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CORRELATIONS AND PATH COEFFICIENTS ANALYSIS BETWEEN POD YIELD AND SOME QUANTITATIVE PARAMETERS IN GROUND NUTS (*ARACHIS HYPOGAEA* L.)

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Abstract
The analysis of the association between pod yield and quantitative characters in ground - nut (*Arachis hypogaea* L.) revealed a positive and significant association. Partitioning the total yield contributions into individual and combined effect showed that total dry matter made the highest individual contribution to pod yield. The combination of total dry matter and haulm yield had the highest combined effect but when the contribution was converted into percentage, the duo of haulm yield and total dry matter made the highest combined or indirect percentage contribution to pod yield.

KEYWORDS: Correlations, path coefficient, pod yield, quantitative parameter and ground nuts.

INTRODUCTION

With the release of new high yielding varieties of groundnut (*Arachis hypogaea* L.) by the Institute of Agricultural Research,(IAR) Ahmadu Bello University Zaria, the crop is poised to make a come back to its former role as a foreign exchange earner for Nigeria. However research is ongoing as to which traits contribute to high yield in different ecologies and cropping systems. The production of groundnuts during the dry season is still an uncommon practice amongst the indigenous farmers, however its cultivation under irrigation has been found to be feasible as the practice is common in other countries in Africa.

Yield is determined by many related traits. It is a sum total of the contributions made by different yield contributing traits. Thus for effective yield improvement, a knowledge of these traits is very important in selection and improvement of crops. Therefore, it is important to understand the relationships between yield and component characters associated with it. Correlation analysis measures the mutual association between a pair of variables independent of other variables under consideration. Owen and Jones (1977). However, correlation analysis in itself does not provide a true knowledge of the amount of contribution made by each of the yield attributes (Ojomo, 1977; Fakorede and Opeke, 1985). Path analysis, a statistical technique that partitions correlations into direct and indirect effects, differentiates between correlation and causation. Afifi and Clark (1984), Wright (1934). This technique is independent of units of measurement, the relative importance between causal relationships may be determined. Li (1975); Loehlin (1987); Pantone *et al*., (1989).

Kaliaperunal and Sundaraj (1994) defined path correlation analysis as a device in which a total (Simple) correlation coefficient is partitioned into its linearly related variables as a direct contribution of a given variable and indirect contributions of other parameter(s) involved. Path analysis has been used is many field of study among which is in agronomic studies to study the factor affecting plant yield Garcia del Moral *et al*.,(1991); Gravois and Helms, (1992); Pantone *et al*.,(1992) and Puri *et al*., (1982).

Li (1968) defined path coefficient (P_i) as the direct path of independent factor (x_i) to the dependent factor (y), as the ratio of standard deviation of xi to the standard deviation of y when other exogenous variables are held constant. Invariably, estimation of the path coefficients enable the user to assess both the direct and indirect effect that one variable has on another. Therefore partitioning correlations into direct and indirect effects by path coefficient analysis may augment information derived from the correlation coefficients.

The objective of this study was therefore, to determine the magnitude and nature of relationship between pod yield and some characters, which are essential for the improvement of pod yield of ground nuts.

MATERIALS AND METHODS

Three varieties of groundnut, sourced from the Institute for Agricultural Research, Ahmadu Bello University Zaria were used for the study. The groundnut varieties were grown in an experiment conducted during the dry seasons of 2003/2004, 2004/2005 and 2005/2006 under field conditions at the Irrigation Research Station Kadawa IAR Substation under irrigation. The experimental design was a split plot design with population and variety serving as the main plots and basin size serving as the subplots. The treatments which consisted of three groundnut varieties (Samnut 23, Samnut 21 and Samnut 11), three plant population densities (50,000,100,000 and 200,000 plants ha^{-1}) and three basin sizes (3mx3m, 3mx4m and 3mx5m) were replicated three times. Single super phosphate at the rate of 125kg ha^{-1} and Igram combi at the rate of 1litre ha^{-1} were applied at planting. All other production and pest management practices (where necessary) other than the plant population and basin sizes were held constant over the entire experimental area and were based on the

Institute for Agricultural Research (IAR) Extension services recommendations. Harvesting was done when the pods reached maturity. Browning of the leaves and the inner ribs of groundnut pods indicates maturity. Data was collected on pod yield, number of mature pods, number of pods plant $^{-1}$, pod yield plant^{-1}, seed plant^{-1}, haulm plant^{-1}, one hundred seed weight, total dry matter and shelling percentage.

Simple correlation coefficients were calculated for each pairs of the parameters using the formula by Steel and Torrie (1984).

