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Genetic Variability and Character Association Studies in Groundnut (*Arachis hypogaea* L)

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Abstract: An attempt was made to evaluate the genetic variability and association of different component characters with pod and kernel yield plant^{-1} in groundnut at District Seed Farm of Kalyani, Bidhan Chandra Krishi Viswavidyalaya, West Bengal during rabi 2014-15. Nineteen genotypes were grown in Randomized Block Design with three replications and evaluated for thirteen characters. Highly significant differences and adequate variability were obtained among the genotypes for all the selected characters. Analysis of variance revealed the existence of significant differences among genotypes for all characters studied. High GCV, high heritability coupled with high genetic advance as percent of mean were observed in case of kernel yield plant^{-1}, no. of pod plant^{-1}, no. of kernel plant^{-1} and 100 kernel weight indicating the role of additive gene in expressing these traits and effectiveness of selection. Correlation studies and path coefficient analysis revealed the importance of plant height, no. of pod plant^{-1}, no. of kernel plant^{-1}, shelling %, SMK, harvest index as they had positive direct effects on pod yield and kernel yield and should be considered for improvement in yield.
Keywords: variability, heritability, correlation, path analysis, groundnut

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the world's major proteins rich food legume crop originated in the Bolivian region of South America belongs to the family Fabaceae. Groundnut contains about 35-54% oil, 6-24 % carbohydrate and 21-36 % proteins and acts as a high-energy source [1].

Groundnut oil is considered as stable and nutritive as it contains right proportions of saturated fatty acid namely, oleic acid (40-50%) and unsaturated fatty acid like linoleic acid (25-35%). Presence of tocopherol, an anti oxidant increases shelf life due to prevention of rancidity of oil. Raw groundnuts are excellent source of vitamins especially E, K, and B groups. Recently, the use of groundnut meal is gaining concern, not only as a dietary supplement for children on protein-poor cereal based diets in economically under developed countries, but also as an effective treatment for children with protein energy malnutrition (PEM). Groundnut cake contains 44 to 69% of protein, and extensively used in livestock feed concentrates and mixtures. Groundnut shells are cheap source of fuel, bedding material for the poultry and also find a place in cardboard manufacture, in industrial applications like enzyme production and in alcohol extraction.

Despite of having immense potential, cultivation of groundnut is hindered by various factors like trends of growing under energy starved conditions in the dry and marginal lands, biotic and abiotic stresses etc. Natural variability in the cultivated groundnut is substantial and has provided ample resources for the development by selection and hybridization of cultivars adapted to different environments [2]. The objective of management of germplasm remains incomplete until and unless the collection is evaluated for various desirable traits to assess the genetic potential of the resources, to identify the duplicates in the collection and to create core collection. So there is an urgent need to develop new strategies to put back genes for higher productivity and to introduce gene for pest and disease resistance in cultivars of groundnut apart from developing low cost and efficient means of crop husbandry [3]. Hence, new source of variability for yield and other economic attributes are to be identified from the large genetic resource available in groundnut. So the study aimed at characterizing germplasm accessions for various characters, to assess the extent of genetic variability for important quantitative traits and also to estimate the interrelationship among the traits.

MATERIALS AND METHODS

Experimental materials and design

The present investigation was carried out at the District Seed Farm of Kalyani, Bidhan Chandra Krishi Viswavidyalaya, West Bengal during rabi 2014-15. The farm is situated at 23.5°N latitude and 89.0°E longitudes with an average altitude of 9.75m above mean sea level with gangetic alluvial sandy loam soil having good drainage facility. Nineteen genotypes (CSMG -2005-28, JSP-51, JSP-53, NRCG CS- 425, Kaushal, ICGS -76, BAU-13, J-75, VG-09074, J-74, CSMG-2006-14, ALG-06-306, VG-09193, VG-09204, VG-09127, VG-0430, Girnar 3, GPBD 5, R-2001-2) were collected through AICRP on Groundnut from various parts of the country and planted in Randomized Block Design (RBD) with three replications. Observations were recorded from ten plants from the middle rows of the plot excluding the border plants, for seventeen important characters viz. plant height (cm), plant weight (g), pod yield plant^{-1}(g), kernel yield plant^{-1} (g), no. of pod plant^{-1}, no. of kernel plant^{-1}, pod length (cm), pod width (cm), 100 kernel weight (g), shelling percentage, sound mature kernel percentage (SMK%), haulm yield, harvest index, days to maturity and oil percentage.

