, pod yield per plant, pod yield per plot as a dependent variable. High genotypic coefficient variation and phenotypic coefficient of variation were found in seed yield per plant, seed yield per plot and several seeds per pod displayed the negligible influence of environment on the phenotypic expression of the characters. High heritability coupled with high genetic advance was seen in seed yield per plant, seed yield per plot, number of secondary branches per plant, number of primary branches per plant, number of pods per plant, and pod length indicating an additive gene effect. Therefore, these characteristics can be used in further breeding programs for crop advancement.

Keywords: chickpea (*Cicer arietinum* L.,), Genetic variability, GCV, PCV, Heritability, and Genetic advance,Yield.

INTRODUCTION:

The chickpea (*Cicer arietinum L.*,) is an annual legume of the family Fabaceae, chickpea seeds are high in protein. It is one of the earliest cultivated legumes.Chickpea is a cool-season grain legume that may withstand hot temperatures during fruiting and ripening (*Ecoport, 2013*). It is thought to have originated in South-East Anatolia and neighboring Syria and Iran, where the earliest remains date back to around 7000 BC. It was introduced to the Mediterranean Basin, Africa, and the Indian subcontinent before 2000 BC. *Cicer arietinum* from sea level up to an altitude of 2500 m in areas where temperatures range from 15^0C to 29^0C (*van der Maesen, 1989*). Chickpeas are mainly cultivated in the cool, dry season of the semi-arid tropics on residual moisture. The plant will be adapted to tropical climates with moderate temperatures and is successfully cultivated under irrigation in the cool season of many tropical countries (*Bejiga et al., 2006*).Globally, chickpea has yield levels of about 850 kg/ha. the crop yields in the developing regions are very low. However, in the case of chickpeas, some developing regions have exceeded the developed countries in terms of yield levels. The yield level in South and South-East Asia has increased by 13% from 717 kg/ha in 1994-1996 to 812 kg/ha in 2008-2010, growing at an annual rate of 0.8% (*Nedumaran et al.,2015*).The mean annual production share of chickpea by region from 2008 to 2017 revealed that Asia shares 83% globally. In 2019, world production of chickpea was 14 million tonnes, led by India with 70% of the global total, and Turkey as a secondary producer of chickpea.

Variability is the either presence of or the generation of genetic differences. It is defined as “the formation of individuals differing in genotype, or the presence of genotypically different individuals, in contrast to environmentally induced differences which as a rule, cause only temporary, nonheritable changes of the genotypes.” Genetic variability in a population is important for biodiversity. The genotypic and phenotypic coefficients of variation help understand the existing variability in the populations whereas, the estimates of heritability and genetic advance provide the indices of transmissibility of characters. Thus, estimates of variability like coefficients of variation, heritability, and genetic advance are very useful for devising suitable selection strategies for developing high-yielding genotypes in chickpea crops.

MATERIALS AND METHODS:

30 chickpea genotypes obtained from different sources were sown in a Randomized Block Design (RBD) with three replications in the Crop Research Centre (CRC), Department of Genetics and Plant Breeding, School of Agriculture, ITM University, Gwalior, during 2021-2022. Each genotype was planted in a separate plot, with a plant-to-plant and row-to-row distance of 10 and 30 cm respectively. Recommended cultural practices were carried out to grow a successful crop. Observations are recorded on 10 traits *viz.*,Plant height, Days to 50% flowering, number of primary branches, number of secondary branches, number of pods per plant, number of seeds per pod, pod length, seed index, yield per plant,and Seed yield per plot.

The data were subjected to analysis using OP STAT (O.P. Sheoran Programmer, Computer Section, CCS HAU, Hisar) and R Studio.

RESULTS AND DISCUSSION:

The Analysis of Variance **(Table1)** showed significant differences among the 30 genotypes of chickpea for all the 10 characters studied which indicates the presence of a sufficient amount of genetic variability among the genotypes and hence revealed the scope of improvement in a breeding program.

