

Correlation and Path Coefficient Analysis in Groundnut (*Arachis hypogaea* L.)

Anamika Roy^{1*}, Lal Ahamed M¹, J. Dayal Prasad Babu², Y. Amaravathi³, K. Viswanath⁴ and B. Sreekanth⁵

¹Department of Genetics and Plant Breeding, Agricultural College, Bapatla (Andhra Pradesh), India.

²C/o DSA, ANGRAU Admin Block, Lam, Guntur (Andhra Pradesh), India.

³Department of Plant Molecular Biology and Biotechnology,
SV Agricultural College, Tirupati, (Andhra Pradesh), India.

⁴Department of Plant Pathology, IFT, RARS, Tirupati, (Andhra Pradesh), India.

⁵Department of Crop Physiology, Cotton Scheme, RARS, Lam, Guntur (Andhra Pradesh), India.

(Corresponding author: Anamika Roy*)

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ABSTRACT: Groundnut is an important oilseed crop of India. Identification of genotypes having very good yield contributing traits forms an important objective in groundnut to improve the kernel yield. The present experiment was conducted to know the association of various yield characters with kernel yield in 33 genotypes of groundnut collected from different parts of the country and world. Character association analysis indicated the significant and positive association of SCMR 60 DAS, harvest index, shelling percentage, 100 kernel weight and oil content with kernel yield per plant at both genotypic and phenotypic levels whereas SCMR 50 DAS recorded positive significant association only at genotypic level. Thus, kernel yield can be improved simultaneously by improving any of these characters. Path coefficient analysis revealed that harvest index, shelling percentage and 100 kernel weight exhibited strong positive correlation and high direct effects on kernel yield per plant both at genotypic and phenotypic levels; but oil content exhibited significant positive correlation and positive direct effect only at genotypic level. It was also recorded that characters viz., SCMR 50 DAS, SCMR 60 DAS and oil content contributed indirectly to kernel yield per plant. Therefore, simultaneous selection for these traits will be rewarding for improving the yield in groundnut.

Keywords: Correlation, groundnut, path analysis, direct effects, indirect effects

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the important oilseed crops grown in tropical and subtropical regions of the world and is fifth in vegetable oil production among the nine major oilseed crops of world (Tillman *et al.*, 2009). Groundnut is a member of family Fabaceae and sub-family Papilionoideae. It is an annual herbaceous legume with self pollination and segmental allopolyploid nature. It is primarily used for its oil (36-54%) and protein (22-36%). The oil is rich in essential polyunsaturated fatty acids *i.e.*, linolenic acid and linoleic acid (Desai *et al.*, 1999). Cultivated *Arachis hypogaea* is believed to have originated very recently *via* hybridization of two diploid wild species (*A. duranensis* and *A. ipaensis*) followed by rare spontaneous duplication of the chromosomes (Halward *et al.*, 1991; Young *et al.*, 1996 and Seijo *et al.*, 2004, 2007).

A proper and balanced nutritional programme based on sufficient numbers of major, minor and other essential nutrients is must for getting higher yields in groundnut (Haleh and Amiri, 2015). The average productivity of groundnut is often less than one ton per hectare (Mace *et al.*, 2006) indicating the importance of germplasm for the improvement of yield and other yield contributing traits. Exploitation of groundnut germplasm for the identification and utilization in breeding programmes

forms an important objective. The association studies in various crops clearly indicated the importance of yield traits in the improvement of yield *per se* which is a dependent variable on these traits (Parvathi *et al.*, 2011; Rajanna *et al.*, 2011; Asha *et al.*, 2013; Kote *et al.*, 2014 and Jadhav *et al.*, 2015). Keeping this in view, Kernel yield in groundnut can be improved by generating the knowledge on association between the yield traits and kernel yield. Keeping this in view, the present investigation was planned to study the correlation and path analysis studies to know the association and direct and indirect effects of yield traits on kernel yield to generate selection criteria to increase kernel yield in groundnut.

