Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 771-776
Received: 13-11-2019
Accepted: 15-12-2019

Venkataravana P
College of Sericulture, University of Agricultural Sciences, Bangalore, Karnataka, India

Pushpa HD
Indian Institute of Oil seed Research, Hyderabad, Telangana, India

Priyadarshini SK
College of Sericulture, University of Agricultural Sciences, Bangalore, Karnataka, India

Sheela V Dudagi
University of Agricultural Sciences, Raichur, Karnataka, India

Corresponding Author:
Venkataravana P
College of Sericulture, University of Agricultural Sciences, Bangalore, Karnataka, India

Genetic variability, correlation and path analysis studies in segregating generation of three crosses for pod yield and its attributing characters in groundnut (*Arachis hypogaea* L.)

Venkataravana P, Pushpa HD, Priyadarshini SK and Sheela V Dudagi

Abstract
An experiment was conducted using three different F_2 populations of three cross combinations *viz.*, TAG 24 × ICGV 00350, TMV 2 × ICGV 86031 and JL 42 × ICGV 91114 to study the extent of genetic variability and correlation of pod yield and its attributing characters. The estimates of PCV and GCV were high for number of branches per plant, pod yield per plant, kernel yield per plant, and oil yield per plant in all the three crosses. It will be more meaningful if the structure of yield is probed through its components rather than directly since there may not be any gene for yield as such but operates only through component characters. Hence, it is anticipated to break genetic barriers of the yield by the study of character association and such associations are best ascertained by phenotypic correlations. Phenotypic correlation coefficient analysis for yield and its attributing traits for all the three crosses were carried out and Characters which showed significant correlation with pod yield per plant were subjected to path analysis in order to partition the correlation coefficients in to direct and indirect effects of component traits on pod yield. In F_2 generation maximum direct effect on pod yield was mainly through kernel yield per plant in all the three crosses. Shelling per cent exhibited direct negative association with pod yield in all the three population. Plant height was found to have indirect negative association with pod yield via. Kernel yield per plant in the crosses.

Keywords: Groundnut, variability, correlation, path analysis

Introduction

Groundnut is the most important oilseed crop grown in the Indian subcontinents. In India, Groundnut Yield being a complex trait is collectively influenced by various component characters, which are polygenically inherited and highly influenced by environmental variations. The improvement of character in a population is a function of variability existing in the population. Hence, it should be essential to assess the existing variability in the population to partition the phenotypic variation into heritable (genetic) and non-heritable (environmental) components and thus, breeding value of the genotype can be precisely estimated by separating genetic variance from environmental variance. It is also important to establish the extent of association between the yield traits. Therefore in the present study, the components of variance such as phenotypic coefficient of variance (PCV), genotypic coefficient of variance (GCV), heritability in broad sense ($h^2b.s$) and predicted genetic advance as per cent mean were computed. This study will facilitated an understanding behind expression of character and also role of environment therein. It will be more meaningful if the structure of yield is probed through its components rather than directly since there may not be any gene for yield as such but operates only through component characters. Hence, it is anticipated to break genetic barriers of the yield by the study of character association and such associations are best ascertained by phenotypic correlations. Phenotypic correlation coefficient analysis for yield and its attributing traits for all the three crosses were carried out and Characters which showed significant correlation with pod yield per plant were subjected to path analysis in order to partition the correlation coefficients in to direct and indirect effects of component traits on pod yield.

Materials and Methods

The experimental materials consisted of three F_2 generation populations of the crosses *viz*. TAG 24 × ICGV 00350, TMV 2 × ICGV 86031 and TMV 2 × JL 42 of groundnut. Each cross consists of 150 population of groundnut belonging to Spanish habit groups. Source of the parent material obtained from All India coordinated Research Project on Groundnut, the investigation was carried out at Agricultural Research Station, Chintamani. F_2 population consisted of highly variable population and following observations were recorded on all the F_2 plants in each cross for yield and its related traits. Observations were also recorded on ten randomly selected plants in the parental population grown along with F_2 generation. Various parameters for PCV, GCV, heritability and genetic advance were estimated for 13 yield and its attributing characters *viz.*, days to 50% flowering, Plant height (cm), Number of branches per plant, Specific leaf area (SLA) (cm^2/g), SPAD Chlorophyll Meter Reading (SCMR) (mg/g), Number of matured pods per plant, Pod yield per plant (g), Kernel yield per plant (g), Sound Mature Kernel (SMK) per cent, Shelling percent, Harvest Index (%), Oil content (%), Oil yield per plant (g). Finally, genotypic and phenotypic coefficients of variation (Burton. 1952) [2]. The data was analyzed for path coefficients to study direct and indirect effects of traits according to Dewey and Lu (1959) [4].

