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

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ABSTRACT: The current study was conducted to determine correlation and direct and indirect effect by path analysis for pod yield per plant and its component by using 38 genotypes of groundnut. The significant and positive genotypic and phenotypic correlations of pod yield per plant were observed with kernel yield per plant, biological yield per plant, harvest index, number of mature pods per plant, 100-pod weight. These were the most important attributes which contributed towards higher pod yield. The phenotypic path coefficient analysis revealed that kernel yield per plant, biological yield per plant and harvest index reported high and positive direct effect on pod yield per plant. This revealed that for improvement of pod yield in groundnut, through phenotypic selection, the due weightage should be given to these three traits.

Keywords: Correlation, Path analysis, Character association.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an annual legume crop native to South America and it is allotetraploid (2n = 4x = 40) with basic chromosome number, x = 10 (Stalker, 1991). Groundnut is one of the principal oilseed crops of the world, ranking 13th among food crops. It also accounts for world's fourth largest source of edible oil and third most important source of vegetable protein. (Basu and Singh 2004). The production is largely confined to Asian and African countries. Asia accounts for about 50% of area and 60% of world production of groundnut with largest share of India (>20%) in the groundnut coverage, followed by China (>18%). However, China accounts for highest share (37%) in the total production of groundnut in the world (Balasubramanian *et al.*, 2024). Groundnut oil is considered as most stable and nutritive as it contains just the right proportion of oleic (40-50%) and linoleic acids (25-35%). It is a rich source of edible oil (44-54%) and high-quality protein (24-30%) hence, groundnut is valued both for edible oil and confectionery purposes. Different components of pod yield have varying degrees of association with pod yield as well as among themselves. The relationships among pod yield contributing characters within a single genotype are crucial for knowing how to combine them optimally. Moreover, the pod yield is affected by its various components directly and/or indirectly through other traits, creating a difficult situation for the plant breeders to select desired traits. Hence, path coefficient analysis could provide a more realistic picture of the inter-relationships, since it partitions the correlation coefficient into direct and indirect effects of independent variable on the dependent variable (Dewey and Lu 1959). Thus, path coefficient analysis and character association provide the information of yield contributing characters and the plant breeders can practice selection using this information for the isolation of superior succession from available germplasm.

MATERIAL AND METHODS

The experimental material consisted of 38 genotypes of groundnut which were received from Main Oilseed Research Station, JAU, Junagadh. These 38 genotypes were raised in a randomised block design with three replications during *Kharif* 2024 at Main Oilseed Research Station, JAU, Junagadh. Each genotype was raised in a single row with spacing of 30 cm × 45 cm. All the recommended cultural practices were adopted to raise a good crop. Five plants were selected at random from each genotype in each replication for recording observations. The Fifteen characters *viz.*, days to 50 % flowering, days to maturity, plant height, number of primary branches per plant, number of mature pods per plant, number of immature pods per plant, 100-pod weight, pod yield per plant, 100-kernel weight, kernel yield per plant, sound mature kernel, shelling out turn, biological yield per plant, harvest index and oil content were studied.

The collected data were analysed to study correlation coefficient and path analysis. Correlation coefficients measure the relationship between two or more series of variables. The genotypic correlation coefficient provides a measure of genotypic inheriant association between different characters, while phenotypic correlation includes both genotypic as well as environmental influences. The phenotypic and genotypic correlation coefficients of all the characters were worked-out as per Al-Jibouri *et al.* (1958). Path coefficient is a standardized partial regression coefficient and as such measures the direct and indirect effects of one variable upon another and permits the separation of correlation coefficient into the component of direct and indirect effects. The phenotypic path coefficient analysis was done as per the method suggested by Dewey and Lu (1959).

RESULT AND DISCUSSION

The analysis of variance for all the fifteen characters under studied is presented in Table 1. The analysis of variance revealed that mean square due to genotypes was highly significant or significant for all the characters (except number of immature pods per plant and sound mature kernel) indicating the presence of sufficient amount of genetic variability among the genotypes. The similar results were also reported by Kalyani and Sasidharan (2020); Donkor *et al.* (2022); Poojitha *et al.* (2024) in groundnut. For rational improvement of pod yield and its components, the understanding of correlation among the traits has been observed very useful. In present investigation, the correlation coefficients were estimated among 13 pair of characters to find out association of pod yield per plant and its components at genotypic (r_g) and phenotypic (r_p) levels.

