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CORRELATION AND PATH COEFFICIENT ANALYSIS IN SPANISH BUNCH GROUNDNUT (*ARACHIS HYPOGAEA* L.)

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ABSTRACT

Groundnut (*Arachis hypogaea* L.), commonly known as peanut, is one of the world's most important legume crops. It is an important source of vegetable oil as well as vitamins and minerals, such as phosphorus (P), calcium (Ca), magnesium (Mg) and potassium (K). Analyzing the association between yield and its component traits, along with conducting path analysis to measure the direct and indirect contributions of various independent traits to a dependent trait, is essential for breeders, as it forms the foundation for the selection. Based on this, an experiment involving 50 genotypes of Spanish bunch groundnut was conducted to study correlation and path coefficient analysis using a randomized block design with three replications at the Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, during *Kharif* 2023. Correlation coefficient analysis revealed that pod yield per plant showed highly significant and positive correlations at both genotypic and phenotypic levels with the number of mature pods per plant, kernel yield per plant, biological yield per plant, and harvest index. The interrelationship among these yield components can help in increasing the yield efficiency of groundnut. The path coefficient analysis revealed that the kernel yield per plant showed a very high and positive direct effect on pod yield per plant, followed by biological yield per plant and harvest index. These characters also exhibited highly significant and positive associations with pod yield per plant. Therefore, they may be considered the most important yield-contributing characters, and significant emphasis should be placed on them when selecting high-yielding groundnut varieties.

Key words : Correlation, Groundnut, Path coefficient analysis.

Introduction

Groundnut (*Arachis hypogaea* L.), commonly known as peanut, is the most important legume crop recognized for its significant nutritional and economic contributions. The name 'Groundnut' (*Arachis hypogaea* L.) originates from the Greek words '*Arachis*,' meaning 'legume,' and '*hypogaea*,' meaning 'below the earth,' reflecting its growth habit. It is a self-pollinated, tetraploid crop with a chromosome number of 2n = 40. Groundnut is characterized by cleistogamy, making it highly self-pollinated in nature (Knauft and Wynne, 1995). Groundnut is grown in a wide range of climates worldwide, particularly in tropical and subtropical regions, as it plays a vital role in sustaining the livelihoods of millions of farmers.

Groundnut is consumed directly as food or snacks, while it is also an important source of vegetable oil. The oil content of the groundnut kernel varies from 44 to 54 percent, depending on the varieties and agronomic conditions. Groundnut is a good source of minerals, such as phosphorus (P), calcium (Ca), magnesium (Mg) and potassium (K), as well as vitamins A, B and B_2. Groundnut holds a distinct position among the oilseeds, as it can be consumed and utilized in diverse ways. Compared to dry fruits, groundnut's chemical composition stands out for its exceptional nutritional value. Some nutrients, such as protein and thiamine, are available in higher quantities in groundnuts than in any other dry fruits. Groundnut oil is considered stable and nutritive, as it contains the right proportions of oleic (40-50%) and linoleic

(25-35%) acids. It is a rich source of edible oil (47-54%) and high-quality protein (24-30%); therefore, groundnut is valued for both edible oil and confectionery purposes. Additionally, its unique ability to fix atmospheric nitrogen enriches soil fertility, making it an important component of sustainable agricultural systems.

The knowledge of the association between yield and its component characters is of immense value for breeders because it forms the basis for selection. It is a well-known phenomenon that different components of yield very often exhibit a considerable degree of association in both positive and negative directions among themselves and with yield as well. The concept of correlation in the context of agricultural research and experimental design was significantly developed and popularized by Fisher (1918). The correlation coefficient reveals the type, nature, and magnitude of the relationship between any pair of characters. A positive correlation between desirable characters is favorable for plant breeders because it facilitates the simultaneous improvement of both characters. A negative correlation, on the other hand, will hinder the simultaneous expression of both characters with high values. In such cases, some economic compromise has to be made.

Path coefficient analysis, a statistical method introduced by Wright (1921), helps in the partitioning of the correlation coefficients into direct and indirect effects of the independent variable on the dependent variable. Correlation coefficients alone do not provide a complete picture of the causal basis of the association. Path coefficient analysis of different components of yield highlights the relative importance of their direct and indirect effects and gives a clear understanding of their association with yield.

Materials and Methods

The experimental material consisted of 50 genotypes of Spanish bunch groundnut (*Arachis hypogaea* L.). The experiment was conducted using a randomized block design with three replications at the Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, during the *Kharif* 2023. Each genotype was planted in a single row, 3.00 m long, with a spacing of 45 × 10 cm.