Statistical Analysis

Analysis of variance was done from the mean data obtained in each character. The experimental data were analyzed statistically following the method of analysis of variance for single factor [6]. The coefficient of variation was calculated as per Burton [5]. Estimates of genetic parameters were computed as per Johnson *et al* [7]. Correlation among phenotypic and genotypic levels among the various characters was calculated as suggested by Arunachalam and Bandyopadhyay [8]. Path coefficient analysis was carried out as described by Dewey and Lu [4].

RESULTS AND DISCUSSION

Highly significant differences were obtained among the genotypes for all the thirteen selected characters (Table 1).This indicated adequate variability among the genotypes considered in this study. The genotype VG-09127exhibited highest mean for plant height whereas the highest mean for plant weight and pod plant^{-1} was observed in ICGS-76. The genotype Girnar-3 produced highest mean for pod yield plant^{-1} as well as kernel yield plant^{-1} obviously having highest harvest index value. In case of no. of kernel plant^{-1} best result was found in NRCCS-425. BAU-13 produced longest pod and also highest oil yielder among the studied genotypes. VG-0430 produced highest mean value for 100 kernel plant^{-1} and highest shelling percentage. J-75 variety produced highest mean value for sound mature kernel %, an important yield attributes of groundnut. Maximum haulm yield was observed in the genotype VG-09204. Among all the studied genotypes the early genotype was CSMG-2006-14 required 118 days to mature.

Table-1: Mean of fifteen characters of nineteen genotypes of Groundnut

SlNo	Genotypes	Plant ht. (cm)	Plant wt. (g)	Pod yield Plant^{-1} (g)	Kernel yield Plant^{-1} (g)	No. of pod plant^{-1}	No. of kernel plant^{-1}	100 kernel wt. (g)	Pod length (cm)	Pod width (cm)	Shelling (%)	SMK (%)	Haulm yield	Harvest index	DTM	Oil (%)
1	CSMG 2005-28	45.333	135.667	54.096	30.915	21.000	71.000	55.392	**2.000**	1.000	57.143	90.600	23.181	39.870	127.667	40.290
2	JSP-51	47.000	151.333	79.481	55.495	39.667	89.000	**59.535**	1.767	0.840	69.817	97.370	23.986	52.517	123.000	40.220
3	JSP-53	50.667	148.000	80.433	60.320	37.000	125.667	43.432	1.633	0.873	74.997	97.607	20.113	54.340	**128.667**	40.333
4	NRCG CS 425	47.000	144.667	81.678	60.584	36.333	**127.667**	41.795	1.900	1.300	74.170	96.343	21.093	56.457	127.667	39.233
5	Kushal	49.000	148.333	69.423	47.509	37.000	108.667	45.721	1.833	1.333	68.430	94.170	21.925	46.800	123.667	38.193
6	ICGS 76	43.667	**154.333**	76.378	54.545	40.000	119.333	45.573	1.600	1.033	71.407	93.010	21.833	49.487	121.333	40.467
7	BAU 13	42.333	141.333	77.448	54.492	36.333	105.667	55.353	**2.000**	1.033	70.357	96.210	22.955	54.793	124.333	**41.547**
8	J-75	47.000	152.000	84.273	60.366	**40.667**	120.667	43.500	1.767	1.067	71.623	**97.790**	23.908	55.440	124.333	35.690
9	VG 09074	50.000	140.000	69.441	47.377	28.333	88.667	50.908	1.533	0.933	68.230	95.113	22.054	49.603	123.000	39.633
10	J-74	45.333	142.333	63.531	39.312	25.333	74.333	51.553	1.600	1.300	61.873	89.423	**24.219**	45.100	122.000	40.533
11	CSMG-2006-14	49.000	142.333	65.329	44.364	20.333	64.000	54.248	1.467	1.100	67.903	89.577	20.965	46.770	117.667	41.067
12	ALG-06-306	43.000	140.333	61.693	40.528	25.333	75.667	51.585	1.733	**1.400**	65.690	88.980	21.165	43.957	121.667	38.800
13	VG-09193	46.333	144.000	60.532	37.787	28.667	89.000	42.272	1.200	0.800	62.420	94.387	22.758	42.033	121.333	40.483
14	VG-09204	46.667	140.000	67.369	43.215	25.667	75.000	51.671	1.633	1.067	64.143	91.997	24.152	48.120	122.667	40.333
15	VG-09127	**51.000**	135.000	64.490	42.681	23.333	70.000	51.478	1.300	1.000	66.280	92.380	22.142	47.763	120.000	40.700
16	VG-0430	47.667	137.333	83.530	63.471	22.667	66.000	74.794	1.367	0.900	**75.980**	94.937	20.059	60.820	120.667	39.233
17	Girnar3	41.000	139.000	**89.423**	**66.385**	22.333	71.000	74.374	1.767	1.367	74.233	92.937	23.038	**64.330**	121.333	40.303
18	GPBD-5	43.667	143.333	75.517	53.442	27.000	89.000	57.542	1.500	1.100	70.763	95.503	22.075	52.683	121.333	41.073
19	R-2001-2	44.333	145.333	64.393	40.915	26.000	75.333	47.648	1.333	0.900	63.633	93.353	23.371	44.233	124.000	39.230
Grand Mean		46.316	143.263	72.024	49.669	29.632	89.772	52.546	1.628	1.071	68.373	93.773	22.368	50.269	122.965	39.861
C. D. At 5%		1.640	1.672	0.601	0.530	2.214	1.748	0.625	0.328	0.257	0.492	1.643	0.427	0.513	2.227	0.530