Results and Discussion

Since F_2 is a segregating population, the range of variability present in all the three crosses was quite high, suggesting that the application of individual plant selection for high pod yield. Among all the three crosses studied the cross TAG 24 × ICGV 00350 showed high kernel yield per plant and high pod yield per plant performance. Simultaneously cross TMV 2 × ICGV 86031 recorded lowest SLA among all the three crosses, followed by TAG 24 × ICGV 00350 which also showed high SCMR value. Other crosses also showed good pod yield and physiological performance, suggesting the presence of high genetic variability present in the F_2 generation where individual plant selection can be practiced and can be grown in row to progeny method in F_3 generation for identifying high yielding lines.

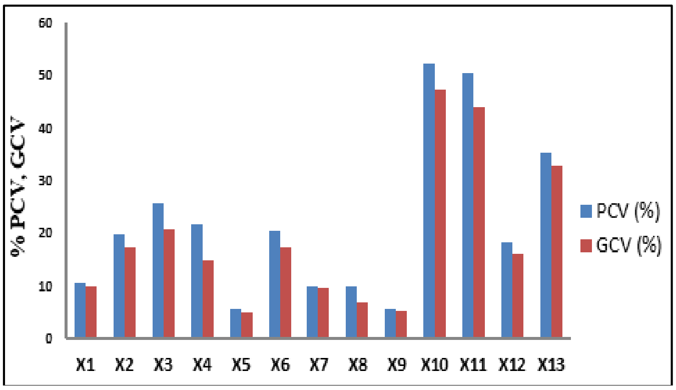

Fig 1: variability distribution in the cross TAG 24 × ICGV 00350

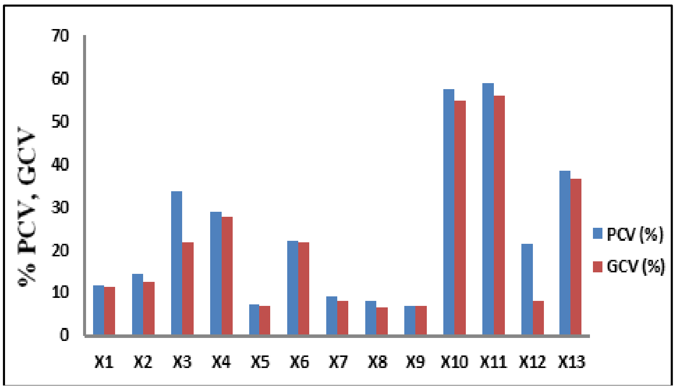

Fig 2: variability distribution in the cross TMV 2 × ICGV 86031

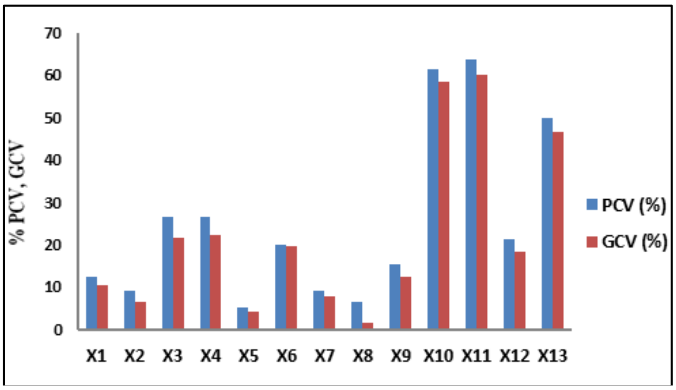

Fig 3: variability distribution in the cross JL 42 × ICGV 91114

X_1- Days to 50% flowering	X_8-SPAD chlorophyll meter reading (mg/g)
X_2- Plant height(cm)	X_9-Specific leaf area(cm^2/g)
X_3-No. of branches	X_{10}-Kernel Yield/plant(g)
X_4-Matured pods /plant	X_{11}- Oil yield/plant(g)
X_5-Sound mature kernel (%)	X_{12}- Harvest index (%)
X_6-Shelling percent	X_{13}- Pod yield/plant(g)
X_7-Oil content (%)	

