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Research Article

Assessment of genetic variability for yield and component traits in groundnut (*Arachis hypogaea* L.) germplasms in sodic and normal soil condition

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Abstract
Groundnut is a predominant oilseed crop in India and ranks first among the edible oilseed groups, which produces high nutritive value kernels. A field experiment was conducted involving 55 groundnut accessions to evaluate their performance under sodicity by relative comparison with normal sandy soil during *Kharif*, 2019. The genotypes VG 18096, VG 15008, TMV 13 and VG 18100 recorded high *per se* performance for pod yield and kernel yield per plant under sodic soil condition. Higher estimates of phenotypic and genotypic coefficient of variation was recorded for the number of matured pods per plant (32.37 and 27.22), pod yield per plant (29.53 and 23.80) and kernel yield per plant (29.45 and 21.44). Heritability and genetic advance as per cent of the mean was found to be high for the number of matured pods per plant, hundred kernel weight and pod yield per plant, which indicated that these traits were governed by additive gene action and were less influenced by the environment. These traits could be improved through simple phenotypic selection.

Key words
Groundnut germplasm, genetic variability, sodicity

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an annual legume crop cultivated in both tropical and temperate regions of the world. Groundnut kernel contains 40-60% edible oil, 20-40% protein, 10-20% carbohydrates, vitamin B and E (Dima *et al.*, 2020). Groundnut oil contains ideal proportion of fatty acids such as oleic acid, linolenic acid, linoleic acid and tocopherol, an anti-oxidant agent which prevents rancidity and increases the shelf life of oil (Hashim *et al.*, 1993). Groundnut haulms serves as a very good fodder for cattle's and green manure crop to improve the soil health. It serves as a multipurpose crop which forms the source of protein and good dietary supplement to the poor people (Mandal *et al.*, 2017). Groundnut is also popularly known as 'unpredictable legume' due to its subterranean fruiting habit. In groundnut the production are affected by many factors such as cultivation in energy deficit areas, dry and marginal lands, biotic and abiotic stresses (Mandal *et al.*, 2017). Among the abiotic stresses, salinity and sodicity are the major limiting factors which affects the groundnut growth in all the stages, and finally yield of the crop is declined (Badigannavar *et al.*, 2007). In India 6.74 mha land area is affected by salt accumulation, out of which 3.78 mha are sodic; while 2.96 mha are saline soils and the problematic soils restricts the cultivation of agricultural crops in these areas (Choudhary and Kharche, 2018).

Groundnut can be grown in water with an EC upto 3.0 dSm^{-1} and enough genotypic variation exists for its tolerance (Singh *et al.*, 2008). In specific, groundnut production is decreased primarily due to low germination

per cent, dry matter production, damage to photosynthetic apparatus and induced Ca, K deficiencies under saline alkaline soil (Zhang *et al.*, 2020). Therefore identification of genotypes that could thrive and yield better under sodic soil conditions are necessary to increase the groundnut area and production. Development of high yielding variety is the prime objective of any crop breeding programme and it is based on the quantum of genetic variability present in the germplasm (Zaman *et al.*, 2011).

Yield improvement depends upon the quantum of genetic variability existing in the population, heritable portion of the genetic variation to the progeny and the genetic advance that can be made in the progeny (Yadlapalli, 2014). Heritability and genetic advance gives the breeder a knowledge about the magnitude and direction of selection (Kumar *et al.*, 2019a). The present work aimed to compare the relative ability of genotypes under normal and sodic soil in order to identify the high yielding tolerant genotypes.

MATERIALS AND METHODS

The experimental material consisted of 55 groundnut genotypes obtained from Regional Research Station (RRS), Vridhachalam. The genotypes were raised in two locations namely (i) RRS, Vridhachalam with fertile sandy soil (EC 0.5 dSm^{-1} and pH 6.5) and (ii) ADAC & RI., Trichy with sodic soil conditions (EC 2.9 dSm^{-1} and pH 8.8). The genotypes were raised in Randomised Block Design (RBD) with three replications during *Kharif* 2019 with a plant spacing of 30 x 10 cm. Proper agronomic practices were ensured during the entire crop period. Biometrical observations *viz.,* days to 50% flowering, plant height (cm), the number of branches per plant, the number of matured pods per plant, pod length (cm), shelling percentage and hundred kernel weight (g), pod yield per plant (g) and kernel yield per plant (g) were recorded from three randomly selected plants.