Table-2: Mean, range and other parameters in Groundnut genotypes

Sl. No	Characters	Range		SED	Variance		GCV	PCV	Heritability (h^2%)	GA at 5%	GA as % of mean (5%)
		Min	Max		GV	PV					
1	Plant ht. (cm)	41.000	51.000	0.809	7.852	8.832	6.0500	6.4167	88.90	5.442	11.7508
2	Plant wt. (g)	135.000	154.333	0.824	29.975	30.994	3.8216	3.8860	96.71	11.091	7.7420
3	Pod yield plant^{-1} (g)	54.096	89.423	0.296	93.984	94.116	13.4601	13.4696	99.86	19.896	27.7085
4	Kernel yield plant^{-1} (g)	30.915	66.385	0.261	100.025	100.127	20.1359	20.1462	99.90	20.592	41.4588
5.	No. of pod plant^{-1}	21.000	49.669	1.092	49.748	51.536	23.8032	24.2271	96.53	14.275	48.1767
6.	No. of kernel plant^{-1}	64.000	127.667	0.862	463.765	464.879	23.9888	24.0176	99.76	44.309	49.3577
7.	100 kernel wt. (g)	41.795	74.794	0.308	87.501	87.643	17.8019	17.8164	99.84	19.254	36.6420
8.	Pod length (cm)	1.200	2.000	0.162	0.040	0.080	12.3250	17.3263	50.60	2.948	18.0606
9.	Pod width (cm)	0.800	1.400	0.127	0.027	0.051	15.2870	21.0787	52.60	2.447	22.8385
10.	Shelling (%)	57.143	74.997	0.242	25.368	25.456	7.3664	7.3792	99.65	10.357	15.1484
11.	SMK (%)	88.980	97.790	0.810	7.401	8.385	2.9011	3.0879	88.27	5265	5.6149
12.	Haulm yield	20.059	24.219	0.211	1.666	1.732	5.7702	5.8844	96.16	2.606	11.6559
13.	Harvest Index	39.870	60.820	0.253	40.922	41.018	12.7256	12.7405	99.77	13.162	26.1841
14.	DTM	117.667	128.667	1.098	7.038	8.846	2.1575	2.4188	79.56	4.874	3.9644
15.	Oil (%)	35.690	41.547	0.261	1.698	1.800	3.2686	3.3656	94.32	2.606	6.5391

Table-3: Genotypic and phenotypic correlation among fifteen characters of groundnut genotypes