The PCV and GCV estimates were relatively high for pod yield per plant, kernel yield per plant, number of branches per plant and oil yield per plant in all the three crosses (Fig 1, 2&3). Similar findings of higher estimates of GCV and PCV were made by Reddi *et al.* (1991) [20]; Kandaswami *et al.* (1986) [10], Manoharan *et al.* (1990a) [14]; Sharma and Varshney (1995) [25]; Sumathi and Ramanathan (1995b) [27], Gowda *et al.* (1996) [7], Khuram *et al.* (1998) [11], Yogendra Prasad *et al.* (2002) [36] g *et al.* (2003) [10], Suvarna *et al.* (2004) [18]. Golkia *et al.* (2005) and Veeramani *et al.* (2005) [32] Pushpa *et al*., (2014) for pod and kernel yield, Nadaf and Habib (1987) [17] for oil yield characters suggesting that individual plant selections can be practiced for the above mentioned characters in the F_3 generation for higher yield. Matured pods per plant showed high PCV and GCV estimates in the crosses TMV 2 × ICGV 86031 and JL 42 × ICGV 91114 (Fig 2&3). Days to fifty per cent flowering showed moderate PCV and GCV estimates in the crosses TMV 2 × ICGV 86031and JL 42 × ICGV 91114 and Plant height showed moderate PCV and GCV estimates in the crosses TAG 24 × ICGV 00350 and JL 42 × ICGV 91114and shelling per cent age showed moderate PCV and GCV estimates in the cross TAG 24 × ICGV 00350 which were in confirmation with the results of Reddy and Gupta (1992) [21], Ganeshan and Sudhakar (1995) [5], Rudraswamy *et al.* (1999) [23], Suneetha *et al*., (2004) [28], Golakia *et al.* (2005) [6] and Pushpa *et al.* (2014). Whereas the values were lower for sound matured kernel per cent, SCMR, oil content and in all the three crosses which were in confirmation with the results of Gowda *et al.* (1996) [7], Venkataravana (2001) [33]. The close correspondence between the estimates of GCV and PCV for most of the traits like Days to fifty per cent flowering, sound matured kernel per cent oil content, specific leaf area and shelling per cent age in all the crosses indicated lesser environmental influence the expression of these traits indicating their suitability for further selection for higher yields. To have an exact idea of the heritable portion of variability, it is necessary to estimate heritability for each character. Broad sense heritability gives an idea about portion of observed variability attributable to genetic differences. In other words, heritability indicates the accuracy with which a genotype can be inferred from its phenotype. The difference between PCV and GCV estimates are indicates of the extent of heritability. Wide differences indicate considerable influence on the environment, resulting in low heritability estimates. However, Johnson *et al.* (1955) [7] reported that when heritability used in conjunction with genetic advance it will be more useful in selection programme.

Character association and path analysis Studies

TAG 24 × ICGV 00350: Pod yield per plant and Kernel yield per had highly significant and positive association with kernel yield per plant, sound matured kernel percent, matured pods per plant, shelling percentage, and SCMR, whereas significant negative association was seen with plant and specific leaf area. SCMR was found to have highly significant positive association with the sound matured kernal per cent, matured pods per plant, shelling percent. High positive direct effect for pod yield per plant was exhibited by kernel yield per plant followed by sound matured kernel per cent. Indirect effect was mainly from matured pods per plant and shelling per cent age via. Kernel yield and SCMR. Shelling per cent age was found to have highly significant positive association with matured pods per plant, sound matured kernel per cent, but highly significant negatively association was seen with plant height, also there was negative indirect effect of plant height via kernel yield (Table 1)

Table 1: Phenotypic correlation coefficients for pod yield and its attributing traits in F_2populations of the cross TAG 24 × ICGV00350