MATERIALS AND METHODS

The present study consisted of thirty three genotypes including exotic groundnut genotypes obtained from Directorate of Groundnut Research, Junagarh, Gujarat and Regional Agricultural Research Station, Tirupati, Andhra Pradesh. The genotypes were sown during *khari*, 2016 in a randomized block design with two replications at Regional Agricultural Research Station farm, ANGRAU, Tirupati. Observations were recorded from five randomly selected plants for eleven characters *viz.*, days to 50 % flowering, SCMR 40 DAS, SCMR 50 DAS, SCMR 60 DAS, SCMR 70

DAS, days to maturity, harvest index, shelling percentage, 100 kernel weight, kernel yield per plant and oil content. The number of days taken to flowering from the day of sowing to opening of flowers in 50 per cent of plants and number of days taken for maturity were recorded on the plot basis. SCMR was measured on the leaflets of third leaf from the apex on the main axis at 40, 50, 60 and 70 DAS under normal sunlight using SPAD chlorophyll meter of Minolta Company, New Jersey, USA (SPAD-502). Oil content in the seed was estimated with the help of Universal Grain analyzer in which dried seed samples (8-12 % moisture content) of 100g was taken and fed into the grain analyzer and the oil content was recorded directly as percentage of oil. The genotypic and phenotypic coefficients of correlation were calculated using the method given by Falconer *et al.* (1964) and path coefficient analysis was worked out as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Analysis of variance for yield and yield attributes revealed significant differences for all the characters studied indicating the presence of considerable amount of variation among the genotypes for the traits studied. Phenotypic and genotypic correlation coefficients between kernel yield per plant and other yield characters and among themselves were estimated in order to access the direction and magnitude of association (Table 1). Correlation studies revealed that six out of eleven characters showed positive significant correlation with kernel yield per plant. The highest significant positive correlation was observed for the trait harvest index (0.8310** and 0.6930**). The traits like SCMR 60 DAS, shelling percentage, 100 kernel weight and oil content recorded positive significant association with kernel yield per plant at both genotypic and phenotypic levels whereas SCMR 50 DAS recorded positive significant association only at genotypic level. Days to 50 % flowering showed negative non-significant correlation with kernel yield per plant (-0.0956 and -0.0918), SCMR 60DAS (-0.1089 and -0.1143), harvest index (-0.0955 and -0.1026), shelling percentage (-0.1585 and -0.1904) and oil content (-0.0729 and -0.1661) at both phenotypic and genotypic levels, respectively. Similar results were also reported by Babariya and Dobariya (2012), Kumar *et al.* (2012) and Gupta *et al.*, (2015) for kernel yield per plant; Korat *et al.*, (2010) and Babariya and Dobariya (2012) for shelling percentage; Gupta *et al.* (2015) for harvest index; Mahalakshmi *et al.*, (2005) and Parameshwarappa *et al.*, (2005) for oil content. SCMR 40 DAS had positive significant association with SCMR 50 DAS (0.6190 and 0.7719), SCMR 60 DAS (0.4304 and 0.5074), SCMR 70 DAS (0.5767 and 0.6827) and 100 kernel weight (0.2660 and 0.3569) at both phenotypic and genotypic levels and with harvest index (0.2577) and days to maturity (0.2514) at genotypic level. Similar results were also reported by Kumar *et al.* (2012) for 100 kernel weight. Days to maturity had positive significant association with 100 kernel weight (0.2732 and 0.3437) at both genotypic and phenotypic levels. Harvest index showed positive significant association with shelling percentage (0.2678

and 0.2794), 100 kernel weight (0.4645 and 0.5415), oil content (0.3487 and 0.4862) and kernel yield per plant (0.6930 and 0.8310) at both genotypic and phenotypic levels. Shelling percentage recorded positive significant association with oil content (0.2643 and 0.3491) and kernel yield per plant (0.4550 and 0.5211). 100 kernel weight had positive significant association with oil content (0.4592 and 0.6382) and kernel yield per plant (0.4863 and 0.6237) at both genotypic and phenotypic levels indicating the important role of these traits in improving kernel yield per plant. These results were in agreement with Zaman *et al.*, (2011), Gupta *et al.*, (2015) and Ashutosh Kushwah *et al.*, (2017) for kernel yield per plant and Parameshwarappa *et al.*, (2005) for oil content. Therefore, due importance should be given to these attributes while fixing selection criteria for improvement of kernel yield in groundnut.

