

## Genetic variability, heritability and genetic advance for yield and its component traits in Spanish Bunch Type groundnut (*Arachis hypogaea*)

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### Abstract

The present study was designed to assess the extent of variability, heritability and genetic advance of 25 groundnut genotypes using randomized block design with three replications. The observations were recorded on five randomly selected plants from each treatment and replication of fourteen different traits. Based on mean performance, high dry pod yield per plant was identified for the genotype UG-252. Moderate estimates of GCV was recorded for 100- kernel weight followed by dry pod yield per plant and harvest index. Genetic parameters revealed that high heritability was recorded for oil content followed by 100- kernel weight and moderate genetic advance as percent of mean was recorded for dry pod yield per plant.

**Keywords:** GCV, PCV, heritability and Genetic advance as percent of mean

### Introduction

The cultivated Groundnut or peanut (*Arachis hypogaea* L.) is an allotetraploid ( $2n = 4x = 40$ ). It most probably originated in the region of eastern foothills of Andes (Southern Bolivia and Northern Argentina). Peanut is widely grown as an oil seed or food crop in more than 144 countries (includes tropical and warm temperate regions) of the world. The commercial production largely confined between 40<sup>o</sup>N and 40<sup>o</sup>S latitudes. Besides being an important oil seed crop it is also utilized for different purposes like seed (kernel) consume directly raw, roasted and boiled or processed into confections and peanut flour for flavor enhancement or crush for oil for edible and industrial uses; source of high quality edible oil (44-56%), protein (22-30%) on a dry seed basis, carbohydrates (10-25%), vitamins (E, K, and B complex), minerals (Ca, P, Mg, Zn and Fe) and fiber; shell used as fuel and animal feed, cattle litter, filler in feed and fertilizer industry; haulm used as animal fodder or in manuring; roots being legume add the nitrogen (100-152 kg ha<sup>-1</sup>N) and organic matter to soil (Nigam, 2014) [7].

Dry pod yield is a complicated feature in groundnut that is influenced by its constituent traits. It is necessary to investigate the nature of genetic variability for yield-related attributes and quality features in groundnut to genetically manipulate pod production, kernel quality and other characteristics. Estimation of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) assists in genotype selection, and heritability combined with genetic progress would be a more beneficial tool in forecasting the consequent effect for genotype selection. Heritability estimates provide information about the traits that are transmitted from parents to their offspring and it has a crucial role in selection criteria to improve pod yield.

It provides information on genetic variation and can be used to forecast how individuals will respond to selection in future generations. The type of gene action affects heritability. Breeding for improved dry pod yields requires a better understanding of the genetic control of critical

features in Spanish bunch groundnut. The occurrence of genetic variability in breeding materials is critical for increasing the gene pool and, as a result, for plant breeding program success. Heritability is a measurement of how well characteristics are transferred from parents to their offspring, and it's extensively applied in breeding programs. Considering heritability provides information on the degree of genetic control over a trait's expression as well as the phenotypic reliability of forecasting its breeding value. Another key statistic is the genetic advance, which is used to predict the expected response to selection. The most successful condition for selection is high genetic advance combined with high heritability, which implies the existence of additive genes in trait inheritance. In groundnut, phenotypic and genotypic coefficients of variation, heritability, and genetic advance have all been used to assess the extent of diversity in breeding material, define acceptable selection processes, and anticipate breeding progress in improving critical traits. The present study was carried out to evaluate the variability, heritability, and genetic advance for dry pod yield traits in a set of Spanish bunch groundnut genotypes and breeding lines to provide necessary genetic information for the improvement of kernel quality in a groundnut breeding program.