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
X_1	1.000	0.146	-0.031	-0.160	-0.138	-0.130	-0.055	-0.130	0.109	-0.137	-0.145
X_2		1.000	-0.043	-0.760**	-0.793**	-0.718**	-0.150	-0.787**	0.679**	-0.834**	-0.833**
X_3			1.000	0.093	0.073	0.078	-0.024	0.064	-0.043	0.060	0.054
X_4				1.000	0.968**	0.953**	0.142	0.884**	-0.936**	0.942**	0.955**
X_5					1.000	0.932**	0.124	0.905**	-0.911**	0.944**	0.957**
X_6						1.000	0.130	0.877**	-0.913**	0.943**	0.940**
X_7							1.000	0.129	-0.158	0.172*	0.173*
X_8								1.000	-0.769**	0.919**	0.915**
X_9									1.000	-0.866**	-0.888**
X_{10}										1.000	0.996**
X_{11}											1.000

TMV 2 × ICGV86031: Pod yield and Kernel per yield plant was found to have highly significant positive association with the matured pods per plant sound matured kernel percent, shelling percent, SCMR, matured pods per plant, and kernel yield was found to have highly significant positive association with the pod yield per plant, whereas specific leaf area and plant height had significant negative correlation with both pod yield per plant and kernel yield. Thus Kernel yield per plant had high positive direct influence for pod yield per plant followed by sound matured kernel and matured pods per plant. SCMR was found to have highly positive significant association with matured pods per plant, sound matured kernel, shelling per cent age and number of branches. Indirect effect was seen mainly through SCMR via kernel yield per plant followed by matured pods per plant via kernel yield per plant which is responsible for highly significant correlation with the pod yield per plant in this cross. Whereas significant negative correlation with plant height. There was also direct negative effect of shelling per cent on pod yield per plant and indirect negative effect of plant height via kernel yield per plant (Table 2).

Table 2: Phenotypic correlation coefficients for pod yield and its attributing traits in F_2population of the cross TMV 2× ICGV86031

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
X_1	1.000	-0.053	-0.124	0.026	0.065	-0.005	0.164	0.060	-0.066	0.004	0.040
X_2		1.000	-0.072	-0.774**	-0.754**	-0.758**	-0.052	-0.737**	0.436**	-0.788**	-0.786**
X_3			1.000	0.143	0.103	0.103	-0.116	0.154*	-0.130	0.126	0.139
X_4				1.000	0.967**	0.908**	-0.004	0.938**	-0.502**	0.945**	0.981**
X_5					1.000	0.878**	0.007	0.923**	-0.511**	0.913**	0.966**
X_6						1.000	0.052	0.888**	-0.453**	0.977**	0.927**
X_7							1.000	0.031	-0.037	0.036	0.012
X_8								1.000	-0.500**	0.948**	0.969**
X_9									1.000	-0.484**	-0.511**
X_{10}										1.000	0.975**
X_{11}											1.000

JL 42 × ICGV 9 1114: Pod yield and Kernel yield per plant was found to be having highly significant and positive association with kernel yield per plant, matured pods per plant, SCMR, sound matured kernel per plant and shelling per cent. There is high direct positive influence on the pod yield per plant by kernel yield per plant followed by matured pods per plant and SCMR. SCMR was also found to have highly positive significant association with number of branches per plant matured pods per plant, sound matured kernel, shelling percentage. Sound matured kernel via kernel yield showed high positive indirect effect on kernel yield per plant. Shelling per cent was found to have negative significant association with plant height. Similarly Oil content showed high significant negative association with pod yield per plant, matured pods per plant, sound matured kernel and shelling percent. Oil content also had negative indirect effect on pod yield per plant via kernel yield per plant (Table 3).