$r = SP_X / \sqrt{SS_X SS_Y}$

r = Correlation coefficient between X and Y.

SP_X = Sums of product

SS_X = Sums of square

X = Independent variable

Y = Dependent variable

Besides the direct effect of the exogenous (X_1) on the endogenous (Y), there is indirect effect of X on Y via other x's by virtue of its relationship with others. A change in a variable, say X_1, will affect its linear correlation r_{12}, with another variable, X_2, which invariable affects Y.

Let P_i be the direct effect of Xi on Y, and change is only partial and proportional to r_{12}. That is, $r_{ij} P_j$ is an indirect effect of X_i via X_j.

Hence,

The direct and indirect effect could be partitioned as done by Dewey and Lu (1959) for a 8-independent variable,

$r_{1y} = P_1 + r_{12} P_2 + r_{13} P_3 + r_{14} P_4 + r_{15} P_5 + r_{16} P_6 + r_{17} P_7 + r_{18} P_8$ (1)

$r_{2y} = r_{12} P_1 + P_2 + r_{23} P_3 + r_{24} P_4 + r_{25} P_5 + r_{26} P_6 + r_{27} P_7 + r_{28} P_8$ (2)

$r_{3y} = r_{13} P_1 + r_{23} P_2 + P_3 + r_{34} P_4 + r_{35} P_5 + r_{36} P_6 + r_{37} P_7 + r_{38} P_8$ (3)

$r_{4y} = r_{14} P_1 + r_{24} P_2 + r_{34} P_3 + P_4 + r_{45} P_5 + r_{46} P_6 + r_{47} P_7 + r_{48} P_8$ (4)

$r_{5y} = r_{15} P_1 + r_{25} P_2 + r_{35} P_3 + r_{45} P_4 + P_5 + r_{56} P_6 + r_{57} P_7 + r_{58} P_8$ (5)

$r_{6y} = r_{16} P_1 + r_{26} P_2 + r_{36} P_3 + r_{46} P_4 + r_{56} P_6 + P_6 + r_{67} P_7 + r_{68} P_8$ (6)

$r_{7y} = r_{17} P_1 + r_{27} P_2 + r_{37} P_3 + r_{47} P_4 + r_{57} P_5 + r_{67} P_6 + P_7 + r_{68} P_8$ (7)

$r_{8y} = r_{18} P_1 + r_{28} P_2 + r_{38} P_3 + r_{48} P_4 + r_{58} P_5 + r_{68} P_6 + r_{78} P_7 + P_8$ (8)

These are converted to percentages to balance the differences in units.

The percentage direct contributions, combined contributions of any two variables and the residual effect are worked out as follows.

a). The direct percentage contribution = $(P_i)^2 \times 100$

b). The combined contributions of any two variables = $2(P_i P_j r_{ij})$

c). The residual effect $(R_x) = 1 - (r_{1y} P_1 + r_{2y} P_2 + r_{3y} P_3 + r_{4y} P_4 + r_{5y} P_5 + r_{6y} P_6 + r_{7y} P_7 + r_{8y} P_8)$

RESULTS AND DISCUSSION

The correlation coefficients for the different pairs of variables assessed are shown in Table 1.Pod yield of groundnut was observed to positively and significantly correlated with all the components assessed (number of mature pods, number of pods plant^{-1}, pod yield plant^{-1}, seed yield plant^{-1}, haulm yield plant^{-1}, hundred seed weight and total dry matter) except shelling percentage. These components exhibited significant positive interrelationship with each other with the exception of shelling percentage, seed yield with haulm yield and hundred seed weight. This shows the importance of these components as yield contributing factors in groundnut. Ado *et al*., (1988) reported that as the correlation coefficients between two variables is the sum of the paths connecting them, partitioning the correlation gives the direct and indirect contributions of the different independent parameters (components) on the dependent variable (pod yield).

TABLE 1. Correlation matrix between some ground nuts yield parameters and pod yield in 2003/04, 2004/05 and 2005/06 combined at Kadawa, Nigeria.

Parameters	1	2	3	4	5	6	7	8
1	1.0000							
2	0.9467***	1.0000						
3	0.6348***	0.6463***	1.0000					
4	0.3585***	0.3646***	0.6247***	1.0000				
5	0.5337***	0.5120***	0.3033***	0.0907	1.0000			
6	0.3753***	0.3448***	0.3992***	0.0376	0.1752	1.0000		
7	0.1740	0.1720	0.2689***	0.1484	0.001	0.5061***	1.0000	
8	0.6874***	0.6750***	0.6582***	0.3331***	0.917***	0.3055***	0.1205	1.0000
Y	0.3865***	0.3756***	0.4082***	0.3133***	0.0718	0.3887***	0.4737***	0.2276***

1- No of mature pods, 2- Number of pods / plant , 3- Pod yield / plant , 4- Seed yield / plant , 5- Haulm yield / plant , 6- Hundred seed weight , 7- Shelling percentage , 8- Total dry matter , Y- Pod yield

TABLE 2. The direct and indirect contribution of some yield parameters to ground nuts pod yield in 2003/04, 2004/05 and 2005/06 combined at Kadawa, Nigeria.

