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Character association and path analysis studies in groundnut (*Arachis hypogaea* L.)

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Abstract
Data was collected on Twelve characters measured on 27 progenies of three crosses and four checks (Cross 1- Phule Unnati x ICGV 15311, cross 2-Phule Unnati x ICGV 15308, cross 3-Phule Unnati x Girnar 4, checks - Phule Unnati, Girnar 4, ICGV 15311, ICGV 15308) examined the extent, character relationships and direct and indirect contributions of different components on dry pod yield and oleic acid using a randomized block design with three replications. The following metrics were noted: harvest index (dry weight basis) (%), sound mature kernel (%), oil content (%), oleic acid (%), protein content (%), number of mature pods plant-1, dry haulm yield plant-1, dry pod yield plant-1, and hundred kernel weight. Compared to their comparable estimates of phenotypic correlation coefficients, the estimates of genotypic correlation coefficients were found to be greater. Dry haulm yield per plant, sound mature kernel, number of mature pods per plant, oil content, shelling percentage, harvest index, days to 50% flowering, days to maturity, hundred kernel weight, and oleic acid (%) all significantly increased the dry pod yield per plant. Dry pod yield per plant showed significant negative correlation with protein content (%). Path coefficient analysis revealed that the number of mature pods per plant showed higher direct effect on dry pod yield per plant followed by days to maturity, oil content, sound mature kernel. Dry pod yield was negatively impacted by protein content, dry haulm yield per plant, days to 50% flowering, shelling percentage, oleic acid percentage, harvest index (dry weight basis), and 100 kernel weight.

Keywords: Groundnut (*Arachis hypogaea* L.), correlation, Path coefficient analysis, dry pod yield

Introduction
Due to their high nutritional and commercial value, groundnuts (*Arachis hypogaea* L.), sometimes known as peanuts, are a major oilseed and legume crop that is farmed worldwide. The Fabaceae or Leguminaceae family includes groundnuts. It is an allotetraploid crop that self-pollinates (Autogamous), has two genomes, A and B, each with a size of 2800 Mb, and a basic chromosome number of ten (2n = 4x = 40). Oleic acid is a monounsaturated fatty acid (MUFA) belonging to the omega-9 group, and it is a key component of Groundnut (*Arachis hypogaea* L.) oil. The proportion of oleic acid in Groundnut varies depending on genetic and environmental factors, with high-oleic varieties containing over 75% oleic acid compared to 40-50% in conventional varieties. Correlation is a biometrical approach that reveals the intensity of the association in between two pairs of characters and also provides information on those components that should be used as criteria for candidate selection in a plant breeding program. When two desirable features have a positive genetic association, it is easier for plant breeders to improve both traits at the same time. For the two attributes to improve together, even the absence of association is helpful. Conversely, when two desirable attributes have a unfavorable relationship, making a substantial improvement to both of them challenging or impossible. To ascertain the relative contribution of each variable to yield, path analysis separates the correlation coefficient into direct and indirect effects (Saeidi *et al*., 2011) [11]. The goal of this study is to use correlation and path analysis to identify the traits that have a stronger link with grain yield.

Materials and Methods
The All India Co-ordinated Research Project on Groundnut, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahilyanagar (M.S.) was the site of the field experiment associated with the current study. 27 F3 progenies of three crossings and four checks—Phule Unnati,

Girnar 4, ICGV15311, and ICGV15308—were employed as the study's material. The All India Co-ordinated Research Project on Groundnut, M.P.K.V., Rahuri, is the source of the lines. Three replications and a randomized block design were used for the experiment. A single row measuring two meters in length, with a 30-cm gap between rows and a 10-cm gap between plants, made up each plot. Plowing and two cross-harrowing operations were used to prepare the area. Each hill was seeded with a single seed spaced 30 x 10 cm^2 apart (between plants and between rows). When necessary, the standard cultural techniques of weeding, watering, and protecting plants were implemented during the growth period. Analysis of variance, a technique frequently used in randomized block designs, was used to the data gathered on individual characters (Panse and Sukhatme, 1967) [9]. Burton (1952) [1] provided the following formula, which was used to determine the genotypic and phenotypic coefficient of variation. As recommended by Dewey and Lu (1959) [3], the genotypic correlation was divided into direct and indirect effects by route analysis in order to create a cause and effect relationship.