The collected data were analysed using TNAU-STAT software to study genetic variability, heritability and genetic advance as percent of mean (GAM). The pooled analysis of variance was carried out using STAR software. Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were studied by using the formula suggested by Burton and Devane (1953). Broad sense heritability was calculated based on Lush (1940). The heritability for various characters were classified as low (<30%), medium (30-60%) and high (>60%) based on Johnson *et al.* (1955). Genetic advance as per cent of mean was estimated by the formula of Johnson *et al.* (1955) and were further categorized as low (<10%), medium (10-20%) and high (>60%). PCV, GCV, heritability and GAM were expressed in percentage.

RESULT AND DISCUSSION

The pooled analysis of variance revealed a significant difference among the genotypes for all the traits studied which suggested that a wide range of genetic variation exists among the genotypes. The results also showed that environment exhibited significant influence on the performance of genotypes (**Table 1**).

Table 1. Pooled analysis of variance

SV	df	MSS								
		DFF	PH	NBP	NMP	PL	SP	HKW	PY	KY
Environment	1	201.70**	38219.3**	91.08*	742.59**	0.71**	34.28	2494.91**	822.01*	387.83**
Replication within Env	4	2.72	263.89**	8.15**	29.47**	0.01	45.11**	34.40*	84.75**	16.81**
Genotype	54	5.73**	135.52**	1.86*	96.09**	0.35**	125.85**	181.95**	69.09**	24.47**
Env : Geno	54	3.41**	105.62**	1.33	20.76**	0.01	29.91**	41.66**	13.95**	4.48
Pooled error	216	1.88	26.24	1.25	6.4	0.03	12.56	12.88	5.28	3.3

*Significant at 5% Level **Significant at 1% Level

DFF - Days to 50% flowering; PH - Plant Height; NBP - Number of branches per plant; NMP - Number of matured pods per plant; PL - Pod length; SP - Shelling percentage; HKW - Hundred kernel weight; PY - Pod yield per plant; KY - Kernel yield per plant

The *per se* performance of 55 groundnut genotypes studied under normal and sodic soil is presented in **Table 2 and Table 3**. Days to 50% flowering possessed a mean value of 27.9. The variety VRI 3 was found to be early type and recorded significantly less number of days to 50% flowering (25.67) whereas the genotype VG 16020 (31.67) exhibited late flowering under normal soil. Under sodic soil, days to 50% flowering recorded a mean value of 29.46. The days to 50% flowering was significantly early in the genotypes VG 13149 (26.67) and TMV 14 (27.00) but it was found to be late in VG 19477 (33). The height of the plant showed an overall mean value of 51.41cm under normal soil. The genotypes TMV 14 (67.11 cm) and VG 18055 (66.56 cm) were significantly tall in habit while the genotypes VG 15011 (36.66 cm) and VG 15006 (36.78 cm) were found to be dwarf. Under sodic soil the height of the plant recorded an overall mean value of 29.89 cm and was significantly high for the genotypes VG 13149 (42.66 cm), CO 6 (40.17 cm) and VG 15008 (38.86 cm) while the genotype VG 15018 (20.71 cm) possessed the low mean value. The genotype VG 18081 (8.00) produced significantly more number of branches per plant and while VG 16003 produced less number of branches (4.00) under normal soil. Number of branches per plant was significantly more in genotype VG 14019 (7.33) while it was low in VG 18076 (3.89) and VG 16002 (4.00) under