Parameters	1	2	3	4	5	6	7	8	Total correlation
1	**0.1484**	0.0986	-12.11	0.0752	-19.35	0.1347	-0.022	31.413	0.387
2	0.1405	**0.1041**	-12.33	0.0765	-18.57	0.1237	-0.021	30.846	0.376
3	0.0942	0.0673	**-19.07**	0.1311	-10.99	0.1433	-0.033	30.078	0.408
4	0.0532	0.0379	-11.92	**0.2098**	-3.289	0.0135	-0.018	15.222	0.313
5	0.0792	0.0533	-5.785	0.0190	**-36.26**	0.0629	-0.000	41.905	0.072
6	0.0557	0.0359	-7.614	0.0079	-6.353	**0.3589**	-0.063	13.961	0.389
7	0.0258	0.0179	-5.129	0.0311	-0.036	0.1816	**-0.124**	5.5066	0.474
8	0.1020	0.0703	-12.56	0.0699	-33.25	0.1096	-0.015	**45.698**	0.228

1- No of mature pods, 2- Number of pods / plant , 3- Pod yield / plant , 4- Seed yield / plant , 5- Haulm yield / plant , 6- Hundred seed weight , 7- Shelling percentage , 8- Total dry matter

* indicates significance with P<0.05, ** indicates significance with P<0.01 and *** indicates significance with P<0.001

TABLE 3. Direct and Indirect partitioning of correlation

A. Number of mature pods (X_2) and Pod yield (X_1)	**Contributions**
.Direct contribution (P_2) number of mature pods	0.1484
Indirect contributions of no of mature pods via no of Pods	0.0986
Indirect contributions of no of mature pods via Pod yield / plant	-12.1083
Indirect contributions of no of mature pods via seed yield / plant	0.0752
Indirect contributions of no of mature pods via Haulm yield / plant	-19.3531
Indirect contributions of no of mature pods via Hundred seed weight	0.1347
Indirect contributions of no of mature pods via shelling percentage	-0.0216
Indirect contributions of no of mature pods via Total dry matter	31.4127
Total Contribution (Direct + Indirect) .	3866
B. Number of pods / plant (X_3) and pod yield (X_1)	
Direct contribution (P_3) of number of pods / plant	0.1041
Indirect contributions of number of pods / plant via no of mature Pods	0.1405
Indirect contributions of number of pods / plant via pod yield / plant	-12.3277
Indirect contributions of number of pods / plant via seed yield / plant	0.0765
Indirect contributions of number of pods / plant via Haulm yield / plant	-18.5667
Indirect contributions of number of pods / plant via hundred seed weight	0.1237
Indirect contributions of number of pods / plant via shelling percentage	-0.0213
Indirect contributions of number of pods / plant via Total dry matter	30.8461
Total contribution (Direct + Indirect)	0.3757
C. Pod yield / plant (X_4) and pod yield (X_1)	
Direct contribution (P_4) of pod yield / plant	19.0742
Indirect contributions of pod yield / plant via no of mature Pods	0.0942
Indirect contributions of pod yield / plant via no of Pods / plant	0.0673
Indirect contributions of pod yield / plant via seed yield / plant	0.1311
Indirect contributions of pod yield / plant via Haulm yield / plant	-10.9983
Indirect contributions of pod yield / plant via one hundred seed weight	0.1433
Indirect contributions of pod yield / plant via shelling percentage	-0.0334
Indirect contributions of pod yield / plant via Total dry matter	30.0784
Total contribution (Direct + Indirect)	0.4084
D. Seed yield / plant and pod yield	
Direct contribution (P_5) of seed yield / plant	0.2098
Indirect contributions of seed yield / plant via no of mature Pods	0.0532
Indirect contributions of seed yield / plant via no of pods / plant	0.0379
Indirect contributions of seed yield / plant via pod yield / plant	-11.9157
Indirect contributions of seed yield / plant via haulm yield / plant	-3.2889
Indirect contributions of seed yield / plant via one hundred seed weight	0.0135