Result and discussion

Correlation

It is statistical measure, for investigating strength (degree) and direction of interrelation among two or more variables. Correlation among characters is may due to pleiotropism possessed by genes or may due to environmental influence or developmental and physiological interrelation. Consequently, correlation coefficient analysis provides valuable information on selection strategies that combine high yield potential with desirable attributes. The number of mature pods per plant, sound mature kernel, dry haulm yield/plant (g), and dry pod yield plant-1 were all found to be positively correlated in a highly significant way. Shoba *et al*. (2013) [13], Dhakar *et al*. (2017) [4], and Dhaygude (2017) [5] all reported the same outcomes. and showed significant positive correlation with harvest index, oil content (%), shelling (%), days to 50% flowering, days to maturity, hundred kernel weight, oleic acid, at both genotypic and phenotypic level of correlation. Same findings were recorded in Gali *et al*. (2023) [6], Shankar *et al.* (2018) [12], Kamdar *et al.* (2020), Meena and Chandra (2022) [8]. While, dry pod yield per plant exhibited significant negative correlation with protein content at both genotypic and phenotypic level of correlation.

Characteristics such as the number of mature pods/plant, dry haulm yield/plant (g), sound mature kernel, shelling (%), and harvest index should therefore be prioritized when making selections for the intended increase in dry pod yield, as they demonstrated a highly significant positive correlation with dry pod yield plant-1. Same observation was noted by Patil *et al.* (2006) [10].

Path Coefficient Analysis

Understanding the direct and indirect effects of related features on the dry pod yield per plant (the dependent variable) can be accomplished effectively with path coefficient analysis. The direction and magnitude of the direct and indirect effects of several yield-contributing features on dry pod yield plants-1 were evaluated in the current study using path coefficient analysis. Any character that has a direct effect on yield provides a basic sense about the viability of selecting a specific character to boost yield. If the correlation among direct effect and a casual component is below or greater of equal magnitude, it indicates a true relationship between the traits and direct selection by those characters is desired. If the correlation coefficient is positive but the direct influence is negative or minimal, the direct casual factors will be evaluated at a very small scale for selection. Path coefficient analysis revealed that highest direct effect on dry pod yield per plant (g) was exhibited by Number of mature pods/plant (0.574), followed by days to maturity (0.529), oil content (%) (0.450), sound mature kernel (%) (0.059). The quantity of mature pods per plant, oil content, oleic acid, and sound mature kernel all had positive direct effects on the dry pod yield per plant in the current study. Same findings were recorded by Cholin *et al*. (2010) [2], Gali Suresh *et al*. (2023) [16], Korale (2017) [7], Dhaygude (2017) [5], Vadher and Kachadia (2020) [14]. Negative direct effects on dry pod yield per plant showed by days to 50% flowering, dry haulm yield/plant, hundred kernel weight (g) shelling (%) harvest index (dry wt. basis) (%), protein content. Same observations were recorded by Wadikar *et al*. (2018), Yadav *et al*. (2014) [15].

Conclusion

The differences recorded in progenies were statistically significant for all the traits studied and the estimates of genotypic coefficient of variation and phenotypic coefficient of variation recorded the good amount of variability among all progenies. The estimates of genotypic correlation coefficients were observed higher than their corresponding estimates of phenotypic correlation coefficients. The dry pod yield per plant showed significant positive correlation with dry haulm yield per plant, sound mature kernel, number of mature pods per plant, oil content, shelling percentage, harvest index, days to 50% flowering, days to maturity, hundred kernel weight, oleic acid (%). Dry pod yield per plant showed significant negative correlation with protein content (%).Path coefficient analysis revealed that the number of mature pods per plant showed higher direct effect on dry pod yield per plant followed by days to maturity, oil content, sound mature kernel, oleic acid (%). While protein content, dry haulm yield per plant, days to 50% flowering, harvest index (dry weight basis), hundred kernel weight showed negative direct effect on dry pod yield.

Table 1: Estimates of Genotypic correlation coefficient with dry pod yield, oleic acid and yield contributing twelve characters of twenty seven progenies (27 progenies + 4 checks) of F_3 generation of Groundnut

Characters	Days to 50% flowering	Days to maturity	Number of mature pods/ plants	Dry haulm yield/plant (g)	Hundred Kernel weight (g)	Shelling (%)	Harvest index (dry wt. basis) (%)	Sound mature kernel (%)	Oil content (%)	Oleic acid (%)	Protein content (%)	Genotypic correlation with Dry pod yield/ plant (g)
Days to 50% flowering	1.000	0.627**	0.540**	0.612**	-0.018	0.454**	0.396**	0.469**	0.564**	0.412**	-0.221*	0.546**
Days to maturity		1000	0.296**	0.628*	-0.033	0.456**	0.082	-0.002	0.291**	0.566**	-0.169	0.489**
Number of mature pods/ plants			1.000	0.818**	0.393*	0.672**	0.638**	0.989**	0.869**	0.068	-0.310**	0.807**
Dry haulm yield/plant (g)				1.000	0.344**	0.753**	0.638**	0.808**	0.880**	0.311**	-0.422**	0.830**
Hundred kernel weight (g)					1.000	0.587**	0.403**	0.258*	-0.086	0.588**	-0.552**	0.288**
Shelling (%)						1.000	0.658**	0.473**	0.345**	0.402**	-0.622**	0.639**
Harvest index (dry wt. basis) (%)							1.000	0.723**	0.678**	0.268**	-0.556**	0.630**
Sound mature kernel (%)								1.000	0.898*	0.014	-0.532**	0.821**
Oil content (%)									1.000	-0.055	-0.363**	0.794**
Oleic acid (%)										1.000	-0.310**	0.249*
Protein content (%)											1.000	-0.726**