The observations were recorded on five randomly selected plants per entry and replication, with their mean values used for statistical analysis. However, data for days to 50% flowering, days to maturity, 100-kernel weight, and oil content were collected on a plot basis. The characters studied were days to 50% flowering, plant height (cm), number of primary branches per plant, days to maturity, number of immature pods per plant, number of mature pods per plant, pod yield per plant (g), kernel yield per plant (g), 100-kernel weight (g), biological yield per plant (g), shelling out-turn (%), harvest index (%), and oil content (%). The phenotypic and genotypic correlation coefficients for all the traits were analyzed as per the method suggested by Al-Jibouri *et al.* (1958). Path coefficient analysis was performed using the method suggested by Dewey and Lu (1959).

Results and Discussion

The study of correlation provides insight into the strength and nature of the relationships between different variables. Understanding these relationships, particularly among yield-contributing characters and their association with pod yield, is crucial for implementing selection strategies aimed at enhancing the genetic potential for pod yield. In the present study, pod yield per plant exhibited a highly significant and positive correlation with the number of mature pods per plant, kernel yield per plant, biological yield per plant, and harvest index at both genotypic and phenotypic levels (Table 1). Similar interrelationships between pod yield and these traits have been reported in groundnuts by several researchers. Highly significant and positive correlations at both genotypic and phenotypic levels have been reported between pod yield per plant and number of mature pods per plant by Bhargavi *et al.* (2015); between pod yield per plant and kernel yield per plant by Wadikar *et al.* (2018); between pod yield per plant and biological yield per plant by Tulsi *et al.* (2017); and between pod yield per plant and harvest index by Reddy *et al*. (2023). Thus, based on these results, the number of mature pods per plant, kernel yield per plant, biological yield per plant, and harvest index have been identified as key traits influencing pod yield in groundnuts and should be prioritized in selection to achieve higher pod yield.

In the present study, days to 50% flowering exhibited highly significant and positive correlations at both genotypic and phenotypic levels with days to maturity and biological yield per plant, suggesting that selection for early flowering is likely to result in early maturity and higher biological yield. Similar results were reported for days to maturity by Hampannavar *et al.* (2018). The plant height showed a highly significant and negative correlation with 100-kernel weight at both genotypic and phenotypic levels, while it exhibited a highly significant and negative correlation with harvest index at the genotypic level and a non-significant and negative correlation at the phenotypic level. The number of primary branches per plant showed a highly significant and positive correlation

Table 1 : Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 13 characters in groundnut

Characters	Corr.	Days to 50 % flowering	Plant height	Number of primary branches per plant	Days to maturity	Number of immature pods per plant	Number of mature pods per plant	Kernel yield per plant	100-kernel weight	Biological yield per plant	Shelling out-turn	Harvest index	Oil content
Pod yield per plant	r_g	0.0596	-0.1352	0.2649	0.0040	0.2634	0.9539**	0.9496**	0.4130**	0.4959**	-0.2584	0.4877**	0.3243*
	r_p	0.0316	-0.0965	0.1364	0.0350	0.2260	0.9332**	0.9458**	0.3555*	0.5073**	-0.0957	0.4890**	0.2441
Days to 50% flowering	r_g	**1.0000**	-0.2138	0.3570*	0.7696**	0.0683	0.0373	-0.0725	-0.0812	0.4478**	-0.3886**	-0.3853**	-0.1355
	r_p	**1.0000**	-0.1346	0.2433	0.6656**	0.0595	0.0190	-0.0809	-0.0605	0.3615**	-0.3370*	-0.3180*	-0.1136
Plant height	r_g		**1.0000**	0.0304	-0.2332	-0.1292	-0.0823	-0.2106	-0.5617**	0.2272	-0.1966	-0.3830**	0.2699
	r_p		**1.0000**	0.0451	-0.1464	-0.0775	-0.0440	-0.1211	-0.3711**	0.1105	-0.0794	-0.2147	0.1498
Number of primary branches per plant	r_g			**1.0000**	0.3650**	-0.5266**	0.3258*	0.1469	-0.0135	0.5473**	-0.2858*	-0.3018*	0.1128
	r_p			**1.0000**	0.2729	-0.3387*	0.2109	0.0551	-0.0368	0.3902**	-0.2160	-0.2700	0.0494
Days to maturity	r_g				**1.0000**	0.0540	0.0034	-0.0700	-0.0120	0.2214	-0.2124	-0.1979	-0.1029
	r_p				**1.0000**	0.0423	0.0171	-0.0322	0.0124	0.2127	-0.1659	-0.1625	-0.0774
Number of immature pods per plant	r_g					**1.0000**	0.1740	0.2319	0.1426	-0.1202	-0.1286	0.3968**	0.0081
	r_p					**1.0000**	0.1634	0.2013	0.1153	-0.0928	-0.0687	0.3328*	0.0048
Number of mature pods per plant	r_g						**1.0000**	0.9540**	0.3059*	0.5469**	-0.0499	0.3887**	0.2494
	r_p						**1.0000**	0.9213**	0.2676	0.5362**	0.0338	0.3949*	0.2033
Kernel yield per plant	r_g							**1.0000**	0.3609*	0.3968**	0.0713	0.5373**	0.2143
	r_p							**1.0000**	0.3028*	0.4170**	0.2196	0.5255**	0.1542
100-kernel weight	r_g								**1.0000**	0.1750	-0.1076	0.2537	-0.0506
	r_p								**1.0000**	0.1563	-0.0928	0.2210	-0.0209
Biological yield per plant	r_g									**1.0000**	-0.3881**	-0.5163**	-0.0015
	r_p									**1.0000**	-0.2328	-0.4980**	-0.0241
Shelling out-turn	r_g										**1.0000**	0.1323	-0.2556
	r_p										**1.0000**	0.1361	-0.2017
Harvest index	r_g											**1.0000**	0.3302
	r_p											**1.0000**	0.2787
Oil content	r_g												**1.0000**
	r_p												**1.0000**