The Table pertaining to the path direct and indirect effects of yield parameters on kernel yield is presented in Table 2. The path analysis noted that days to 50% flowering recorded negative direct effect and also negative non-significant association with kernel yield per plant both at phenotypic and genotypic levels indicating improvement in kernel yield per plant through direct selection of this trait is not possible. Days to maturity recorded positive direct effect at both phenotypic and genotypic levels and positive non-significant correlation with kernel yield per plant at genotypic level. Therefore, restrictions are to be imposed to nullify the undesirable indirect effects in order to make use of the direct effect of this trait. SCMR 40 DAS recorded positive direct effect and also positive non-significant association with kernel yield per plant at both genotypic and phenotypic levels. SCMR 50 DAS recorded negative direct effect at both genotypic and phenotypic level and positive significant correlation with kernel yield per plant at genotypic level. SCMR 60 DAS recorded positive significant correlation at both genotypic and phenotypic levels but direct effect was negative at genotypic level indicating that indirect effects seem to be the cause of positive correlation. SCMR 70 DAS showed positive non-significant correlation with kernel yield per plant and negative direct effects at both genotypic and phenotypic levels. Harvest index recorded positive direct effect and also positive significant correlation with kernel yield per plant at both genotypic and phenotypic levels. So, this trait may be considered as one of the major contributors for yield improvement in breeding programmes. Shelling percentage recorded positive significant correlation and also positive direct effect at both genotypic and phenotypic levels indicating the use of this trait in improvement of dependent variable in plant breeding programme. 100 kernel weight recorded positive significant correlation and also positive direct effect at both genotypic and phenotypic levels indicating direct selection for this trait would give positive results. Oil content recorded positive significant correlation at both genotypic and phenotypic levels and positive direct effect at genotypic level and negative direct effect at phenotypic level revealing direct selection for this trait would be rewarding.

Table 1: Phenotypic (above diagonal) and genotypic (below diagonal) correlations among 11 characters in 33 groundnut (*Arachis hypogaea* L.) genotypes.

Character	Days to 50% flowering	SCMR 40DAS	SCMR 50DAS	SCMR 60DAS	SCMR 70DAS	Days to maturity	Harvest index	Shelling %	100 kernel weight (g)	Oil content (%)	Kernel yield per plant (g)
Days to 50 % flowering	1.0000	0.0644	0.1019	-0.1089	0.0750	0.3873**	-0.0955	-0.1585	0.2977*	-0.0729	-0.0956
SCMR 40DAS	0.0540	1.0000	0.6190**	0.4304**	0.5767**	0.1502	0.2324	-0.1542	0.2660*	0.1212	0.1081
SCMR 50DAS	0.0833	0.7719**	1.0000	0.6181**	0.7364**	0.3761**	0.4114**	0.1145	0.4709**	0.1639	0.2245
SCMR 60DAS	-0.1143	0.5074**	0.7707**	1.0000	0.6844**	0.2272	0.3300*	0.2854*	0.4794**	0.3251*	0.3341*
SCMR70DAS	0.0893	0.6827**	0.8276**	0.7711**	1.0000	0.3175*	0.2901*	0.1312	0.3809**	0.2256	0.1677
Days to maturity	0.5379**	0.2514*	0.5023**	0.3309*	0.5063**	1.0000	-0.0861	-0.0795	0.2732*	-0.0750	-0.0417
Harvest index	-0.1026	0.2577*	0.4751**	0.3763**	0.2660*	-0.1103	1.0000	0.2678*	0.4645**	0.3487**	0.6930**
Shelling %	-0.1904	-0.1158	0.1834	0.3530**	0.1466	-0.1561	0.2794*	1.0000	0.1628	0.2643*	0.4550**
100 kernel weight	0.3360*	0.3569**	0.5861**	0.5527**	0.4144**	0.3437**	0.5415**	0.2029	1.0000	0.4592**	0.4863**
Oil content	-0.1661	0.2061	0.2841*	0.4978**	0.3112*	-0.0931	0.4862**	0.3491**	0.6382**	1.0000	0.2955*
Kernel yield /plant	-0.0918	0.0636	0.3790**	0.3914**	0.1890	0.0241	0.8310**	0.5211**	0.6237**	0.5892**	1.0000

*=significant at 5% level

**=significant at 1% level

Thus, for improvement of kernel yield per plant, along with SCMR 40 DAS which is showing positive direct effect, other characters which are showing positive indirect effects viz., SCMR 60 DAS, days to maturity, harvest index and 100 kernel weight are to be considered simultaneously during selection. Similar results were also reported by Durgarani *et al.*, (1987), Venkateswarlu *et al.*, (2007), Alam (2014), Gupta *et al.*, (2015), Ashutosh Kushwah *et al.*, (2016) and Nelson *et al.*, (2020) on path effects in groundnut. The residual effect was 0.3129 and 0.6077 at genotypic and phenotypic levels, respectively, indicating that all important characters were not included under study to account fully for the variation in kernel yield per plant.