### Material and Methods

The present investigation was carried at instructional farm of College of Technology and Engineering (CTAE), during Udaipur in *kharif*, 2021. The experimental materials of the study comprised of 25 bunch groundnut genotypes along with 3 checks of were evaluated in Randomized Block Design with 3 replications during *kharif* 2021. Geographically, the experimental site is located at an elevation of 582.17 meter above the mean sea level on latitude of 24°35' North and longitude of 73°42' East. The climate of Udaipur is tropical, summer is tolerably hot and winters are quite pleasant. The region experiences scanty rainfall in monsoon season. Observations were recorded on 5 randomly selected plants in each replication for plant height (cm), number of branches per plant, sound mature

kernels (%), dry pod yield per plant (g), kernel yield per plant (g), 100-kernel weight (g), shelling percentage (%), biological yield per plant (g), harvest index (%) except for days to 50% flowering, days to maturity, oil content (%) and protein content on a plot basis.

### Statistical analysis

The analysis of variance for the Randomized Block Design of the experiment was carried out using Panse and Sukhatme (1967) formula. The fixed-effect model is given below:

$$Y_{ij} = \mu + t_i + b_j + e_{ij}$$

Where,  $Y_{ij}$  = Yield of  $i^{\text{th}}$  entry in the  $j^{\text{th}}$  replication

$\mu$  = General mean

$t_i$  = Effect of the  $i^{\text{th}}$  entry ( $i = 1, 2, \dots, v$ )

$b_j$  = Effect of the  $j^{\text{th}}$  replicate ( $j = 1, 2, \dots, r$ )

$e_{ij}$  = Environmental effect

The genotypic coefficient of variability (GCV), phenotypic coefficient of variability (PCV) and environmental coefficient of variability (ECV) were computed by formula suggested by Burton and de Vane (1953) [1].

$$GCV = (\text{Genotypic standard deviation})/\text{Mean} \times 100 \text{ or } (\sigma_g/\bar{x}) \times 100$$

$$PCV = (\text{Phenotypic standard deviation})/\text{Mean} \times 100 \text{ or } (\sigma_p/\bar{x}) \times 100$$

Heritability in a broad sense ( $h^2_{bs}$ ) was calculated according to the formula suggested by Hanson *et al.* (1956) [4].

$$H^2_{bs} = (\sigma^2_g)/(\sigma^2_p) \times 100$$

Where,  $\sigma^2_g$  = Genotypic variance  $\sigma^2_p$  = Phenotypic variance

The genetic advance was estimated by using the formula given by Johnson *et al.* (1955) [5].

$$\text{Genetic advance (GA)} = h^2_{bs} \times K \times \sigma_p h$$

Genetic advance as per cent of mean for the character

$$GA (\%) = ((h^2_{bs} \times K \times \sigma_p)/\bar{x}) \times 100$$

Where,

$K$  = Selection differential at 5 per cent selection intensity ( $K = 2.06$ )

$h^2_b$  = Heritability coefficient (Broad sense)

$\sigma_p$  = Phenotypic standard deviation

$\bar{x}$  = Mean value of the character

### Result and Discussion

#### Analysis of variance

In Table-1, The analysis of variance indicated highly significant differences for the characters studied between genotypes *viz*; The mean sum of squares due to genotype was highly significant for days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, sound mature kernels (%), dry pod yield per plant (g), 100-

kernel weight (g), shelling percentage (%), biological yield per plant (g), harvest index (%), oil content (%) and protein content (%) while kernel yield per plant (g) (0.47) was non-significant. The mean sum of squares due to replications for all the characters exhibited non-significant.

**Table 1:** Analysis of variance for 14 characters in groundnut

S.NO	Characters	Replication	Genotype	Error
	d.f.	[2]	[24]	[48]
1	Days to 50% flowering	0.94	3.75**	1.18
2	Days to maturity	4.01	31.11**	2.07
3	Plant height (cm)	5.34	27.26**	2.04
4	No of branches per plant	0.06	1.00**	0.13
5	Pods per plant	0.04	3.58**	1.48
6	100-Kernel weight (g)	0.33	76.52**	1.92
7	Shelling percentage	1.83	18.73**	4.41
8	Sound mature kernel (%)	5.48	19.53*	9.68
9	Kernel yield per plant (g)	0.25	0.47	0.29
10	Dry pod yield per plant (g)	0.09	6.63**	0.83
11	Biological yield per plant (g)	1.36	29.86**	2.56
12	Harvest index (%)	0.47	61.16**	19.80
13	Oil percent	0.27	31.12**	0.37
14	Protein percent	2.12	5.30*	2.45