Table 1: Analysis of variance (mean squares) for 15 characters in 38 genotypes of groundnut.

Source	D.f.	Mean squares for							
		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of mature pods per plant	Number of immature pods per plant	100-pod weight (g)	Pod yield per plant (g)
Replications	2	1.13	0.37	5.64	4.97**	2.11	0.55	292.75	9.57
Genotypes	37	3.84*	9.03**	90.53**	2.01**	18.25**	0.36	658.27**	19.73**
Error	74	2.14	2.58	4.12	0.77	4.48	0.23	135.90	5.15

Sources	D.f	Mean squares for						
		100-kernel weight (g)	Kernel yield per plant (g)	Sound mature kernel (%)	Shelling out turn (%)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)
Replications	2	3.12	4.66	0.97	54.97	81.11*	6.82	0.16
Genotypes	37	90.16**	10.32**	0.54	149.06**	100.97**	147.32**	8.92**
Error	74	9.73	2.23	0.53	35.68	23.81	43.27	0.37

*, ** Significant at 5 % and 1 % levels, respectively.

The data given in Table 2 revealed that in general (except in few cases) the genotypic correlation coefficients were relatively higher in magnitude than their corresponding phenotypic correlations. Similar findings have been reported by Dolma *et al.* (2010); Jonah *et al.* (2012) in groundnut. Such high amount of genotypic correlations could results due to masking or modifying effect of environments. This indicates that though there was high degree of correlation between two variables at genotypic level, its phenotypic expression was deflated by the influence of environments. It was also indicated that there was inherent relationship between pair of characters studied.

Pod yield per plant had significant and positive correlations both at genotypic and phenotypic levels with kernel yield per plant, biological yield per plant, harvest index, 100-pod weight, number of mature pods per plant. Similar result has also been reported for pod yield per plant with kernel yield per plant and harvest index by Kumar and Shekhar (2016); Reddy *et al.* (2017); biological yield per plant by Gupta *et al.* (2015b) and Dhakar *et al.* (2017); number of mature pods per plant by Suneetha *et al.* (2004); Patil *et al.* (2006); Trivikrama *et al.* (2017); Chandrashekhara *et al*. (2020); Killada *et al*. (2023). Likewise, 100-kernel weight had significant and positive correlation with pod yield per plant at genotypic level only and was supported by Babariya and Dhobariya (2012).

Among the component traits, days to 50 % flowering had significant and positive correlation at genotypic level with number of mature pods per plant and shelling out turn. Number of primary branches per plant had significant and positive correlation at both genotypic and phenotypic levels with biological yield per plant. Number of mature pods per plant had highly significant and positive correlation at both genotypic and phenotypic levels with kernel yield per plant, Similarly, significant and positive correlation only at genotypic level was observed with shelling out turn and harvest index. 100-pod weight had highly significant and positive correlation at both genotypic and phenotypic levels with 100-kernel weight. Kernel yield per plant had significant and positive correlation at genotypic level with 100-pod weight. 100-kernel weight had significant and positive correlation at genotypic level with kernel yield per plant. Kernel yield per plant had highly significant and positive correlation at both genotypic and phenotypic levels with biological yield per plant. Harvest index and shelling out turn both had significant and positive correlation at both the levels with kernel yield per plant. The present results on correlation coefficient revealed that kernel yield per plant, biological yield per plant, harvest index, number of mature pods per plant and 100-pod weight were the most important yield attributes and may contribute considerably toward higher pod yield in groundnut. The interrelationship among yield components would help in increasing the pod yield potential and therefore, more emphasis should be given to these components while selecting better genotypes in groundnut.

Table 2: Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 13 characters in groundnut.