Table 3: Phenotypic correlation coefficients for pod yield and its attributing traits in F_2population of the cross JL 42× ICGV 91114

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
X_1	1.000	0.106	-0.004	-0.004	0.096	0.116	0.059	-0.007	0.059	-0.080	0.096
X_2		1.000	-0.003	-0.093	-0.115	-0.184*	-0.067	-0.149	0.121	-0.150*	-0.137
X_3			1.000	0.136	0.094	0.175*	-0.083	0.162**	-0.124	0.148	0.133
X_4				1.000	0.905**	0.795**	-0.189*	0.955**	-0.912**	0.886**	0.945**
X_5					1.000	0.802**	-0.202*	0.885**	-0.900**	0.895**	0.923**
X_6						1.000	-0.242**	0.835**	-0.861**	0.949**	0.899**
X_7							1.000	-0.115	0.186*	-0.238**	-0.206*
X_8								1.000	-0.901**	0.881**	0.931**
X_9									1.000	-0.950**	-0.973**
X_{10}										1.000	0.982**
X_{11}											1.000

X_1- Days to 50% flowering	X_4-Matured pods /plant	X_6-Shelling per cent	X_9-Specific leaf area(cm^2/g)
X_2- Plant height(cm)	X_5-Sound mature kernel(%)	X_7-Oil content(%)	X_{10}-Kernel Yield/plant(g)
X_3-No. of branches		X_8-SPAD chlorophyll meter reading(mg/g)	X_{11}- Pod yield/plant(g)

In the present investigation after analyzing the association of plant height with other traits, it suggests that selection can be practiced for genotypes with dwarf plant type which indirectly leads to selection of high yielding types in next generations. Matured pod per plant positive association with both pod and kernel yield per plant in F_2 generation for all the population were similar to the reports of Singh and Singh (1999) [26], Sah *et al*. (2000) [24], Nagda *et al.* (2004) [18], Trivikrama *et al.* (2017) [30] in groundnut. Individual plant selections can also be practiced for plants with higher matured pods which ultimately leads to improvement in both pod and kernel yield per plant in the later generations. These results were in confirmation with the reports of (Sharma and Varshney, 1995) [25] for pod yield per plant and kernel yield per plant; MakhanLal *et al.* (2003) [10] for number of kernels per plant; Venkataravana *et al*., (2004) [34] for number of matured pods per plant, Kalmeshwar *et al*. (2006) [9], Mane *et al*. (2008) [13] for sound matured kernel. This association indicates that these yield related parameters can be used as primilinary screening tools for selecting the high yielding genotypes in the next generation. Kernel yield per plant exhibited highly significant and positive association with shelling percent, matured pod per plant, sound matured kernel per cent and SCMR in all the population. These results were also confirmed by the reports of Roy *et al.* (2003) [12] and Suneetha *et al.* (2004) [28] for kernel yield and shelling percentage. Whereas SCMR also showed significant positive association with sound matured kernel per cent, matured pods per plant in all the population. This report suggests that SCMR can be used as in directional selection criteria for high pod yield. The reports of Nageshwar Rao *et al.* (2001) [19], Vasanthi *et al.* (2004) [31] and Talwar *et al.* (2004) [29] obtained similar trend of results in groundnut. Specific Leaf Area exhibited significant negative association with matured pods per plant, shelling per cent, and SCMR in all the population. These results were in confirmation with the reports of Wright *et al.* (1994) [35], Arjunan *et al.* (1999) [1], Reddy (2003) *et al.* [22] Thus the selection for the individual plants with low SLA will result in higher yield in groundnut for above mentioned traits.