Table 2. Mean performance of groundnut genotypes under normal soil

Genotypes	DF	PH	NBP	NMP	PL	SP	HKW	PY	KY
VRI 2	28.33	56.67	5.44	16.22	2.73	74.36**	31.57	11.61	8.69
VRI 3	25.67*	55.11	5.56	14.11	2.71	72.99*	32.62	15.46	11.29
VRI 4	28.33	54.56	6.55	19.89	2.50	67.12	35.87	16.54	11.17
VRI 5	27.67	47.33	6.00	17.22	2.74	73.50**	37.93	11.48	8.45
VRI 6	26.67	56.22	6.11	23.44**	2.78	75.70**	27.33	17.03	12.93
VRI 7	27.33	48.11	5.22	12.11	3.21**	65.79	36.46	16.09	10.46
VRI 8	28.33	57.89	5.56	17.78	2.90	71.45	31.40	18.56	13.24
TMV 10	28.00	46.11	5.44	11.45	2.71	69.09	33.21	16.26	11.17
TMV 13	28.00	61.34*	5.89	28.56**	2.42	74.49**	34.35	21.55*	15.98**
TMV 14	27.00	67.11**	5.33	18.45	2.75	71.67	34.89	14.76	10.60
CO 6	27.33	61.78**	6.55	15.44	2.67	65.41	33.32	15.40	10.15
CO 7	27.67	47.89	5.67	18.11	2.70	75.31**	28.01	16.85	12.69
VG13149	27.00	49.67	6.11	19.44	2.87	67.91	37.35	21.37*	14.32
VG13153	28.33	58.11	5.55	18.33	2.83	69.58	36.10	16.05	11.22
VG13154	28.33	50.00	6.11	15.89	2.79	72.93*	33.93	17.51	12.71
VG13159	28.33	49.78	7.78	17.33	3.21**	66.89	31.92	16.61	11.06
VG13163	27.67	46.44	6.00	24.00**	3.02	59.67	35.44	19.01	11.13
VG14019	27.00	38.89	7.33	18.44	2.91	59.14	36.91	25.17**	14.91*
VG14021	28.00	39.78	6.22	20.78	2.93	58.08	39.29	24.57**	14.19
VG15006	28.00	36.78	6.45	20.33	3.41**	71.80	35.78	19.98	14.33
VG15007	28.33	42.22	7.44	22.11*	2.99	58.86	37.79	24.48**	14.41
VG15008	28.00	45.67	6.56	29.00**	2.80	63.14	43.54**	25.54**	16.37**
VG15010	28.00	49.44	7.45	12.45	2.82	73.18*	42.31**	18.37	13.46
VG15011	28.00	36.66	6.00	17.22	3.24**	63.11	42.41**	17.96	11.11
VG15013	27.33	37.22	6.89	18.44	2.69	73.78**	47.30**	13.90	10.22
VG15014	27.00	51.67	5.67	17.89	2.80	72.90*	31.27	17.17	12.44
VG15016	27.33	63.22**	6.44	13.78	3.18**	75.20**	39.07	15.46	11.56
VG15018	27.33	53.67	6.67	12.45	2.89	71.91	34.11	17.06	12.20
VG15019	29.00	43.44	5.78	18.67	2.78	71.37	35.29	16.17	11.58
VG16002	27.00	55.56	6.67	11.78	3.40**	67.13	29.18	16.12	10.76
VG16003	27.33	56.11	4.00	8.11	2.57	65.24	38.38	8.02	5.26
VG16004	27.00	47.89	6.33	17.11	2.58	72.85*	37.36	14.89	10.90
VG16013	28.33	46.22	7.00	19.67	3.08	66.35	33.48	16.03	10.26
VG16014	27.67	53.11	5.56	15.33	3.17**	72.21*	40.58*	14.17	10.21
VG16015	27.67	61.89**	6.45	15.33	3.12*	72.57*	44.61**	14.64	10.62
VG16016	27.00	62.67**	6.67	15.22	3.21**	74.63**	48.30**	10.72	8.06
VG16017	27.00	56.89	5.78	15.22	3.59**	72.52*	53.83**	11.11	8.09
VG16018	28.00	51.67	7.44	20.89	2.70	73.47**	32.26	16.18	11.88
VG16020	31.67	53.11	6.00	12.22	2.75	67.74	33.72	14.72	10.02
VG16021	28.67	47.00	7.44	13.33	2.57	70.85	27.73	15.36	10.87
VG18002	27.33	45.67	6.22	15.22	2.71	73.11*	30.26	15.77	11.53
VG18049	27.33	56.33	7.33	23.78**	2.80	64.69	28.32	20.36	13.23
VG18055	28.00	66.56**	5.11	15.11	2.69	71.27	39.18	15.00	10.76
VG18076	27.00	59.11*	6.00	17.22	3.02	71.45	47.45**	16.35	11.66
VG18077	26.67	46.22	6.45	27.56**	2.77	64.55	24.92	16.94	10.67
VG18081	28.00	49.78	8.00	18.67	3.16**	61.08	36.99	20.51	12.71
VG18089	29.00	45.44	5.22	19.00	3.01	67.88	39.26	16.61	11.13
VG18090	27.00	42.89	6.22	27.56**	2.90	70.56	36.97	15.00	10.64
VG18096	27.00	58.55	5.56	18.11	2.97	58.62	38.29	24.20**	14.27
VG18097	28.00	54.33	4.78	19.11	2.92	66.33	41.04*	18.94	12.28
VG18098	30.33	49.66	6.22	23.56**	2.92	71.05	31.17	18.30	13.02
VG18100	30.00	55.44	6.78	22.11*	2.82	54.24	39.78	26.35**	14.27
VG19477	29.00	50.78	5.56	14.56	2.82	65.35	43.46**	20.78*	13.37
VG19489	29.00	50.56	4.67	16.33	3.12*	72.31*	42.34**	19.52	14.12
VG19496	30.33	51.56	5.00	11.45	2.98	63.36	38.88	16.89	10.54
G Mean	27.90	51.41	6.15	17.87	2.90	68.69	36.63	17.30	11.73
CD 5%	1.74	7.56	2.06	3.68	0.19	3.48	3.45	3.37	2.71
CD 1%	2.29	9.95	2.71	4.85	0.25	4.58	4.54	4.43	3.57