Characters		Plant ht.(cm)	Plant wt. (gm)	DTM	No. of pod Plant-1	No. of kernel Plant-1	100 kernel wt. (g)	Pod length (cm)	Pod width (cm)	Shelling (%)	SMK (%)	Haulm yield	HI	Oil (%)	Pod yield Plant-1 (g)	Kernel yield Plant-1 (g)
Plant ht. (cm)	GC	1.000	0.045	0.027	0.057	0.106	-0.331	-0.279	-0.047	0.058	0.203	-0.343	-0.127	-0.134	0.510*	0.665**
	PC	1.000	0.003	0.144	0.102	0.111	0.303	-0.348	-0.217	0.063	0.205	-0.324	-0.124	-0.172	0.509*	0.660**
Plant wt. (gm)	GC		1.000	0.221	0.867**	0.740**	0.487*	0.196	-0.124	0.317	0.526*	0.125	0.097	-0.375	0.379	0.348
	PC		1.000	0.251	0.867**	0.734**	0.474*	0.070	-0.091	0.316	0.489*	0.115	0.090	-0.377	0.376	0.347
DTM	GC			1.000	0.433	0.606**	0.402	0.795**	-0.140	0.029	0.466*	0.020	0.040	-0.219	0.117	0.109
	PC			1.000	0.448	0.556*	-0.347	0.790**	0.014	0.037	0.406*	0.005	0.028	-0.248	0.112	0.106
No. of pod Plant-1	GC				1.000	0.903**	0.500*	0.480*	-0.134	0.428	0.724**	0.058	0.238	-0.345	0.477*	0.457*
	PC				1.000	0.893**	0.486*	0.470*	-0.073	0.425	0.679**	0.049	0.229	-0.350	0.472*	0.457*
No. of kernel Plant-1	GC					1.000	0.609**	0.453	-0.001	0.473*	0.689**	-0.164	0.256	-0.328	0.460*	0.465*
	PC					1.000	0.606**	0.304	0.004	0.473*	0.648**	-0.162	0.255	-0.322	0.460*	0.466*
100 kernel wt. (g)	GC						1.000	0.011	0.074	0.257	-0.129	-0.040	0.517*	0.256	-0.333	0.328
	PC						1.000	0.002	0.062	0.257	-0.119	-0.039	0.515*	0.242	-0.334	0.328
Pod length (cm)	GC							1.000	0.706**	0.107	0.164	0.200	0.211	-0.210	0.266	-0.229
	PC							1.000	0.691**	0.066	0.074	0.151	0.158	-	0.179	-0.153

														0.087		
Pod width (cm)	GC								1.000	0.069	0.515*	0.015	0.122	-0.194	0.071	-0.071
	PC								1.000	0.050	0.502*	-0.010	0.095	-0.186	0.054	-0.053
Shelling (%)	GC									1.000	0.634**	-0.420	0.895**	-0.161	0.923**	0.962**
	PC									1.000	0.595**	-0.418	0.891**	-0.158	0.921**	0.961**
SMK (%)	GC										1.000	-0.074	0.572**	-0.262	0.693**	0.681**
	PC										1.000	-0.058	0.540*	-0.260	0.654**	0.641**
Haulm yield	GC											1.000	-0.233	-0.060	-0.182	-0.306
	PC											1.000	-0.223	-0.057	-0.175	-0.301
Harvest index	GC												1.000	-0.114	0.958**	0.958**
	PC												1.000	-0.109	0.956**	0.956**
Oil (%)	GC													1.000	-0.221	-0.205
	PC													1.000	-0.217	-0.202
Pod yield Plant^{-1} (g)	GC														1.000	0.992**
	PC														1.000	0.991**
Kernel yield Plant^{-1} (g)	GC															1.000
	PC															1.000

** Significant at 1% level * Significant at 5% level

Table-4: Direct and indirect effects at genotypic level of thirteen characters of Groundnut genotypes to determine the effect of other characters on pod yield plant^{-1}