Table 2 represents the mean value for fourteen different traits. Maximum mean value for dry pod yield per plant was exhibited by genotype UG-252 (15.90g) followed by genotype UG-140 (14.97g). The genotype UG-256 gave maximum mean value for kernel yield per plant (6.20g). Maximum sound mature kernel percentage was exhibited by the genotype UG-247 (90.37%). The genotype UG-137 showed maximum mean value (74.70%) for shelling percentage followed by genotype UG-140 (73.97%). Genotype UG-251 had maximum mean value for 100-kernel weight (58.40g) followed by genotype UG- 247 (51.13 g). The genotype UG-246 possessed maximum mean value (12.67 pods) for number of pods per plant followed by UG-135, 139 and 249 (12 pods). Genotype UG-137 had maximum mean value (8.17) for number of branches per plant. Genotype UG-139 possessed maximum mean value (38.83 g) for biological yield per plant. Maximum mean value (50.91%) for harvest index was shown by genotype UG-254. Genotype UG-136 showed maximum mean value (46.33%) for oil content while genotype UG- 255 had maximum mean value (24.87%) for protein content.

As earliness is desirable character, genotype UG-135 was found earliest to flower (31.07) and GG-7 (check) was found early maturing (101.67). (Table 2)

Similar results were found by patidar *et al.* (2017) [9], Solanki *et al.* (2019) [10], kumari and Sasidharan (2020) [6].

**Table 2:** Mean values of days to 50 % flowering (DFF), Days to maturity (DM), Plant height (PH), number of branches per plant (NBPP), pods per plant (PPP), 100-kernel weight (100-KW) and shelling percentage (SP) in groundnut

S.no.	Genotype	DFF	DM	PH	NBPP	PPP	100-KW	SP
1	UG-134	32.33	108.00	36.00	6.33	10.67	42.23	68.03
2	UG-135	31.07	104.67	38.57	6.53	12.00	40.70	69.47
3	UG-136	34.60	112.33	43.70	6.57	11.00	42.63	72.30
4	UG-137	34.30	108.33	34.63	8.17	10.67	39.40	74.70
5	UG-138	31.70	105.00	36.10	6.80	10.33	37.57	68.10
6	UG-139	32.50	108.00	35.27	6.60	12.00	38.87	63.10
7	UG-140	31.83	106.00	39.83	6.43	11.00	43.47	73.97
8	UG-141	31.67	105.00	36.17	6.77	8.67	38.53	71.87

9	UG-245	33.33	106.33	36.30	6.43	8.67	49.67	70.47
10	UG-246	34.83	105.67	35.17	5.97	12.67	51.03	71.77
11	UG-247	32.67	112.00	35.60	7.53	11.67	51.13	73.90
12	UG-248	34.00	111.33	37.13	6.30	10.33	40.33	73.03
13	UG-249	33.67	112.33	36.47	6.77	12.00	41.10	70.70
14	UG-250	33.67	108.67	36.90	5.67	9.33	40.30	69.90
15	UG-251	33.67	113.33	35.40	7.30	10.00	58.40	67.00
16	UG-252	32.00	107.33	43.70	6.37	10.00	41.50	73.20
17	UG-253	34.33	112.67	45.23	6.43	10.00	44.33	71.93
18	UG-254	34.67	105.33	40.03	5.73	11.33	40.07	70.93
19	UG-255	35.00	107.67	39.90	7.23	8.33	39.40	71.30
20	UG-256	34.33	108.00	40.40	6.37	11.33	38.67	71.77
21	UG-257	33.67	113.00	41.23	6.37	11.00	42.67	70.10
22	UG-258	33.33	106.33	36.00	6.67	11.00	39.00	70.07
23	TG-37A	33.67	105.67	37.20	6.50	10.33	38.80	70.50
24	JL 501	33.73	104.67	40.20	5.73	10.67	38.90	70.60
25	GG 7	34.23	101.67	35.47	7.30	11.00	39.47	73.03

**Table2 contd....**

Mean values of sound mature kernel (SMK), kernel yield per plant (KYPP),

dry pod yield per plant (DPYPP), biological yield per plant (BYPP), harvest index (HI), oil content % (OC), protein content % (PC) in groundnut.