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

Table 2 : Phenotypic path coefficient analysis showing direct (diagonal) and indirect effects of different characters on pod yield per plant in groundnut.

Characters	Days to 50% flowering	Plant height	Number of primary branches per plant	Days to maturity	Number of immature pods per plant	Number of mature pods per plant	Kernel yield per plant	100-kernel weight	Biological yield per plant	Shelling out-turn	Harvest index	Oil content	Phenotypic correlation with pod yield per plant
Days to 50% flowering	**-0.0057**	-0.0002	0.0024	0.0030	0.0001	0.0005	-0.0482	-0.0004	0.1411	0.0621	-0.1217	-0.0014	0.0316
Plant height	0.0008	**0.0012**	0.0005	-0.0006	-0.0001	-0.0011	-0.0721	-0.0025	0.0431	0.0146	-0.0821	0.0018	-0.0965
Number of primary branches per plant	-0.0014	0.0001	**0.0100**	0.0012	-0.0004	0.0051	0.0328	-0.0002	0.1523	0.0398	-0.1033	0.0006	0.1364
Days to maturity	-0.0038	-0.0002	0.0027	**0.0044**	0.0001	0.0004	-0.0192	0.0001	0.0830	0.0306	-0.0622	-0.0009	0.0350
Number of immature pods per plant	-0.0003	-0.0001	-0.0034	0.0002	**0.0013**	0.0040	0.1199	0.0008	-0.0362	0.0127	0.1273	0.0001	0.2260
Number of mature pods per plant	-0.0001	-0.0001	0.0021	0.0001	0.0002	**0.0242**	0.5486	0.0018	0.2092	-0.0062	0.1511	0.0025	0.9332**
Kernel yield per plant	0.0005	-0.0001	0.0005	-0.0001	0.0003	0.0223	**0.5954**	0.0020	0.1627	-0.0405	0.2010	0.0019	0.9458**
100-kernel weight	0.0003	-0.0004	-0.0004	0.0001	0.0001	0.0065	0.1803	**0.0066**	0.0610	0.0171	0.0845	-0.0003	0.3555*
Biological yield per plant	-0.0021	0.0001	0.0039	0.0009	-0.0001	0.0130	0.2483	0.0010	**0.3902**	0.0429	-0.1905	-0.0003	0.5073**
Shelling out-turn	0.0019	-0.0001	-0.0022	-0.0007	-0.0001	0.0008	0.1308	-0.0006	-0.0908	**-0.1844**	0.0520	-0.0024	-0.0957
Harvest index	0.0018	-0.0003	-0.0027	-0.0007	0.0004	0.0095	0.3129	0.0015	-0.1943	-0.0251	**0.3825**	0.0034	0.4890**
Oil content	0.0007	0.0002	0.0005	-0.0003	0.0000	0.0049	0.0918	-0.0001	-0.0094	0.0372	0.1066	**0.0121**	0.2441