Table 3. Mean performance of groundnut genotypes under sodic soil

Genotypes	DFF	PH	NBP	NMP	PL	SP	HKW	PY	KY
VRI 2	29.00	34.13	4.55	13.56	2.70	75.15	28.73	11.28	8.40
VRI 3	29.00	32.16	5.44	13.00	2.66	76.31*	31.12	13.08	10.33
VRI 4	28.67	27.18	4.67	18.66	2.45	73.49	30.25	14.03	10.39
VRI 5	29.67	33.71	5.56	16.66	2.71	72.98	23.05	11.13	8.14
VRI 6	30.33	27.62	5.56	20.78**	2.74	66.51	22.50	15.14	9.78
VRI 7	30.67	33.49	5.11	10.44	3.18*	70.98	36.42	14.96	9.63
VRI 8	29.33	31.71	5.11	16.55	2.89	71.81	29.59	17.40	12.60
TMV 10	30.33	26.81	4.56	11.22	2.67	69.12	25.39	14.85	10.22
TMV 13	29.00	36.81	5.22	27.22**	2.35	71.12	31.20	21.34**	15.75**
TMV 14	27.00	33.47	5.22	17.45	2.67	65.72	23.87	12.49	8.33
CO 6	28.67	40.17*	6.45	14.56	2.60	60.43	32.31	14.62	9.25
CO 7	27.67	38.07	5.45	17.67	2.62	74.56	27.70	14.84	11.05
VG13149	26.67*	42.66**	5.44	19.00	2.80	60.02	36.77	21.05**	12.32
VG13153	28.67	37.71	4.89	17.78	2.78	67.47	35.33	14.97	10.14
VG13154	31.00	38.01	6.00	15.44	2.72	73.12	32.01	16.32	11.93
VG13159	30.33	36.24	6.00	14.22	3.17*	65.44	29.49	15.78	10.21
VG13163	30.00	28.20	4.67	23.78**	2.87	59.80	31.97	17.41	10.85
VG14019	27.67	30.89	7.33**	11.78	2.88	63.76	27.48	11.79	7.78
VG14021	28.33	25.65	5.89	12.11	2.88	59.67	26.44	17.05	11.26
VG15006	28.67	28.52	5.11	14.56	3.01	71.46	33.98	10.39	7.33
VG15007	28.00	32.10	5.00	21.78**	2.81	71.38	32.50	17.79	12.95*
VG15008	28.67	38.86*	5.44	28.67**	2.76	64.04	31.50	23.27**	15.35**
VG15010	27.33	33.04	4.89	14.44	2.23	71.96	41.62**	16.89	12.24
VG15011	30.00	25.94	5.66	14.56	3.22*	61.08	41.78**	16.16	9.08
VG15013	31.67	31.43	4.89	18.00	2.55	73.32	26.56	11.88	8.77
VG15014	30.33	23.17	5.11	16.56	2.73	74.28	26.84	14.03	10.62
VG15016	28.67	24.87	4.33	13.11	3.03	74.38	28.05	10.70	8.01
VG15018	29.67	20.71	4.89	11.44	2.71	71.46	29.42	14.59	10.55
VG15019	29.33	24.04	5.67	13.22	2.71	65.21	27.12	13.20	8.85
VG16002	30.00	31.25	4.00	11.11	3.34**	64.89	28.59	14.84	9.38
VG16003	28.33	32.42	4.00	6.78	2.52	62.77	37.08	6.95	4.37
VG16004	31.33	35.20	4.22	14.33	2.43	69.47	35.78	10.60	7.34