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of mature pods per plant	100-pod weight	100-kernel weight	Kernel yield per plant (g)	Shelling out turn (%)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Pod yield per plant (g)
Days to 50% flowering	r_g	1.0000	-0.1260	-0.1214	-0.0167	0.3744*	-0.2348	-0.0636	0.2164	0.3519*	0.2904	-0.2680	0.0267	0.0491
	r_p	1.0000	-0.0568	-0.0616	0.0039	0.1979	-0.1300	-0.0535	0.1367	0.2121	0.2371	-0.2253	0.0186	0.0310
Days to maturity	r_g		1.0000	-0.0363	0.0865	0.0607	-0.2378	-0.3416*	-0.2970	-0.2902	0.1390	-0.2770	0.2541	-0.1110
	r_p		1.0000	-0.0550	-0.0252	0.0189	-0.1979	-0.2749	-0.2434	-0.2302	0.0626	-0.1619	0.1796	-0.0987
Plant height (cm)	r_g			1.0000	-0.0817	0.3074	-0.0629	-0.0496	0.2240	0.1763	0.2537	-0.1048	-0.3926*	0.1801
	r_p			1.0000	-0.0389	0.2778	-0.0229	-0.0368	0.2080	0.1362	0.2344	-0.0842	-0.3710*	0.1733
Number of primary branches per plant	r_g				1.0000	-0.2292	-0.0204	0.1763	0.1054	-0.0728	0.5606**	-0.4452**	0.3354*	0.1116
	r_p				1.0000	-0.0922	0.0716	0.1585	0.1120	-0.0617	0.3752*	-0.2047	0.2421	0.1346
Number of mature pods per plant	r_g					1.0000	-0.4814**	-0.3621*	0.5561**	0.3823*	0.1556	0.3430*	0.0857	0.4108*
	r_p					1.0000	-0.3526*	-0.2870	0.5125**	0.2763	0.2262	0.2358	0.0652	0.3997*
100-pod weight (g)	r_g						1.0000	0.8612**	0.3563*	-0.1686	0.3107	0.2017	0.1202	0.4510**
	r_p						1.0000	0.7476**	0.3068	-0.1497	0.2516	0.1826	0.0866	0.3863*
100-kernel weight (g)	r_g							1.0000	0.3373*	0	0.2322	0.1482	0.0763	0.3322*
	r_p							1.0000	0.3202	0.0048	0.1860	0.1708	0.0627	0.3082
Kernel yield per plant (g)	r_g								1.0000	0.4105*	0.4998**	0.4169*	0.1712	0.8146**
	r_p								1.0000	0.3610*	0.4911**	0.4174*	0.1511	0.8208**
Shelling out turn (%)	r_g									1.0000	-0.0966	-0.0968	-0.0238	-0.1894
	r_p									1.0000	-0.1351	-0.0902	-0.0266	-0.2258
Biological yield per plant (g)	r_g										1.0000	-0.3877*	0.2517	0.6172**
	r_p										1.0000	-0.3976*	0.2390	0.6038**
Harvest index (%)	r_g											1.0000	-0.0569	0.4838**
	r_p											1.0000	-0.0647	0.4806**
Oil content (%)	r_g												1.0000	0.1743
	r_p												1.0000	0.1540

*, ** Significant at 5% and 1% levels, respectively

In the selection programme, when less number of variable are considered, correlation study alone can serve the purpose. However, when variables increase, the situation becomes more and more complex. For overcoming this complexity, path analysis (Wright, 1921; Dewey and Lu 1959) method was adopted to partition the total correlation coefficient into direct and indirect effects, so that relative merit of each trait is established and their number is reduced in selection programmes. The results of genotypic and phenotypic path coefficient analysis is presented in Table 3 and Fig. 1.

Number of mature pods per plant, 100-pod weight had significant, high and positive phenotypic correlation with pod yield per plant but its direct effect was negative and negligible. Number of mature pods per plant exhibited high and positive indirect effect *via* kernel yield per plant. 100-pod weight exhibited low and positive indirect effect *via* kernel yield per plant. Kernel yield per plant, biological yield per plant and harvest index had highly significant, high and positive phenotypic correlation with pod yield per plant and its direct effect was positive and high. Kernel yield per plant exhibited low and positive indirect effect *via* biological yield per plant and harvest index. Biological yield per plant exhibited high and positive indirect effect *via* kernel yield. Harvest index exhibited moderate and positive indirect effect *via* kernel yield per plant.