*, ** Significant at 5% and 1% levels, respectively. Residual effect, R = 0.0694

with biological yield per plant, suggesting that selection for a higher number of primary branches may result in a higher biological yield per plant. Similar results were reported by Tulsi *et al.* (2017). The days to maturity exhibited positive and significant correlations with the number of immature pods per plant, the number of mature pods per plant, and biological yield per plant at both genotypic and phenotypic levels. Similar results were also observed by Babariya and Dobariya (2012) for biological yield per plant. The number of immature pods per plant exhibited a highly significant and positive correlation with the harvest index at the genotypic level but showed a significant and positive correlation at the phenotypic level. It also showed positive and significant correlations at both genotypic and phenotypic levels with the number of mature pods per plant, kernel yield per plant, 100-kernel weight, and oil content. The number of mature pods per plant exhibited highly significant and positive correlations with kernel yield per plant and biological yield per plant. This indicated that selection for an increased number of mature pods per plant may lead to higher kernel yield per plant and biological yield per plant, thus contributing to an overall increase in pod yield per plant. Similar results were also observed by Tulsi *et al.* (2017) for biological yield per plant. Kernel yield per plant revealed highly significant and positive correlations with biological yield per plant and harvest index. This suggests that selection for higher kernel yield may result in a higher biological yield per plant and harvest index. Similar findings were reported by Gupta *et al.* (2015) as well. The 100-kernel weight exhibited non-significant but positive correlations with biological yield per plant and harvest index at both genotypic and phenotypic levels. The biological yield per plant showed a highly significant and negative correlation with the harvest index, suggesting that an increase in biological yield per plant may result in a reduced harvest index in groundnut. Similar results were obtained by Babariya and Dobariya (2012).

Path analysis provides information about the causes and effects of situations in understanding the association between two variables. Pod yield is influenced by various components directly as well as indirectly *via* other traits, which creates a complex situation for a breeder to make a selection. Therefore, path coefficient analysis could provide a more realistic picture of the interrelationship, as it considers the direct as well as indirect effects of the variables by partitioning the correlation coefficient. In the present study, the path coefficient analysis revealed that the kernel yield per plant, followed by biological yield per plant and harvest index showed a very high and positive direct effect on pod yield per plant (Table 2). These traits also showed positive and highly significant correlations with pod yield per plant. Therefore, these traits have emerged as the primary factors influencing pod yield, and direct selection for them would be highly beneficial for improving yield. Similar results were obtained by Bhargavi *et al.* (2015), Tulsi *et al.* (2017), and Deepa *et al.* (2022) for kernel yield per plant; Babariya and Dobariya (2012), Hampannavar *et al.* (2018), and Yadav *et al.* (2023) for biological yield per plant; and Reddy *et al.* (2023) for harvest index.

In the present study, the characters such as plant height, number of primary branches per plant, days to maturity, number of immature pods per plant, number of mature pods per plant, 100-kernel weight, and oil content showed negligible but positive direct effects on pod yield per plant. Therefore, these characters are also considered very important yield-contributing characters for selection. Days to 50% flowering showed negative and negligible direct effects of pod yield per plant, while shelling out-turn showed negative and low direct effects of pod yield per plant. An important consideration for formulating the path diagram is that all the important causal factors affecting the pod yield per plant are included. Since yield is a very complex character affected by so many factors, it might not be feasible to include all the characters. Under these circumstances, provision is made for a residual path that would take care of all such factors that were excluded from the study. In the present study, the residual effect was 0.0694, suggesting that there may be a few additional, but relatively minor, component traits responsible for influencing pod yield per plant beyond those studied.

Conclusion

The findings from the correlation analysis revealed that the number of mature pods per plant, kernel yield per plant, biological yield per plant and harvest index are the most important attributes and may significantly contribute to increased pod yield in groundnuts. The interrelationships among these yield components offer valuable insights for improving overall yield efficiency. Therefore, these traits should be prioritized when selecting superior groundnut varieties. Path analysis further revealed that the maximum direct effects were exerted by kernel yield per plant, biological yield per plant, and harvest index. These characters also exhibited highly significant and positive associations with pod yield per plant. Therefore, they may be considered the most important yield-contributing characters and significant emphasis should be placed on them when selecting high-yielding groundnut varieties.

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