VG16013	31.33	29.86	4.89	10.67	2.91	62.96	32.15	12.07	7.73
VG16014	29.67	26.16	5.33	12.45	3.12	67.28	39.32*	13.48	9.05
VG16015	27.67	27.62	4.78	11.22	3.05	74.77	40.58*	12.65	9.46
VG16016	27.33	33.54	4.67	12.44	3.19*	72.11	48.06**	10.03	7.39
VG16017	27.67	26.39	4.33	8.89	3.57**	71.82	53.45**	10.31	7.60
VG16018	30.00	27.44	5.22	11.33	2.66	73.21	31.66	9.73	7.38
VG16020	29.33	26.04	5.89	11.89	2.67	65.40	22.56	13.03	8.05
VG16021	31.00	25.27	4.55	12.11	2.51	65.46	20.21	13.39	7.89
VG18002	30.33	25.44	5.45	14.89	2.66	74.32	25.03	12.53	9.78
VG18049	28.00	23.73	4.78	11.11	2.81	72.29	25.63	10.93	7.92
VG18055	29.00	26.11	5.11	14.44	2.27	71.87	29.02	9.39	6.71
VG18076	28.00	26.34	3.89	10.56	2.98	61.77	30.46	13.11	7.52
VG18077	28.67	23.89	5.11	11.78	2.54	62.85	24.18	7.07	4.12
VG18081	30.67	25.86	4.44	12.78	3.10	66.11	36.69	10.89	7.62
VG18089	32.00	21.28	5.11	9.78	2.92	66.69	21.44	8.49	6.03
VG18090	29.67	24.82	5.67	15.22	2.72	62.37	27.39	13.26	8.15
VG18096	31.67	32.80	5.22	17.22	2.91	58.00	29.99	23.60**	12.77*
VG18097	29.67	26.22	4.22	16.00	2.87	63.75	26.92	15.05	9.71
VG18098	29.67	26.77	5.33	19.67*	2.88	69.63	27.53	17.77	12.22
VG18100	31.00	29.99	5.00	21.89**	2.75	68.33	29.83	18.41*	12.59*
VG19477	33.00	26.41	5.56	14.44	2.76	64.58	35.96	19.43**	11.71
VG19489	32.00	37.93	4.56	15.67	3.08	70.37	33.03	17.20	11.79
VG19496	29.33	27.82	5.00	11.00	2.90	63.17	38.56*	15.19	9.53
G Mean	29.47	29.89	5.10	14.87	2.80	68.04	31.13	14.14	9.56
C.D.(5%)	2.56	8.25	1.46	4.16	0.36	7.22	7.35	3.95	3.09
C.D.(1%)	3.38	10.86	1.93	5.48	0.48	9.51	9.67	5.21	4.06

sodic soil. The overall mean length of the pod under the normal soil was 2.90 cm. The genotypes *viz.,* VG 16017 (3.59 cm), VG 15006 (3.41 cm), VG 16002 (3.40 cm) and VG 15011 (3.24 cm) registered significantly higher mean pod length while it was low in the variety TMV13 (2.42 cm). Pod length possessed a mean value of 2.8 cm under the sodic soil and was significantly high in genotype VG 16017 (3.57 cm), VG 16002 (3.34 cm), VG 15011 (3.22 cm), VG 16016 (3.19 cm), VRI 7 (3.18 cm) and VG 13159 (3.17 cm).