Hence, some more yield traits need to be included to get true image of variation in kernel yield per plant. Thus, the traits, harvest index, shelling percentage and 100 kernel weight exhibited strong positive correlation and high direct effects on kernel yield per plant both at genotypic and phenotypic levels. The trait, oil content, exerted positive direct effect only at genotypic level. These traits emerged as the major components of kernel yield per plant improvement to devise selection. These characters may also be included in formulating the selection criterion for improving kernel yield in groundnut and will form the basis for future selection in groundnut using these genotypes.

Table 2: Direct and indirect effects (genotypic & phenotypic) of yield components on kernel yield per plant in 33 groundnut (*Arachis hypogaea* L.) genotypes.

Character		Days to 50% flowering	SCMR 40DAS	SCMR 50DAS	SCMR 60DAS	SCMR 70DAS	Days to maturity	Harvest index	Shelling %	100 kernel weight (g)	Oil content	Correlation coefficient
Days to 50 % flowering	G	-0.2404	0.0051	-0.0310	0.0066	-0.0113	0.2419	-0.0799	-0.0702	0.0964	-0.0091	-0.0918
	P	-0.0778	0.0074	-0.0252	-0.0097	-0.0065	0.0210	-0.0551	-0.0482	0.0905	0.0080	-0.0956
SCMR 40DAS	G	-0.0130	0.0947	-0.2870	-0.0293	-0.0867	0.1131	0.2006	-0.0427	0.1024	0.0114	0.0636
	P	-0.0050	0.1155	-0.1533	0.0384	-0.0503	0.0081	0.1340	-0.0469	0.0809	-0.0133	0.1081
SCMR 50DAS	G	-0.0200	0.0731	-0.3718	-0.0445	-0.1051	0.2259	0.3699	0.0676	0.1682	0.0156	0.3790**
	P	-0.0079	0.0715	-0.2476	0.0551	-0.0642	0.0204	0.2373	0.0348	0.1432	-0.0180	0.2245
SCMR 60DAS	G	0.0275	0.0481	-0.2866	-0.0577	-0.0979	0.1488	0.2930	0.1302	0.1586	0.0274	0.3914**
	P	0.0085	0.0497	-0.1531	0.0892	-0.0597	0.0123	0.1903	0.0868	0.1458	-0.0358	0.3341**
SCMR70DAS	G	-0.0215	0.0647	-0.3077	-0.0445	-0.1270	0.2277	0.2071	0.0541	0.1189	0.0171	0.1890
	P	-0.0058	0.0666	-0.1824	0.0610	-0.0872	0.0172	0.1673	0.0399	0.1159	-0.0248	0.1677
Days to maturity	G	-0.1293	0.0238	-0.1868	-0.0191	-0.0643	0.4498	-0.0859	-0.0576	0.0986	-0.0051	0.0241
	P	-0.0301	0.0173	-0.0931	0.0203	-0.0277	0.0541	-0.0497	-0.0242	0.0831	0.0082	-0.0417
Harvest index	G	0.0247	0.0244	-0.1767	-0.0217	-0.0338	-0.0496	0.7785	0.1030	0.1554	0.0268	0.8310**
	P	0.0074	0.0268	-0.1019	0.0294	-0.0253	-0.0047	0.5767	0.0815	0.1413	-0.0384	0.6930**
Shelling %	G	0.0458	-0.0110	-0.0682	-0.0204	-0.0186	-0.0702	0.2175	0.3688	0.0582	0.0192	0.5211**
	P	0.0123	-0.0178	-0.0284	0.0254	-0.0114	-0.0043	0.1545	0.3042	0.0495	-0.0291	0.4550**
100 kernel weight (g)	G	-0.0808	0.0338	-0.2179	-0.0319	-0.0526	0.1546	0.4216	0.0748	0.2870	0.0352	0.6237**
	P	-0.0232	0.0307	-0.1166	0.0427	-0.0332	0.0148	0.2679	0.0495	0.3041	-0.0505	0.4863**
Oil content (%)	G	0.0399	0.0195	-0.1056	-0.0287	-0.0395	-0.0419	0.3785	0.1287	0.1832	0.0551	0.5892**
	P	0.0057	0.0140	-0.0406	0.0290	-0.0197	-0.0041	0.2011	0.0804	0.1397	-0.1100	0.2955*

** significant at 1% level; * significant at 5% level; G = Genotype P= Phenotype; Bold and diagonal values indicate direct effects; Residual effect = 0.3129 at genotypic level; Residual effect = 0.6077 at phenotypic level.

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Conflict of Interest. All authors have seen and approved the manuscript as submitted and there is no conflict of interest to declare.

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