Table 2: Estimates of phenotypic correlation coefficient with dry pod yield, oleic acid and yield contributing twelve characters of twenty seven progenies (27 progenies + 4 checks) of F_3 generation of Groundnut

Characters	Days to 50% flowering	Days to maturity	Number of mature pods/ plants	Dry haulm yield/plant (g)	Hundred Kernel weight (g)	Shelling (%)	Harvest index (dry wt. basis) (%)	Sound mature kernel (%)	Oil content (%)	Oleic acid (%)	Protein content (%)	Phenotypic correlation with Dry pod yield/ plant (g)
Days to 50% flowering	1.000	0.481**	0.447**	0.508**	0.046	0.290**	0.344**	0.210*	0.360**	0.379**	-0.139**	0.400**
Days to maturity		1000	0.250*	0.454**	0.125	0.359**	0.086	0.046	0.123	0.463**	-0.103	0.334**
Number of mature pods/ plants			1.000	0.716**	0.288**	0.541**	0.623**	0.687**	0.615**	0.077	-0.174	0.748**
Dry haulm yield/plant (g)				1.000	0.259*	0.578**	0.577**	0.564**	0.611**	0.292**	-0.236**	0.696**
Hundred kernel weight (g)					1.000	0.492**	0.324**	0.327**	0.095	0.405**	-0.179**	0.298**
Shelling (%)						1.000	0.550**	0.559**	0.409**	0.317**	-0.221**	0.483**
Harvest index (dry wt. basis) (%)							1.000	0.511**	0.486**	0.253*	-0.257**	0.622**
Sound mature kernel (%)								1.000	0.629**	0.039	-0.215**	0.644**
Oil content (%)									1.000	-0.016	-0.085	0.529**
Oleic acid (%)										1.000	-0.170	0.228*
Protein content (%)											1.000	-0.323**

Table 3: Direct (diagonal) and indirect (above and below diagonal) path coefficient for twelve characters of Twenty-seven progenies (27 progenies + 4 check) of F_3 generation in Groundnut

Sr. No.	**Characters**	**Days to 50% flowering**	**Days to maturity**	**Number of mature pods/plants**	**Dry haulm yield/plant (g)**	**Hundred kernel weight (g)**	**Shelling (%)**	**Harvest index (dry wt. basis) (%)**	**Sound mature kernel (%)**	**Oil content (%)**	**Oleic acid (%)**	**Protein content (%)**	**Genotypic correlation with Dry pod yield/ plant (g)**
1	Days to 50% flowering	-0.172	0.332	0.310	-0.301	0.001	-0.027	-0.006	0.027	0.254	0.007	0.122	0.546**
2	Days to maturity	-0.108	0.529	0.170	-0.308	0.002	-0.027	-0.001	-0.003	0.131	0.010	0.093	0.489**
3	Number of mature pods/ plants	-0.093	0.156	0.574	-0.402	-0.001	-0.040	-0.010	0.060	0.391	0.001	0.171	0.807**
4	Dry haulm yield/ plant (g	-0.105	0.332	0.469	-0.491	-0.001	-0.045	-0.010	0.047	0.396	0.005	0.232	0.830**
5	Hundred kernel weight (g)	0.003	-0.017	0.225	-0.169	-0.003	-0.035	-0.006	0.015	-0.038	0.011	0.304	0.288**
6	Shelling (%)	-0.078	0.241	0.386	-0.370	-0.002	-0.059	-0.011	0.027	0.155	0.007	0.342	0.639**
7	Harvest index (dry wt. basis) (%)	-0.068	0.043	0.366	-0.313	-0.001	-0.039	-0.016	0.042	0.305	0.005	0.306	0.630**
8	Sound mature kernel (%)	-0.080	-0.001	0.585	-0.397	-0.002	-0.028	-0.012	0.059	0.404	0.001	0.293	0.821**
9	Oil content (%)	-0.097	0.154	0.499	-0.433	0.001	-0.020	-0.011	0.053	0.450	-0.001	0.200	0.794**
10	Oleic acid (%)	-0.071	0.299	0.039	-0.152	-0.002	-0.024	-0.004	0.002	-0.025	0.019	0.170	0.249*
11	Protein content (%)	0.038	-0.089	-0.178	0.207	0.002	0.037	0.009	-0.031	-0.163	-0.005	-0.551	-0.726**

RESIDUAL EFFECT: 0.137 Bold features indicate direct effect

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