S.no.	Genotype	SMK	KYPP	DPYPP	BYPP	HI	OC	PC
1	UG-134	86.10	5.27	11.17	28.37	39.41	43.77	22.00
2	UG-135	88.47	5.23	11.93	31.40	37.94	35.53	22.17
3	UG-136	83.10	5.40	12.10	34.30	35.99	46.33	22.97
4	UG-137	83.53	5.17	14.60	38.50	35.63	45.07	19.50
5	UG-138	83.37	5.03	11.13	36.73	37.90	39.20	22.70
6	UG-139	84.97	5.00	14.80	38.83	40.84	44.93	20.87
7	UG-140	83.53	5.60	14.97	34.57	42.34	33.47	21.47
8	UG-141	84.03	5.20	14.33	34.33	40.76	35.17	23.07
9	UG-245	81.67	5.67	11.50	28.67	35.41	41.70	22.00
10	UG-246	85.80	5.80	10.60	34.43	33.80	40.57	23.00
11	UG-247	90.37	6.10	12.47	36.37	36.58	41.70	20.00
12	UG-248	83.90	5.00	12.17	31.03	37.01	43.40	20.37
13	UG-249	89.43	5.17	12.47	34.07	36.65	40.90	20.57
14	UG-250	88.00	5.73	13.97	29.00	48.06	44.70	23.23
15	UG-251	86.50	4.87	10.17	31.33	32.45	42.63	20.90
16	UG-252	80.17	5.30	15.90	35.20	46.13	43.63	23.23
17	UG-253	81.60	4.97	13.80	30.13	45.82	41.63	24.03
18	UG-254	84.97	5.27	13.80	27.30	50.91	44.47	21.03
19	UG-255	85.93	5.20	12.80	31.57	40.44	42.83	24.87
20	UG-256	84.97	6.20	14.20	35.43	40.35	45.33	22.60
21	UG-257	86.10	5.30	13.80	35.20	39.23	41.43	20.40
22	UG-258	84.33	5.03	13.07	31.77	40.42	40.53	20.93
23	TG-37A	89.07	5.77	12.80	36.40	35.30	42.57	21.23
24	JL 501	87.13	5.93	14.63	34.50	42.39	43.53	22.57
25	GG 7	83.73	4.67	13.40	31.43	42.59	43.03	21.83

### Estimates of genetic parameter

#### Phenotypic and genotypic coefficient of variation

In general, the magnitude of the phenotypic coefficient of variance (PCV) was higher than the genotypic coefficient of variance (GCV) for all the traits. (table 3). The high estimation of PCV and GCV (>20%) were not detected. It indicates that these traits are not recommended for improvement through direct selection. Moderate estimation (10-20%) of phenotypic and genotypic coefficient of variance recorded for 100-kernel weight (g) and dry pod yield per plant (g). This suggested that via selection, there is a little

chance of improvement in these traits in the desired direction. The low estimates of PCV and GCV were observed for Days to 50% flowering, Days to maturity, Plant height (cm), No of branches per plant, Pods per plant, Shelling percentage, Sound mature kernel (%), Kernel yield per plant (g), Biological yield per plant (g), Harvest index (%), Oil content (%) and

Protein content (%) suggesting that genetic factors play a significant impact on the manifestation of these characteristics. (table 3) Protein content (%) suggesting that genetic factors play a significant impact on the manifestation of these characteristics. (table 3)

**Table 3:** Estimate of coefficient of variation (PCV and GCV), heritability, genetic advance, and genetic advance in percent of the mean for 14 characters in groundnut