Under normal soil the number of matured pods per plant was significantly more in VG 15008 (29.00) followed by TMV13 (28.56), VG 18077 (27.56), VG 18077 (27.56), VG 13163 (24.00), VG 18049 (23.78), VG 18098 (23.56), VRI 6 (23.44), VG15007 (22.11) and VG 18100 (22.11) while the genotype VG 16003 (8.40) possessed lesser number of matured pods per plant. Number of matured pods per plant recorded a mean value of 14.87 under sodic soil. It was significantly high in genotypes *viz.,* VG 15008 (28.67), TMV 13 (27.22), VG 13163, VG 18100 (21.89), VG 15007 (21.78), VRI 6 (20.78) and VG 18098 (19.67) and was low in VG 16003 (6.78). Shelling percentage was relatively higher in VRI 6 (75.70 %), CO 7 (75.31 %), VG 15016 (75.20 %), VG 16016 (74.63 %) and TMV 13 (74.49 %) but it was low in VG 18100 (54.24 %) under normal soil. Shelling percentage possessed a mean value of 68.04 % under sodic soil. The variety VRI 3 recorded significantly higher shelling percentage (76.31 %) followed by VRI 2 (75.15 %) whereas the genotypes VG 18096 (58.00 %) showed lowest shelling out-turn. Under normal soil hundred kernel weight was highly significant in VG 16017 (53.83 g), VG 16016 (48.3 g), VG 18076 (47.75 g) and VG 15013 (47.30 g) while it was low in VG 18077 (24.92 g). Similarly under sodic soil hundred kernel weight was high and significant among the genotypes VG 16017 (53.45 g), VG 16016 (48.05 g), VG 15011 (41.78 g), VG 15010 (41.62 g), VG 16015 (40.57 g), VG 16014 (39.32 g) and VG 19496 (38.56 g) while it was low in VG 16021 (20.20 g). In respect of pod yield per plant, the genotype VG 18100 (26.35 g) recorded significantly higher mean values followed by VG 15008 (25.54 g), VG 14019 (25.17 g), VG 14021 (24.57 g), VG 15007 (24.48 g), VG 18096 (24.20 g), TMV 13 (21.55 g), VG 13153 (21.37 g) and VG 19477 (20.78 g) under the normal soil while it was lower for the genotype VG 16003 (8.02 g). Under sodic soil pod yield per plant was significantly higher among the genotypes VG 18096 (23.60 g), VG 15008 (23.26 g), TMV 13 (21.34 g), VG 13149 (21.04 g), VG 19477 (19.42 g) and VG 18100 (18.41 g) with a mean of 14.14 g while the genotype VG 16003 (6.94 g) recorded low pod yield. Under the normal soil kernel yield per plant was significantly higher in the genotype VG 15008 (16.37 g) followed by TMV 13 (15.98 g), VG 14019 (14.91 g); whereas, the genotypes VG 16003 (5.26 g), VG 16016 (8.06 g) and VG 16017 (8.09 g) registered lower mean values for kernel yield per plant. Under sodic soil kernel yield per plant was high and significant in TMV 13 (15.75 g), VG 15008 (15.35 g), VG 15007 (12.95 g), VG 18096 (12.77 g) and VG 18100 (12.59 g) with a mean of 9.56 g. While the genotypes VG 18077 (4.12 g), VG 16003 (4.37 g) and VG 18089 (6.03 g) registered low kernel yield in sodic soil condition. From the above results, it was inferred that the genotypes TMV 13, VG 15008 and VG 14019 were categorized as high yielding genotypes under the normal soil condition whereas the genotypes VG 18096, VG 15008, TMV 13 and VG 18100 were found to be tolerant to the sodicity condition and produced higher mean pod and kernel yield per plant.

Studies on genetic variability parameters under normal soil and sodic soil: Genetic variability present in a breeding material for the target trait is a pre-requisite for effective selection in a breeding programme (Kumar *et al.*, 2019). In general, the phenotypic coefficient of variation (PCV) was found to be higher than genotypic coefficient of variation (GCV) under the normal and sodic soil suggesting the predominance of environmental influence on the expression of these characters (Zaman *et al.*, 2011). High PCV was noticed for the traits *viz.,* the number of matured pods per plant (27.32), pod yield per plant (24.03), the number of branches per plant (21.73) and kernel yield per plant (21.09) under normal soil (**Table 4**). Chavadhari *et al.* (2017) reported a high PCV for kernel yield per plant, the number of matured pods per plant and the number of branches per plant. Bhargavi *et al.* (2016) also reported high PCV for kernel yield per plant. Under sodic soil, high PCV was observed for the number of matured pods per plant (32.37), pod yield per plant (29.53), kernel yield per plant (29.45), hundred kernel weight (23.94) and plant height (22.28) which showed that variation for these traits is not only influenced by the genotype but also by the environment. Chavadhari *et al.* (2017) also reported high PCV values for matured pods per plant, kernel yield per plant and hundred kernel weight.