Table 3: Phenotypic path coefficient analysis showng direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in groundnut.

Characters	Days to 50% flowering (2)	Days to maturity (3)	Plant height (cm) (4)	Number of primary branches per plant (5)	Number of mature pods per plant (6)	100-pod weight (g) (7)	100-kernel weight (g) (8)	Kernel yield per plant (g) (9)	Shelling out turn (%) (10)	Biological yield per plant (g) (11)	Harvest index (%) (12)	Oil content (%) (13)	Correlation with Pod yield per plant
Days to 50% flowering	**0.0112**	0.0003	-0.0021	-0.0001	-0.0023	0.0030	0.0002	0.0867	-0.0810	0.0919	-0.0768	0.0001	0.0310
Days to maturity	-0.0006	**-0.0055**	-0.0019	0.0009	-0.0002	0.0046	0.0010	-0.1543	0.0880	0.0243	-0.0552	0.0004	-0.0987
Plant height (cm)	-0.0007	0.0003	**0.0337**	0.0013	-0.0032	0.0005	0.0001	0.1319	-0.0520	0.0908	-0.0287	-0.0007	0.1733
Number of primary branches per plant	0.0000	0.0001	-0.0013	**-0.0338**	0.0011	-0.0016	-0.0006	0.0710	0.0236	0.1453	-0.0697	0.0005	0.1346
Number of mature pods per plant	0.0022	-0.0001	0.0094	0.0031	**-0.0116**	0.0081	0.0011	0.3249	-0.1056	0.0876	0.0804	0.0001	0.3997*
100-pod weight (g)	-0.0015	0.0011	-0.0008	-0.0024	0.0041	**-0.0230**	-0.0028	0.1946	0.0572	0.0975	0.0622	0.0002	0.3863*
100-kernel weight (g)	-0.0006	0.0015	-0.0012	-0.0054	0.0033	-0.0172	**-0.0038**	0.2030	-0.0018	0.0720	0.0582	0.0001	0.3082
Kernel yield per plant (g)	0.0015	0.0013	0.0070	-0.0038	-0.0059	-0.0071	-0.0012	**0.6341**	-0.1379	0.1902	0.1422	0.0003	0.8208**
Shelling out turn (%)	0.0024	0.0013	0.0046	0.0021	-0.0032	0.0034	0.0000	0.2289	**-0.3821**	-0.0523	-0.0307	-0.0001	-0.2258
Biological yield per plant(g)	0.0027	-0.0003	0.0079	-0.0127	-0.0026	-0.0058	-0.0007	0.3114	0.0516	**0.3874**	-0.1355	0.0005	0.6038**
Harvest index (%)	-0.0025	0.0009	-0.0028	0.0069	-0.0027	-0.0042	-0.0006	0.2646	0.0345	-0.1540	**0.3407**	-0.0001	0.4806**
Oil content (%)	0.0002	-0.0010	-0.0125	-0.0082	-0.0008	-0.0020	-0.0002	0.0958	0.0102	0.0926	-0.0220	**0.0020**	0.1540