In F_2 generation maximum direct effect on pod yield was mainly through kernel yield per plant in all the three crosses. These results are in accordance with the reports of Moinuddin (1997) [15] for pod yield; Gomes *et al.* (2005) for the kernel yield per plant in groundnut. Hence selection for kernel yield would contribute greatly towards enhancing pod yield per plant in F_2 generation. Even though matured pods per plant and sound matured kernel per cent had a very low direct effect on pod yield per plant their significant correlation with pod yield per plant was mainly due to high indirect effect via kernel yield per plant. These observations are acknowledged by the results of Gomes and Lopes (2005) for matured pods per plant on kernel yield per plant. This relationship suggests the use of these parameters contributing indirectly for selection of higher yielding genotypes in the F_2 population. Shelling per cent exhibited direct negative association with pod yield in all the three population, similar result was found with Moinuddin (1997) [15], Trivikrama *et al.* (2017) [30]. Plant height was found to have indirect negative association with pod yield via. Kernel yield per plant in the crosses TAG 24 x ICGV00350 and TMV 2 x ICGV 86031. The reports of Manoharan *et al.* (1990a) [14] also reported similar results. Whereas Shelling per cent exhibited indirect positive association via kernel yield in all the three population, these findings were in conformity with that of Abraham (1990). SCMR exhibited high indirect and positive effect on pod yield via kernel yield per plant in cross TMV 2 x ICGV 86031, but in the cross JL 42 x ICGV 91114 Specific leaf area showed high indirect and negative effect on pod yield per plant via kernel yield per plant. These results indicate that both SLA and SCMR can also be used as the indirect selection criteria for high yield in the above mentioned crosses. Maximum indirect effect for pod yield was through shelling per cent, matured pods per plant and kernel yield per plant in all the three population. Thus, in the present investigation path coefficient analysis clearly indicated that high positive direct effect through kernel yield per plant followed by matured pods per plant. The indirect effect was mainly due to sound matured kernel per cent, shelling per cent and SCMR via kernel yield per plant hence priority should be given to these traits in indirect selection for pod yield improvement. Along with this even SLA and SCMR is also contributing in an indirect way to the kernel yield so these physiological parameters can be emphasized while selecting for high yielding genotypes (Table 4, 5 & 6).

Table 4: Phenotypic path analysis indicating direct and indirect effect on pod yield in F_2population of the cross TAG 24× ICGV 00350

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	r
X_1	0.01136	-0.04932	-0.09301	0.10422	-0.00022	0.01216	-0.05181	-0.76568	-0.833**
X_2	-0.00863	0.0649	0.11348	-0.13832	0.00021	-0.01364	0.07148	0.86529	0.955**
X_3	-0.00901	0.06279	0.11729	-0.13532	0.00018	-0.01397	0.0697	0.86488	0.957**
X_4	-0.00815	0.06184	0.10934	-0.14516	0.00019	-0.01354	0.0697	0.86538	0.94**
X_5	-0.0017	0.00921	0.0146	-0.01883	0.00145	-0.00198	0.01205	0.15797	0.173*
X_6	-0.00894	0.05734	0.10609	-0.12725	0.00019	-0.01544	0.05875	0.84349	0.915**
X_7	0.00771	-0.06076	-0.10684	0.13251	-0.00023	0.01188	-0.07635	-0.79511	-0.888**
X_8	-0.00947	0.06116	0.11047	-0.1368	0.00025	-0.01418	0.06611	0.91825	0.996**

Residual effect =0.049, Note: Bold values indicates the direct effect of that character with pod yield per plant

Table 5: Phenotypic path analysis indicating direct and indirect effect on pod yield in F_2population of the cross TMV 2× ICGV 86031

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	r
X_1	**0.00597**	-0.17127	-0.20035	0.26822	-0.03867	-0.00094	-0.64773	-0.786**
X_2	-0.00462	**0.22123**	0.25705	-0.32146	0.04922	0.00109	0.77714	0.981**
X_3	-0.0045	0.21394	**0.26581**	-0.31061	0.04847	0.0011	0.75053	0.966**
X_4	-0.00452	0.20094	0.23327	**-0.35393**	0.04661	0.00098	0.80341	0.927**
X_5	-0.0044	0.20745	0.24543	-0.31426	**0.05249**	0.00108	0.77981	0.969**
X_6	0.0026	-0.11111	-0.1357	0.1604	-0.02626	**-0.00216**	-0.39771	-0.511**
X_7	-0.0047	0.20908	0.24261	-0.3458	0.04978	0.00105	**0.8223**	0.975**

Residual effect = 0.066 Note: Bold values indicates the direct effect of that character with pod yield per plant

Table 6: Phenotypic path analysis indicating direct and indirect effect on pod yield in F_2 population of the cross JL 42× ICGV 91114