Table 1: Analysis of Variance (ANOVA)

		MEAN SUM OF SQUARES		
SL.NO	**CHARACTERS**	**REPLICATION (Df = 2)**	**TREATMENT(Df =29)**	**ERROR (Df =58)**
1.	Plant height	430.88	87.30**	1.62
2.	Number of primary branches	243.744	12.646**	1.181
3.	Number of secondary branches	771.03	291.54**	3.85
4.	Number of pods per plant	1545.28	680.52**	6.97
5.	Number of seeds per pod	11.5111	0.5169**	0.2238
6.	Pod length	1.14411	0.35833**	0.00561
7.	Days to 50% flowering	461.01	150.52**	2.61
8.	seed index	52.811	7.965**	0.639
9.	Seed yield per plant	2548.6	1017.2**	10.0
10.	Seed yield per plot	2.31053	0.91601**	0.00896

** significant at a 5% level of significance

Range of variability for plant height (56.6- 83.3 cm),days to50% flowering(62.3- 85.3),number of primary branches (11.6–19.3),number of secondarybranches(53.6 -93.6), number of pods per plant (124.6– 174.6), number of seeds per pod(1.3– 2.6), pod length (1.2 - 2.5cm),seedindex(15.6–21.6), yieldperplant(32.6-102g) and Seed yield per plot (0.9-3)wereobservedTable-2, Fig.1

Alwawi*et al.*, (2010), Ali *et al.*, (2008), Muhammad *et al.*, (2008), Meena *et al.*, (2006) and sable *et al.*, (2000).

Table 2: Mean performance of 30 genotypes for 10 Characters Under Study

Sl.No	Genotypes	Plant Height	Number of Primary Branches per plant	Number of Secondary Branches per plant	No. of Pods Per Plant	No. of Seeds Per Pod	Pod Length	Days to 50% Flowering	100 Seed Weight	Seed Yield Per Plant	Seed Yield Per Plot
1.	Pusa 2024	61	15.3	66	124.6	2	1.8	62.3	16.3	51	1.5
2.	IPCK- 2004-29 (Shubra)	62	14.3	72.6	135	1.6	1.4	65.3	16.6	69.6	2.1
3.	IPCK- 2004-29 (Ujjwal)	64.3	12.3	71	144	2	1.7	70.3	18	59.6	1.8
4.	Pusa- 1088	72.3	17.3	82	154	2.3	1.6	66	19	99.6	3
5.	Pusa- 1103	70	14	64.6	134.6	1.6	1.6	71.6	16.6	91	2.7
6.	JG- 130	72.3	14.6	69.6	147.3	2.6	2.0	67	18.6	79.6	2.4
7.	JG- 63	72.3	13.3	73	162.3	2	2.3	71	19.3	63	1.9
8.	JGK- 2	66	11.6	68.6	125	2.3	1.8	63	16	81	2.4
9.	JGK- 3	64.6	14.3	71.3	134	1.6	1.5	69	18.6	99.6	3
10.	JG- 226	68	16	82.6	164.3	2	2.4	64.6	18.3	64	1.9
11.	JG- 6	65.6	14.6	66.3	131.6	1.6	2.3	71.6	20	49.6	1.5
12.	JGK- 14	62.3	14	66.3	131.3	1.3	1.5	65	15.6	75.3	2.2
13.	JGK- 1	64.3	18.3	85.3	147.3	2.3	1.4	67	19.3	81.6	2.4
14.	RMG-1079	66.3	15.3	65	135.6	1.6	2.1	76	20.3	62	1.8
15.	ML-1299	74.6	18	88.3	165.3	2.3	1.4	75.3	17.6	102	3.0

16	PVSA-672	59	13	67	137	2.3	1.6	73.3	17.3	35	1
17	RMG-1041	56.6	12	58.6	133.6	1.6	2.1	81.3	20	70	2.1
18	RMG-1015	63.3	15.6	67	147.3	2.6	1.6	79.6	17	55	1.6
19	Jyoti	62	15.3	57.3	127.3	1.6	1.6	84.6	21.3	77.3	2.3
20	C-115	65	12.6	53.6	134.6	2	1.2	81	16.6	88.6	2.6
21	C-113	65.6	13.3	65	141.3	2.6	1.5	69.3	17	58.6	1.7
22	C-223	74.3	17.6	79.6	166.6	1.3	1.7	73.3	16.6	96.3	2.9
23	JG-24	64.6	14.6	66	157	2	1.2	81	19.3	68.3	2
24	C-1014	83.3	14	66.3	164	1.6	1.4	82.3	17.6	55	1.6
25	C-1023	67	15.3	66.6	145	2.3	1.4	75.3	21.6	32.6	0.9
26	C-137	67.6	19.3	93.6	174.6	1.6	1.6	69	17	83	2.5
27	C-210	65	14.6	63.6	145.3	2.6	1.9	77	19.6	68.6	2
28	C-126	71	19	86.6	166.6	1.6	2.5	84.6	15.6	94	2.8
29	C-1025	64	14	64	165	1.6	1.9	82.3	18.6	58.6	1.7
30	AVTI-G5	62.6	17.3	84.6	169	1.6	2	85.3	17.3	80.6	2.4
	Grand Mean	66.5889	15.0556	71.1	147.044	1.9889	1.7711	73.5111	18.1222	71.7	2.1606
	CD 5%	2.0834	1.7763	3.2067	4.3141	0.7731	0.1224	2.6398	1.3062	5.1687	0.1547
	CD 1%	2.772	2.3634	4.2665	5.74	1.0286	0.1628	3.5123	1.7379	6.877	0.2059