In normal sandy soil, genotypic coefficient of variation (GCV) was high for the traits *viz.,* the number of matured pods per plant (24.09) and pod yield per plant (20.71) and the present result was in accordance with the findings of Kumar *et al.* (2019) for the number of matured pods per plant and pod yield per plant. While under sodic soil, GCV was found to be high for the number of matured pods per plant (27.22), pod yield per plant (23.8) and kernel yield per plant (21.44). This suggested higher genetic quotient in the inheritance of the above traits and hence the selection could be done based on the above traits. Similar results were obtained for matured pods by Vasanthi *et al.* (2015) and for kernel yield per plant by Chavadhari *et al.* (2017) and seed yield by Singh *et al.* (2008). Moderate GCV was obtained for hundred kernel weight (18.85) and plant height (14.1) while it was low for pod length (7.98), the number of branches per plant (6.59), shelling percentage (6.17) and days to 50% flowering (3.61). This could be because of narrow genetic variability for these characters among the genotype.

Table 4. Estimation of genetic variability parameters in groundnut germplasms grown in normal soil devoid of sodicity

S.No.	Traits	G Mean	Range		PCV	GCV	h^2	GAM
			Min	Max				
1	Days to 50% flowering	27.90	25.67	31.67	4.88	2.92	35.87	3.60
2	Plant Hei ght (cm)	51.41	36.66	67.11	16.11	13.24	67.46	22.39
3	Number of branches per plant	6.15	4.00	8.00	21.73	5.63	6.72	3.01
4	Number of mature pods per plant	17.87	8.11	29.00	27.32	24.09	77.76	43.76
5	Pod Length (cm)	2.90	2.42	3.59	8.90	7.85	77.75	14.25
6	Shelling Percentage	68.69	54.24	75.70	8.06	7.41	84.54	14.04
7	Hundred kernel weight (g)	36.63	24.92	53.83	16.42	15.32	87.13	29.47
8	Pod Yield per plant (g)	17.30	8.02	26.35	24.03	20.71	74.30	36.78
9	Kernel Yield per plant (g)	11.73	5.26	16.37	21.09	15.35	53.01	23.03

High PCV and GCV were obtained for the traits number of matured pods per plant and pod yield per plant under sandy soil. Yadlapalli (2014) also noticed higher estimates of PCV and GCV for the traits number of matured pods per plant and pod yield per plant. The high PCV and GCV for the above characters indicates greater scope for the development of high yielding genotypes (Bhargavi *et al.*, 2016). While under sodicity, both PCV and GCV ranked high for the number of matured pods per plant, pod yield per plant and kernel yield per plant and were in accordance with the findings of Tirkey *et al.* (2018) for pod yield per plant and kernel yield per plant and Hampannavar *et al.* (2018) for the number of matured pods and kernel yield per plant. Thus a trait with high PCV and GCV would be effective under direct selection.

Table 5. Estimation of genetic variability parameters in groundnut germplasms grown in sodic soil

S.No.	Traits	G Mean	Range		PCV	GCV	h^2	GAM
			Min	Max				
1	Days to 50% flowering	29.4667	26.66	33	6.5341	3.6101	30.5268	4.109
2	Plant Height (cm)	29.8908	20.71	42.66	22.2811	14.1022	40.059	18.3867
3	Number of branches per plant	5.0991	3.89	7.33	19.1633	6.5908	11.8286	4.6695
4	Number of mature pods per plant	14.8705	6.78	28.66	32.3744	27.2247	70.7168	47.1619
5	Pod Length (cm)	2.8041	2.23	3.56	11.4043	7.9832	49.0018	11.512
6	Shelling Percentage	68.0412	58	76.31	9.0641	6.1724	46.3732	8.6588
7	Hundred kernel weight (g)	31.129	20.2	53.45	23.943	18.8538	62.007	30.5834
8	Pod Yield per plant (g)	14.1422	6.94	23.6	29.5387	23.8004	64.9211	39.5043
9	Kernel Yield per plant (g)	9.5625	4.12	15.75	29.4577	21.449	53.0169	32.1722