S. No.	Characters	GCV	PCV	ECV	h <sup>2</sup>	GA	GG
1	Days to 50% flowering	2.77	4.27	3.26	41.99	1.23	3.70
2	Days to maturity	2.88	3.17	1.33	82.39	5.82	5.39
3	Plant height (cm)	7.61	8.48	3.74	80.51	5.36	14.07
4	No of branches per plant	8.19	9.80	5.39	69.78	0.93	14.09
5	Pods per plant	7.86	13.89	11.45	32.01	0.97	9.16
6	100-Kernel weight (g)	11.78	12.23	3.28	92.82	9.90	23.38
7	Shelling percentage	3.08	4.28	2.96	51.95	3.24	4.58
8	Sound mature kernel (%)	2.13	4.22	3.65	25.31	1.88	2.20
9	Kernel yield per plant (g)	4.60	11.01	10.01	17.43	0.21	3.95
10	Dry pod yield per plant (g)	10.65	12.73	6.97	70.01	2.40	18.35
11	Biological yield per plant (g)	9.08	10.27	4.81	78.06	5.49	16.52
12	Harvest index (%)	9.34	14.57	11.19	41.05	4.90	12.32
13	Oil content (%)	7.64	7.77	1.45	96.54	6.48	15.46
14	Protein content (%)	4.46	8.42	7.14	28.04	1.06	4.86

### Heritability and Genetic advance as a % of the mean

Estimates of heritability combined with genetic advances were more useful than heritability alone in estimating the resultant gain under best-individual selection. In the present investigation, the high estimate of heritability in a broad sense (>65%) was recorded for most of the characters and noted highest for oil content (96.54%) followed by 100-kernel weight (92.82%), days to maturity (82.39%), plant height (80.51%), biological yield per plant (78.06%), dry pod yield per plant (70.01%), number of branches per plant (69.78%). However, shelling percentage (51.95%), days to 50% flowering (41.99%), harvest index (41.05%) and number of pods per plant (32.01%) exhibited moderate (30-60%) while protein content (28.04%), sound mature kernel (25.31%) and kernel yield per plant (17.43%) had low (<30%) heritability, these traits are highly influenced by environmental effect and genetic improvement through selection will be difficult. A similar result was found by Patidar *et al.* (2017) [9] and Kumari *et al.* (2019).

Moderate estimates of Genetic Advance as a % mean (10-20%) were observed in dry pod yield per plant (18.35%) followed by biological yield (16.52%), oil content (15.46%), number of branches per plant (14.09%), plant height (14.07%) and harvest index (12.32%). However, days to maturity (5.39%), protein content (4.86%), shelling percentage (4.58%), kernel yield per plant (3.95%), days to 50% flowering (3.70%) and sound mature kernel (2.20%) showed low genetic gain (<10%), utilization of heterosis breeding for improvement of this characters as it is governed by non-additive genes. A similar result was found by Vasanthi *et al.* (2016) [11] and Hampannavar *et al.* (2017) [3].

As a result, the high heritability, as well as higher estimates of genetic advance over the percentage of mean, will be rewarding because it is most likely driven by additive genes and selection will be effective and it was recorded for the trait 100- kernel weight (g). High estimates of heritability and medium genetic advance over a percentage of mean were observed for plant height, no. of branches per plant, dry pod yield per plant, biological yield per plant and oil content and high heritability to low genetic advance was observed for days to maturity, selection will be ineffective because the trait is highly influenced by the environment.

### Conclusion

The moderate estimation of genotypic coefficients of variance was reported only to 100-kernel weight (g) and dry pod yield per plant (g) in this experiment. This indicated that there is a lot to enhance in this attribute in the desired direction through selecting processes. Days to 50% flowering, Days to maturity, Plant height (cm), No of branches per plant, Pods per plant, Shelling percentage, sound mature kernel (%), Kernel yield per plant (g), Biological yield per plant (g), Harvest index (%), Oil content (%) and Protein content (%) all had low PCV and GCV estimations, indicating that genetic variables play a significant role in the expression of these traits. High heritability, as well as higher estimates of genetic advance over the percentage of mean was recorded for the trait 100-kernel weight (g), most likely driven by additive genes and selection will be effective.

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