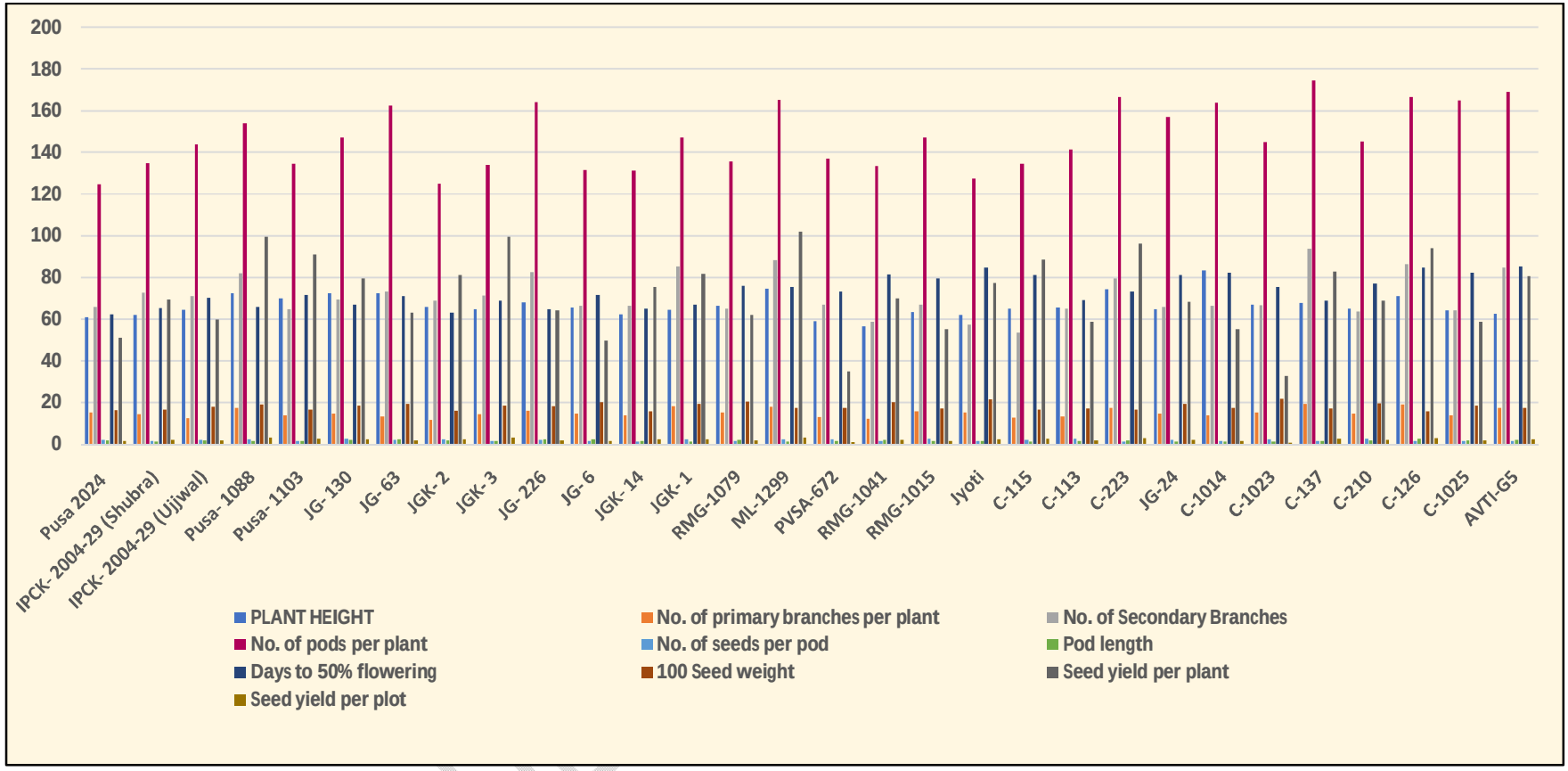

Fig 1: Mean Performance of 30 Genotypes for Characters Under Study

COEFFICIENT OF VARIATION:

The magnitude of GCV was found highest in seed yield per plant (25.5) seed yield per plot(25.4)followed by, pod length (19.3), number of seeds per pod (15.7), number of secondary branches per plant (13.7), number of primary branches per plant (12.9), number of pods per plant (10.1), days to 50% flowering (9.5), seed index (8.6) and plant height (8).

The magnitude of PCV was found highest in the number of seeds per pod (28.5), seed yield per plant (25.9), seed yield per plot (25.8), followed by pod length (19.8), number of primary branches per plant (14.8), number of secondary branches per plant (14), number of pods per plant (10.3), days to 50% flowering (9.8), seed index (9.6) and plant height (8.2).

The Estimates of Phenotypic Coefficient of Variation (PCV) for all the 10 characters under study were found to be higher than the Genotypic Coefficient of Variation (GCV) indicating the influence of the environment on the phenotypic expression of these characters.

These results are reported by the Arshad *et al.,* 2003. Khan *et al.,* 2011 suggested that the seeds per pod had maximum PCV and GCV followed by test weight. Dwivedi and Gaibriyal, 2009 reported

Table 3: Coefficient of variation (GCV, PCV) for all the characters under study

Sl. No	Characters	Genotypic Coefficient of Variation	Phenotypic Coefficient of Variation
1	Plant height	8	8.2
2	Days to 50% flowering	9.5	9.8
3	Number of primary branches per plant	12.9	14.8
4	Number of secondary branches per plant	13.7	14
5	Number of pods per plant	10.1	10.3
6	Number of seeds per pod	15.7	28.5
7	Pod length	19.3	19.8
8	seed index	8.6	9.6
9	Seed yield per plant	25.5	25.9
10	Seed yield per plot	25.4	25.8