PCV – Phenotypic coefficient of variation; GCV – Genotypic coefficient of variation; h^2 – Heritability; GAM – Genetic advance as percent of mean

Co-efficient of variability will gives only the quantum of genetic variability present in the population. However if it is considered along with the heritability, it will give more reliable information on the heritable portion of genetic variation. Under normal soil, heritability in the broad sense higher for the traits hundred kernel weight (87.13), shelling percentage (84.54), the number of matured pods per plant (77.76), pod length (77.75), pod yield per plant (74.30) and plant height (67.46). Similar pattern of results have also been reported for the number of matured pods per plant and pod yield per plant by Bhargavi *et al.* (2016) and by Rao (2016) in case of plant height. The characters kernel yield per plant (53.01) and days to 50% flowering (35.87) were moderately heritable, whereas the trait number of branches per plant (6.72) possessed low heritability value. With regard to sodic soil, high heritability was recorded by the number of matured pods per plant (70.71), pod yield per plant (64.92) and hundred kernel weight (62.00). The characters *viz.,* kernel yield per plant (53.01), pod length (49.00), shelling percentage (46.37), plant height (40.05), and days to 50% flowering (30.52) exhibited a moderate heritability whereas the number of branches per plant (11.82) possessed low heritability values. The high heritability values indicated preponderance of additive gene action and hence the single plant selection could be followed to improve these traits (Singh *et al.*, 2017).

The foremost important criterion of selection is consideration of heritability estimate along with the genetic advance for the trait of interest. Under normal sandy soil, genetic advance as per cent of mean (GAM) was high for the characters number of matured pods per plant (43.76), pod yield per plant (36.78), hundred kernel weight (29.47), kernel yield per plant (23.03) and plant height (22.39). Pod length (14.25) and shelling percentage (14.04) showed moderate GAM while days to 50% flowering (3.60) and the number of branches per plant (3.01) recorded low GAM. Similarly under sodic soil, GAM was high for the characters number of matured pods per plant (47.16), pod yield per plant (39.5), kernel yield per plant (32.17) and hundred kernel weight (30.58). Patil *et al.* (2014) also observed high GAM for hundred kernel weight and Meta and Monpara (2010) for the number of matured pods per plant, pod yield and kernel yield per plant. Moderate GAM was observed for plant height (18.38) and pod length (11.51), while shelling percentage (8.65), the number of branches per plant (4.66) and days to 50% flowering (4.10) possessed low GAM values. High heritability coupled with high genetic advance for a character indicate easily fixable nature of the trait.

In this study the traits *viz.,* plant height, the number of matured pods per plant, hundred kernel weight and pod yield per plant showed high heritability coupled with high GAM under normal soil while the traits number of matured pods, hundred kernel weight and pod yield per plant recorded high heritability and high GAM under sodic soil; hence the single plant selection could be effectively adopted for improving these traits. Kernel yield per plant, an economically important character showed a moderate heritability along with high genetic advance and high GCV under sodic soil suggested that the character is controlled by an additive gene action and lower estimates of heritability may be due to the larger influence of environmental factors as concluded by Meta and Monpara (2010) in the case of soybean

The genotypes raised in two locations showed significant difference for all the nine quantitative characters studied. The mean performance was found to be significantly high in the genotypes VG 18096, VG 15008, TMV 13 and VG 18100 in case of pod yield and kernel yield per plant under sodicty. The phenotypic and genotypic coefficient of variation (PCV and GCV) was high for the traits number of matured pods per plant and pod yield per plant under both normal and sodicity stressed condition which showed the existence of large amount of variation and stable nature of these characters. The traits number of matured pods per plant, hundred kernel weight and pod yield per plant recorded high heritability and genetic advance as percent of mean (GAM) in both locations. Kernel yield recorded moderate heritability and high GAM under sodicity. High GAM shows additive gene action and the selection would be effective whereas moderate heritability was due to high environmental effects on kernel yield. The characters number of matured pods per plant, pod yield per plant and kernel yield per plant showed more variability in conjunction with high heritability and genetic advance providing good scope for the improvement of traits under sodic soil.

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