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	r
X_1	0.15782	-0.01989	-0.17906	-0.00035	0.13982	0.10113	0.74652	0.945**
X_2	0.14281	-0.02198	-0.18067	-0.00037	0.12952	0.09974	0.75416	0.923**
X_3	0.12539	-0.01762	-0.22537	-0.00045	0.1222	0.09546	0.79975	0.899**
X_4	-0.02985	0.00445	0.05459	0.00185	-0.01681	-0.02065	-0.20038	-0.206*
X_5	0.15073	-0.01945	-0.18812	-0.00021	0.1464	0.09986	0.74244	0.931**
X_6	-0.14398	0.01978	0.19407	0.00034	-0.13187	-0.11086	-0.80048	-0.973**
X_7	0.13985	-0.01968	-0.21395	-0.00044	0.12902	0.10533	0.84246	0.982**

Residual effect =0.152 Note: Bold values indicates the direct effect of that character with pod yield per plant

X_1-Matured pods /plant	**X_5-SPAD chlorophyll meter reading(mg/g)**
X_2-Sound mature kernel(%)	X_6-Specific leaf area(cm2/g)
X_3-Shelling per cent	X_7 -Kernel Yield/plant(g)
X_4-Oil content(%)	r- Correlation with pod yield

References

1. Arjunan A, Manoharan V, Senthil N. Path analysis of characters contributing to drought resistance in groundnut (*Arachis hapogaea* L.). Madras Agric. J. 1999; 86: 36-39.
2. Burton GW, De Vane GM. Estimating heritability in tall Fescue (*Festuca arundinaceae*) from replicated clonal material. Agron. J. 1953; 45:478-481.
3. Chauhan RM, Shukla PT. Variability, heritability and genetic advance in bunch and spreading types of groundnut (*Arachis hypogaea* L.). Indian J Agric. Sci. 1985; 55:71-74.
4. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 1959; 51:515-518.
5. Ganeshan K, Sudhakar D. Variability studies in Spanish bunch groundnut. Madras Agric. J. 1995; 82(5):395-397.
6. Golakia PR, Makne VG, Monpara BA. Heritable variation and association in Virginia runner and Spanish bunch group of groundnut. Nat. J Plant. Imprv.2005; 7(1):50-53.
7. Gowda MVC, Prabhu TG, Bhat RS. Variability and association of late leaf spot resistance and productivity in two crosses of groundnuts. Crop Improv. 1996; 23(1):44-48.
8. Johanson HW, Robinson HF, Comstock RE. Estimates of genetic and environmental variability in soybean. Agron. J. 1955; 47:413-418.
9. Kalmeshwar GP, Kenchangoudar PV, Parmshwarappa KG, Salimath PM. A study of correlation and path analysis in groundnut. Karnataka J Agric. Sci. 2006; 19: 272-277.
10. Kandaswami M, Soundarapandian G, Kadambasavanasundaram M. Genetic variability and Genotype x Environment interaction in some quantitative characters of (*Arachis hypogaea* L.) Madras Agric. J. 1986; 73:301-307.
11. Khuram B, Naazar A, Malik SN. Estimation of variability and heritability for quantitative traits in groundnut. Sarhad. J Agric. 1998; 1998; 14:575-579.
12. Makhan Lal, Roy D, Ojha OP. Genetic variability and selection response for root and other characters in groundnut (*Arachis hypogaea* L.). Legume Res. 2003; 26(2):128-130.
13. Mane P. S, Lad DB, Jagtap PK. Correlation and path coefficient analysis in summer bunch groundnut. J Maharastra. Agri. Univ. 2008; 33(2):174-176
14. Manoharan V, Varman PV, Ramalingam RS. Character association in groundnut (*Arachis hypogaea* L.) hybrids. Madras Agric. J 1990a; 77(9-12):512-514.
15. Moinuddin HH. Evaluation of genetic variability and correlation studies in summer groundnut (*Arachis hypogea* L.) genotypes. M.Sc. (Agri.). Thesis submitted to UAS, Bengaluru, Karnataka, India, 1997; 1-47.