Characters	Plant ht. (cm)	Plant wt. (g)	DTM	No. of pod plant^{-1}	No. of kernel plant^{-1}	100 kernel wt. (g)	Pod length (cm)	Pod width (cm)	Shelling (%)	SMK (%)	Haulm yield	Harvest Index	Oil (%)	Pod yield plant^{-1} (g)
Plant ht. (cm)	**0.00568**	-0.01289	0.00038	0.00045	-0.00333	0.00268	-0.00090	-0.00675	-0.00034	0.00653	0.00269	-0.11714	0.02100	0.510
Plant wt. (g)	-0.00026	**0.68551**	0.00304	0.00683	-0.02328	0.00394	0.00063	-0.00178	-0.00184	0.01695	-0.00098	0.08978	0.01400	0.379
DTM	0.00016	0.06321	**0.01373**	0.00341	-0.01905	0.00325	0.00255	-0.00200	-0.00017	0.01500	-0.00015	0.03715	0.02310	0.117
No. of pod plant^{-1}	0.00032	0.24752	0.00594	**0.00787**	-0.02839	0.00405	0.00154	-0.00192	-0.00249	0.02332	-0.00046	0.21958	0.00432	0.477
No. of kernel plant^{-1}	0.00060	0.21131	0.00832	0.00711	**0.03145**	0.00493	0.00146	-0.00001	-0.00275	0.02218	0.00128	0.23659	0.00786	0.460
100 kernel wt. (g)	-0.00188	-0.13896	-0.00551	-0.00394	0.01915	**-0.00810**	0.00003	0.00107	-0.00149	-0.00414	0.00031	0.47679	-0.01243	-0.333
Pod length (cm)	-0.00159	0.05598	0.01091	0.00378	-0.01424	-0.00009	**0.00321**	0.01013	-0.00062	0.00528	-0.00156	0.19455	0.00324	0.266
Pod width (cm)	-0.00267	-0.03544	-0.00192	-0.00106	0.00972	-0.00060	0.00227	**0.01434**	-0.00040	-0.01657	0.00012	0.11276	0.00912	0.071
Shelling (%)	0.00033	0.09037	0.00040	0.00337	-0.01488	-0.00208	0.00034	0.00098	**-0.00582**	0.02042	0.00402	0.82597	0.00421	0.923
SMK (%)	0.00115	0.15028	0.00640	0.00570	-0.02166	0.00104	0.00053	-0.00738	-0.00369	**0.03220**	0.00058	0.52817	0.00832	0.693
Haulm yield	-0.00195	0.03570	0.00027	0.00046	0.00516	0.00032	0.00064	-0.00021	0.00303	-0.00239	**-0.00783**	-0.21481	0.00111	-0.182
Harvest Index	-0.00072	0.02777	0.00055	0.00187	-0.00806	-0.00419	0.00068	0.00175	-0.00521	0.01843	0.00182	**0.92291**	0.01265	0.958
Oil (%)	-0.00076	-0.10708	-0.00300	-0.00272	0.01031	-0.00207	-0.00067	-0.00278	0.00094	-0.00844	0.00047	-0.10513	**-0.00178**	-0.221

Residual effect- 0.01952

Table-5: Direct and indirect effects at genotypic level of thirteen characters of Groundnut genotypes to determine the effect of other characters on kernel yield plant^{-1}

Characters	Plant ht. (cm)	Plant wt. (gm)	DTM	No. of pod plant^{-1}	No. of kernel plant^{-1}	100 kernel wt. (gm)	Pod length (cm)	Pod width (cm)	Shelling (%)	SMK (%)	Haulm yield	Harvest index	Oil (%)	Kernel yield plant^{-1} (gm)
Plant ht. (cm)	**0.00728**	-0.01122	0.00047	0.00093	-0.16425	-0.00211	0.00050	0.00126	0.00287	-0.00083	0.03802	-0.10911	0.00083	0.665
Plant wt. (gm)	-0.00033	**0.24843**	0.00377	0.01410	-0.19835	-0.00310	-0.00035	0.00033	0.01553	-0.00215	-0.01384	0.08363	0.00231	0.348
DTM	0.00020	0.05500	**0.01701**	0.00704	-0.22328	-0.00256	-0.00143	0.00037	0.00145	-0.00190	-0.00216	0.03461	0.00135	0.109
No. of pod plant^{-1}	0.00041	0.21538	0.00736	**0.01626**	-0.16542	-0.00319	-0.00086	0.00036	0.02101	-0.00296	-0.00647	0.20454	0.00213	0.457
No. of kernel plant^{-1}	0.00077	0.18387	0.01030	0.01468	**0.91247**	-0.00388	-0.00081	0.00103	0.02321	-0.00281	0.01817	0.22038	0.00202	0.465
100 kernel wt. (gm)	-0.00240	-0.12092	-0.00683	-0.00813	0.64229	**0.00637**	-0.00002	-0.00020	0.01260	0.00053	0.00440	0.44413	-0.00158	0.328
Pod length (cm)	-0.00203	0.04871	0.01352	0.00780	-0.41721	0.00007	**-0.00180**	-0.00189	0.00525	-0.00067	-0.02213	0.18123	0.00129	-0.229
Pod width (cm)	-0.00342	-0.03084	-0.00238	-0.00218	0.23746	0.00047	-0.00127	**-0.00268**	0.00337	0.00210	0.00165	0.10503	0.00120	-0.071
Shelling (%)	0.00043	0.07863	0.00050	0.00696	-0.35987	0.00164	-0.00019	-0.00018	**0.04906**	-0.00259	0.05757	0.76939	0.00099	0.962
SMK (%)	0.00148	0.13077	0.00792	0.01178	-0.21867	-0.00082	-0.00029	0.00138	0.03112	**-0.00408**	0.00821	0.49199	0.00162	0.681
Haulm yield	-0.00250	0.03107	0.00033	0.00095	0.67213	-0.00025	-0.00036	0.00004	-0.02551	0.00030	**-0.11071**	-0.20010	0.00037	-0.306
Harvest index	-0.00092	0.02417	0.00068	0.00387	-0.39651	0.00329	-0.00038	-0.00033	0.04391	-0.00234	0.02577	**0.85969**	0.00070	0.958
Oil (%)	-0.00098	-0.09318	-0.00372	-0.00562	0.46936	0.00163	0.00038	0.00052	-0.00790	0.00107	0.00660	-0.09793	**-0.00616**	-0.205