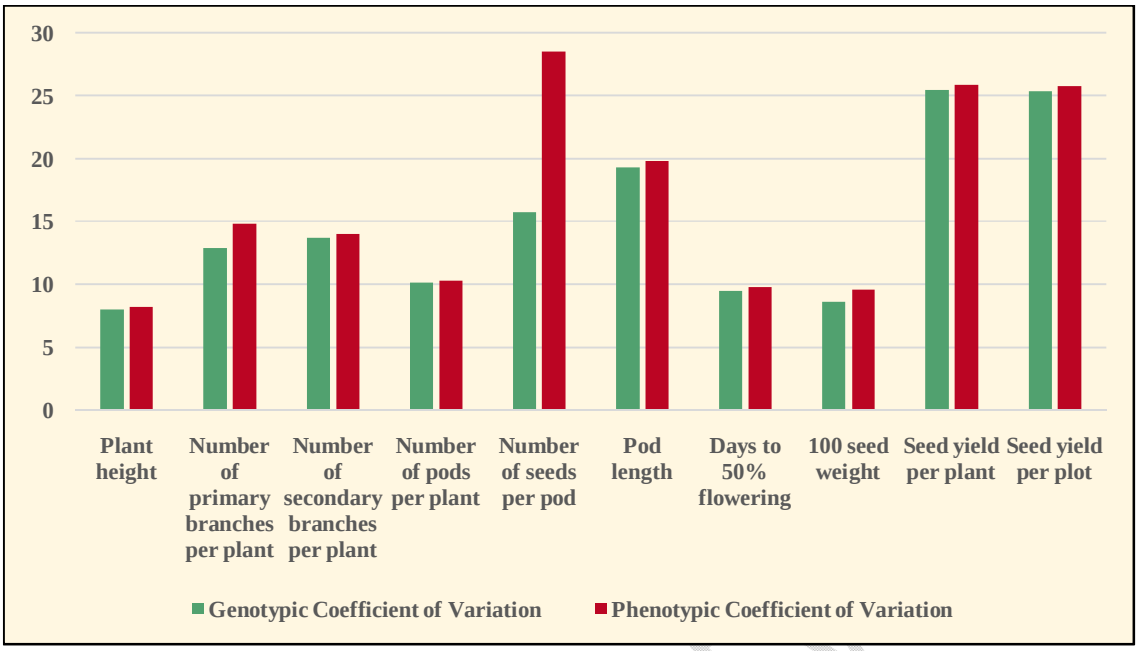

Fig 2: Coefficient of Variation (PCV and GCV) for all the characters under study

HERITABILITY AND GENETIC ADVANCE:

The magnitude of heritability ranged from97.1 to 30 in seed yield per plot and the number of seeds per pod respectively. The highest heritability was seen in seed yield per plot (97.1) followed by the number of pods per plant (96), and pod length (95). Days to 50% flowering (94), seed yield per plant (90), number of secondary branches per plant (90), plant height (90), seed index (79), number of primary branches per plant (70), and number of seeds per pod (30) (Table 4 & Fig 3).

Genetic advances ranged from 0.3 to 37.19 in the number of seeds per pod and seed yield per plant respectively.

High heritability coupled with high genetic advance is seen in seed yield per plant, High heritability coupled with high genetic advance indicates additive gene action which is beneficial for crop improvement.

These results were to the findings of Naresh *et al.*, (2015), Kumar *et al.*, (2015), Pattanaik*et al.*, (2015), Bhujwal*et al.*, (2013), Archana *et al.*, (2008)

Table 4: Heritability, Genetic Advance, and Genetic Advance as percent Mean for all the characters under study

Sl. No	Characters	Heritability h^2 (bs) (%)	Genetic Advance (%)	GA as a percent of the mean (%)
1	Plant height	90	10.7	16
2	Days to 50% flowering	94	14	19.1
3	Number of primary branches per plant	70	3.51	23.3
4	Number of secondary branches per plant	90	19.7	27.8
5	Number of pods per plant	96	30.3	20.6
6	Number of seeds per pod	30	0.3	17.8
7	Pod length	95	0.6	38.9
8	100 seed weight	79	2.8	15.8
9	Seed yield per plant	90	37.19	51.8
10	Seed yield per plot	97.1	1.1	51.6