16. Nadaf HL, Habib AF, Goud JV. Analysis of genetic diversity in bunch groundnut. J Oil Seeds Res. 1986; 3:37-45.
17. Nadaf HL, Habib AF. Studies on genetic variability in bunch groundnut. Mysore J Agric. Sci. 1987; 21:297-301.
18. Nagda AK, Joshi VN. Correlation and path coefficient analysis in drought tolerant genotypes of groundnut (*Arachis hypogaea* L.). In Proceedings of National symposium: Enhancing production of groundnut of sustaining food and nutritional security. 2004, 51.
19. Nageshwar Rao RC, Talwar HS, Wright GC. Rapid assessment of specific leaf area and leaf nitrogen in peanut using chlorophyll meter. J Agron. Crop Sci. 2001; 186:175-182.
20. Reddi MV, Reddy KR, Reddy KHP, Rao JA. Heritability, genetic advance and character association in groundnut over three environments. J Maharashtra Agril. Univ. 1991; 16(3):383-385.
21. Reddy KR, Gupta RVS. Variability and inter relationship of yield and its component characters in groundnut. J. Maharashtra Agril. Univ. 1992; 17(2):224-226.
22. Reddy PV, Sudhakar P, Sujatha D, Babitha M, Latha P.. Transgressive segregation in groundnut. In: Proceedings of National Seminar on Physiological Interventions for Improved Crop Productivity and Quality: Opportunities and Constraints, Indian Society for Plant Physiology, New Delhi. 2003, 84.
23. Rudraswamy P, Nehru SD, Kulkarni RS, Manjunath A. Estimation of genetic variability and inbreeding depression in six crosses of groundnut *(Arachis hypogaea* L.). Mysore J Agric. Sci. 1999; 33(3):248-252.
24. Sah JN, Ramesh Kumar, Varshney SK. Correlation and path analysis in mutant cultures of groundnut. J Oilseeds Res. 2000; 17(1):23-28.
25. Sharma VK, Varshney SK. Analysis of harvest index in groundnut. J Oilseeds Res. 1995; 12(2):171-175.
26. Singh SB, Singh JP. Correlation analysis of growth and yield components in groundnut. J Maharashtra Agric. Univ. 1999; 24(1):48-49.
27. Sumathi R, Ramanathan T. Heritability estimates by parent – Offspring regression method ingroundnut. Madras Agric. J 1995b; 82(4):323-324.
28. Suneetha K, Dasaradha C, Rami Reddy, Ramana JV. Genetic variation and character association in groundnut (*Arachis hypogaea* L.). In: proceedings of National symposium on enhancing productivity for sustaining food and nutritional security, NRCG, Junagadh, 2004.
29. Suvarna SN, Kenchanagaudar PV, Talwar HS. Effect of imposed drought conditions on genetic variation and association of physiological and yield Traits in groundnut. J Oilseed Res. 2004; 21:234-239.
30. Trivikrama Reddy A, Reddi M, Sekhar A, Vijayabharathi T, Lakshmi Pathy G, Lakshmikantha Reddy *et al*. Correlation and Path Analysis of Kernel Yield and its Components in Groundnut (*Arachis hypogaea* L.). Int. J Curr. Microbiol. App. Sci. 2017; 6(12):10-16
31. Vasanthi P, Babitha M, Reddy PV, Sudhakar P, Venkateswarulu O. Combining ability for Water Use Efficiency in groundnut (*Arachis hypogaea* L.). In: proceedings of National symposium on enhancing productivity for sustaining food and nutritional security, NRCG, Junagadh, 2004.
32. Veeramani BB, Prakash M, Jagdeeshan S, Kavimani S, Saravanan K, Ganesan J *et al*. Variability studies in M_2 generation of groundnut (*Arachis hypogaea* L.). Legume Res. 2005; 28(1):68-70.
33. Venkataravana P. Variability and correlation studies in groundnut. Crop Res. 2001; 21(1):81-83.
34. Venkataravana P, Shankaranarayana V, Madhuprasad VL, Shantala J, Venugopal R. Yield component Analysis and its Implication for selection in Early Generations of Groundnut (*Arachis hypogaea* L.). In: Proceedings of National symposium on enhancing productivity for sustaining food and nutritional security, NRCG, Junagadh, 2004, 37.
35. Wright GC, Nageshwara Rao RC, Farquhar GD. Water use efficiency and carbon isotope discrimination in peanut under water deficit conditions. Crop Sci. 1994; 34:92-97.
36. Yogendra Prasad, Verma AK, Haider ZA, Jayalal Mahto. Variability studies in Spanish bunch groundnut. J Res., (BAU). 2002; 14:91-93.