Residual effect- 0.036344

It was evident from the (Table 2) result that the magnitude of phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters studied. This indicates that the apparent variation was not only due to genotypes but also due to influence of environment. The characters like pod length and pod width showed larger difference between phenotypic and genotypic coefficient of variation indicating the greater influence of environment on these characters. However, in rest of the characters minimum difference between phenotypic and genotypic coefficients of variation was observed indicating less environmental influence and scope of selection for these traits. Similar results were also reported by Yadlapalli [9] and Rao [14]. The heritability showed highest value for kernel yield plant^{-1}, followed by pod yield plant^{-1} and 100 kernel weight. This result was in consonance with the report of earlier workers [10-12]. However, the genetic advance as percent over mean was found high in no. of kernel plant^{-1}, no. of pod plant^{-1} and kernel yield plant^{-1}. Genetic Advance as per cent of mean (GA) is more reliable index for understanding the effectiveness of selection in improving the traits because the estimates are derived by involvement of heritability, phenotypic standard deviation and intensity of selection. Thus, GA along with heritability provides clear picture regarding the effectiveness of selection for improving the plant characters. In this context, kernel yield plant^{-1}, no. of pod plant^{-1}, no. of kernel plant^{-1} and 100 kernel weight was characterized by high GCV, high heritability and high genetic advance and indicated lesser influence of environment in expression of these characters and these characters are controlled by additive gene effect, hence, amenable for simple selection. Similar findings were also observed by Siddiquey *et al.* [10] and Patil *et al*. [13]. On the other hand, characters like, plant weight, haulm yield and sound mature kernel % having high heritability values, had low estimates of genetic advance. These characters indicated predominance of non-additive gene action and the lower heritability was being exhibited due to favourable influence of environmental factors therefore, selection for these characters may not be rewarding.

Correlation coefficient at genotypic levels was, in general higher than phenotypic level in all the characters (Table 3). Such results are generally obtained when the genes governing two traits are similar but the environmental conditions pertaining the expressions of these traits have a small and similar effect. Genotypic correlation was found more significant than phenotypic correlation indicating that, there was prevalence of environmental interaction and strong association between characters genetically and there was some scope for selection of better yielding types. Plant height, no. of pod plant^{-1}, no. of kernel plant^{-1}, shelling %, SMK, harvest index reflected significantly positive correlation with the no. of pod plant^{-1} and no. of kernel plant^{-1} both at genotypic and phenotypic levels. So these characters exhibited correlated response with the pod and kernel yield and therefore might be considered for selection of better yielding genotype. Similar findings were observed by several previous workers [9-10 and 14-15].

In order to obtain a clear picture of the inter-relationship between different characters, the direct and indirect effects of the different characters on pod yield plant^{-1} and kernel yield plant^{-1} were worked out at genotypic level (Table 4 and 5). All the direct effects towards pod yield plant^{-1} were positive except haulm yield and oil % however in case of kernel yield plant-1 along with haulm yield and oil % negative effects were shown through pod length and pod weight. In general, the indirect effects were either positive or negative and lower in magnitude with low residual effect in both pod yield plant^{-1} (0.019528) and kernel yield plant^{-1} (0.036344). Considering the relationship of all the traits with pod yield and kernel yield plant^{-1} the present investigation showed the importance of harvest index, shelling %, SMK, plant height, no. of pod plant^{-1}, no. of kernel plant^{-1} and plant weight for improving pod and kernel yield plant^{-1} as they had positive direct effects on yield. So, direct selection for these characters would be effective for yield improvement in groundnut. These results are in conformity with previous reports [10, 14 and16].

So for increasing kernel yield per plant a groundnut genotype should have tall height, more number of pod plant^{-1}, kernel plant^{-1}, excellent amount of shelling %, good plant weight and high harvest index value because these characters were positively associated with kernel yield and resemble high estimates of heritability along with high genetic advance.

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