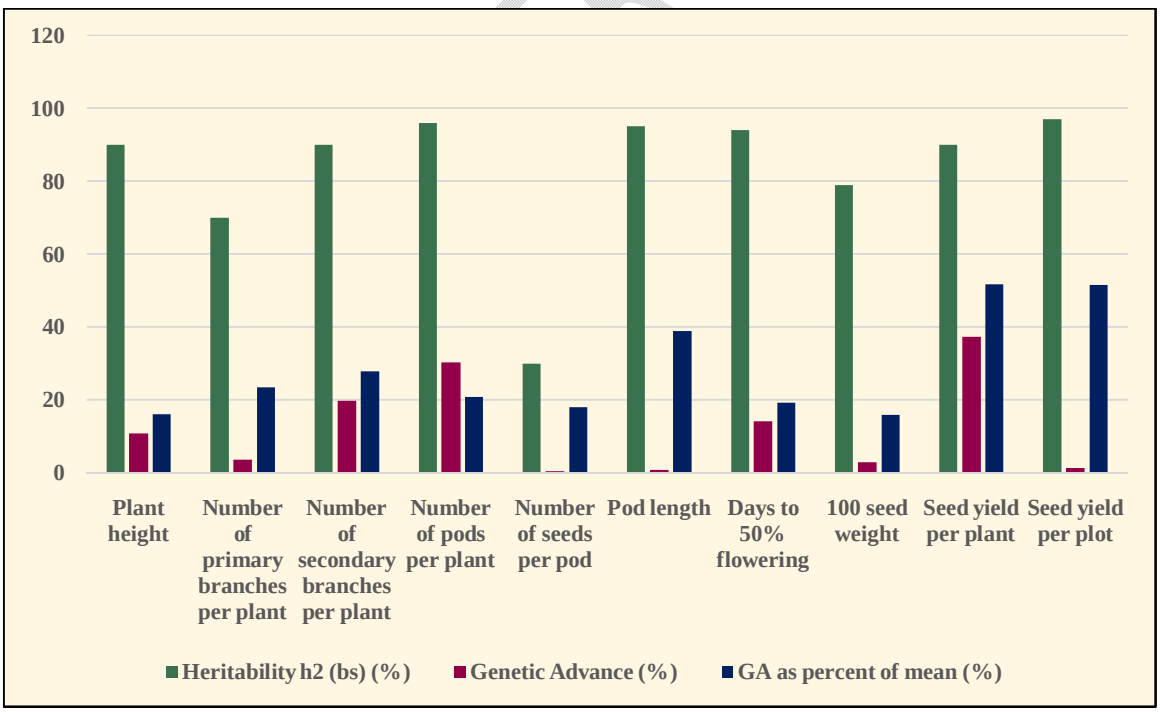

Fig 3: Coefficient of Variation (PCV and GCV) for all the characters under study

CONCLUSION:

In this study, it is concluded that among the 30 genotypes of chickpea, the two genotypes C-136, C-1014, GNG-1958, C-223, C-126, C-128, C-115, and C-137 were found to be superior in terms of yield. Seed yield per plant, number of seeds per pod, seed yield per plot, and pod length exhibited high GCV, PCV, and other genetical parameters revealed that the higher heritability and genetic advance as percent of mean were for several pods per plant, days to 50% flowering, seed yield per plant, number of secondary branches per plant, plant height. The above-mentioned characters will prove helpful for a selection of the desirable yield-related traits as they are possessing additive gene action which is completely transferable.

FUTURE SCOPE

Chickpea has low digestible carbohydrates with a good amount of protein, important fats, and a variety of minerals and vitamins. It is a very nutrient-dense pulse crop that has health value for pregnant women and young children. Its growth depends on zinc, a mineral that is abundant in chickpeas. The current high rates of population increase would exacerbate the discrepancy between the country's demand and its output for chickpeas. This circumstance highlights the necessity of breeding Chickpea crops to increase the yield. For increasing the yield, the need fora variable population of chickpeasconcerning desirable traits is required to evaluate. Hence, the evaluation of genetic variability, heritability, and the genetic advance was carried out in chickpea genotypes. The identified genotypes having valuable traits would be utilized further in the breeding programs.

REFERENCES:

Ali, Q., Sadaquar, A., Arshad, S., Farooq, J., Ahsan, M., Waseem, M. and Iqbal, A. (2011). Genetic variability and correlation analysis for quantitative traits in chickpea genotypes (Cicer arietinum L.,). Journal of Bacteriology Research, 3: 6-9.

ALwawi, Hayel, Mohammad Moulla, and Wafaa Choumane. "Genotype-environment interaction and genetic parameters in chickpea (Cicer arietinum L.) landraces." *Journal of Agricultural Science* 2.1 (2010): 154.

Arshad, Muhammad, *et.al*, "Genotype-environment interaction for grain yield in chickpea (Cicer arietinum L.)." *Pak. J. Bot* 35.2 (2003): 181-186.

Gul, R., *et al.*, "Genetic analysis and interrelationship of yield attributing traits in chickpea (Cicer arietinum L.)." *The Journal of Animal and Plant Sciences* 23.2 (2013): 521-526.

Khan, H., Ahmad, S.Q., Forhad, A., Khan, M.S., Nayar and Iqbal (2006). Genetic variability and correlation among quantitative traits in chickpea germplasm. Sarhad Journal of Agriculture, 22(1): 55-59.

Meena, V.K., Verma, P., Tak, Y. and Meena, D. (2021). Genetic variability, correlation and path coefficient studies in chickpea (Cicer arietinum L.,) Genotypes in South Eastern Rajasthan. Biological Forum- An International Journal, 13 (3a): 93-98.

Muhammad, S., Asif, Z. and Muhammad, A. (2005). Interrelationships and variability studies for grain yield and various components in chickpea (Cicer arietinum L.,). Journal of Agriculture and Social Science, 1(3): 266-269.

Parhe, SACHIN D., P. N. Harer, and D. R. Nagawade. "Investigation of genetic divergence in chickpea (Cicer arietinum L.) genotypes." *The Bioscan* 9.2 (2014): 879-882.

Rao, C.M. and Rao, Y.K. (2005) Association and path analysis under four environments in chickpea (Cicer arietinum L.,). Legume Research, 28(4): 272-275.