*, ** Significant at 5% and 1% levels, respectively
Residual effect = 0.0887

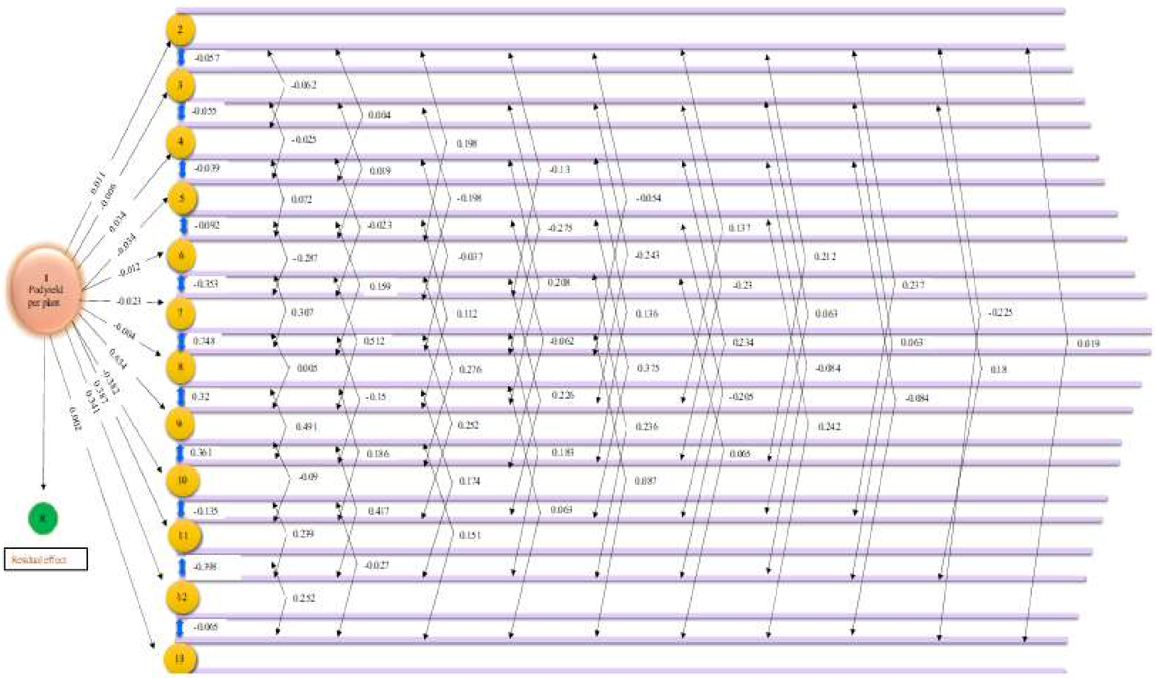

Fig. 1. Phenotypic path coefficient analysis for 13 characters in groundnut.

In addition to this, the path analysis revealed that the characters like kernel yield per plant, biological yield per plant harvest index exhibited positive direct effects of higher magnitude on pod yield per plant and direct selection of three traits leads to increase in pod yield. These similar results also supported by findings of Awatade *et al.* (2009); Babariya and Dobariya (2012); Dandu *et al.* (2012); Kahate *et al.* (2014); Gupta *et al.* (2015 b); Patel *et al.* (2021) for kernel yield per plant and Awatade *et al.* (2009); Babariya and Dobariya (2012); Dandu *et al.* (2012), for biological yield per plant. Khaniya *et al.* (2023) reported positive direct effects of higher magnitude of harvest index on pod yield per plant. Thus, these characters turned out to be the major components of pod yield and direct selection of three traits leads to increase in pod yield in groundnut.

In the present study phenotypic path coefficient analysis revealed that the residual effect was 0.0887 which suggested that the residual effect of low magnitude indicated that majority of the yield attributes have been included in the study of path coefficient analysis. It was apparent that higher direct effect was exerted by harvest index and biological yield per plant. Both of these traits also exhibited significant and positive association with pod yield per plant and hence, these both traits may be considered as most important yield contributing characters and due emphasis should be placed on these components while breeding for high pod yield in groundnut. It is also concluded that the characters which are most important for correlation studies are also important for path coefficient analysis. Thus, it could be suggested that correlation and path analysis study should be considered together for rapid gain for final improvement in pod yield of groundnut.

CONCLUSIONS

Correlation analysis revealed that significant and positive genotypic and phenotypic correlations of pod yield per plant were observed with kernel yield per plant, biological yield per plant, harvest index, number of mature pods per plant, 100-pod weight. These were the most important attributes which contributed towards higher pod yield. Significant and positive correlation was also recorded among pair of traits *viz*., number of primary branches per plant with biological yield per plant; number of mature pods per plant with kernel yield per plant; 100-pod weight with 100-kernel weight; kernel yield per plant with shelling out turn, biological yield per plant and harvest index at both genotypic and phenotypic levels. The phenotypic path coefficient analysis revealed that kernel yield per plant, biological yield per plant and harvest index reported high and positive direct effect on pod yield per plant. This revealed that for improvement of pod yield in groundnut, through phenotypic selection, the due weightage should be given to these three traits.

FUTURE SCOPE

The characters like kernel yield per plant, biological yield per plant, harvest index, number of mature pods per plant, 100-pod weight contribute toward increasing the yield in groundnut.

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