Indirect contributions of seed yield / plant via shelling percentage	-0.0184
Indirect contributions of seed yield / plant via total dry matter	15.2219
Total contribution (Direct + Indirect)	0.3133

E. Haulm yield and pod yield

Direct contribution (P_6) of haulm yield / plant	-36.2622
Indirect contributions of haulm yield via no of mature Pods	0.0792
Indirect contributions of haulm yield via no of pods / plant	0.0533
Indirect contributions of haulm yield via pod yield / plant	-5.7852
Indirect contributions of haulm yield via seed yield / plant	0.0190
Indirect contributions of haulm yield via one hundred seed weight	0.0629
Indirect contributions of haulm yield via shelling percentage	-0.0001
Indirect contributions of haulm yield via total dry matter	41.9049
Total contribution (Direct + Indirect)	0.0718

F. Hundred Seed weight and pod yield

Direct contribution (P_7) of hundred seed weight	0.3589
Indirect contributions of hundred seed weight via no of mature Pods	0.0557
Indirect contributions of hundred seed weight via no of pods / plant	0.0359
Indirect contributions of hundred seed weight via pods yield / plant	-7.6144
Indirect contributions of hundred seed weight via seed yield / plant	0.0079
Indirect contributions of hundred seed weight via haulm yield / plant	-6.3531
Indirect contributions of hundred seed weight via shelling percentage	-0.0628
Indirect contributions of hundred seed weight via total dry matter	13.9607
Total contribution (Direct + Indirect)	0.3888

G. Shelling Percentage and pod yield

Direct contribution (P_8) of shelling percentage	-0.1241
Indirect contributions of shelling percentage via no of mature Pods	0.0258
Indirect contributions of shelling percentage via no of pods / plant	0.0179
Indirect contributions of shelling percentage via pods yields / plant	-5.1291
Indirect contributions of shelling percentage via seed yield / plant	0.0311
Indirect contributions of shelling percentage via haulm yield / plant	-0.0363
Indirect contributions of shelling percentage via hundred seed weight	0.1816
Indirect contributions of shelling percentage via total dry matter	5.5066
Total contribution (Direct + Indirect)	0.4735

H. Total Dry Matter and pod yield

Direct contribution (P_9) of total dry matter	45.6979
Indirect contributions of total dry matter via no of mature Pods	0.1020
Indirect contributions of total dry matter via no of pods / plant	0.0703
Indirect contributions of total dry matter via pod yield / plant	-12.5546
Indirect contributions of total dry matter via seed yield / plant	0.0699
Indirect contributions of total dry matter via haulm yield / plant	-33.2524
Indirect contributions of total dry matter via hundred seed weight	0.1096
Indirect contributions of total dry matter via shelling percentage	-0.0149
Total contribution (Direct + Indirect)	0.2278

Percentage contribution of some yield parameters and pods yield of ground–nut in 2003/04, 2004/05 and 2005/06 combined at Kadawa, Nigeria..

Parameters	
1. **Individual Contributions**	**Percent Contribution**
No of mature pods	2.20
Number of pods / plant	1.08
Pod yield / plant	36,382.5
Seed yield / plant	4.40
Haulm yield / plant	131,494.7
One hundred seed weight	12.88
Shelling percentage	1.54
Total dry matter	208,829.8

2. **Combined contributions**	
No of mature pods and Number of pods / plant	2.93
of mature pods and pods yield / plant	-359.37
No of mature pods and seed yield / plant	2.23
No of mature pods and haulm yield / plant	-574.4
No of mature pods and hundred seed weight	3.99
No of mature pods and shelling percentage	-0.64
No of mature pods and total dry matter	932.33
No of pods / plant and pod yield / plant	-256.67
No of pods / plant and seed yield / plant	1.59
No of pods / plant and haulm yield / plant	-386.55
No of pods / plant and hundred seed weight	2.58
No of pods / plant and shelling percentage	-0.44
No of pods / plant and total dry matter	642.22
Pods yield / plant and seed yield / plant	-499.9
Pods yield / plant and haulm yield / plant	419.57
Pods yield / plant and hundred seed weight	-546.56
Pods yield / plant and shelling percentage	127.30
Pods yield / plant and total dry matter	-114,744
Seed yield / plant and haulm yield / plant	-138
Seed yield / plant and hundred seed weight	0.57
Seed yield / plant and shelling percentage	0.77
Seed yield / plant and total dry matter	638.71
Haulm yield / plant and hundred seed weight	-456.03
Haulm yield / plant and shelling percentage	0.90
Haulm yield / plant and total dry matter	-303,913.3
Hundred seed weight and Shelling percentage	-4.51
Hundred seed weight and total dry matter	1002.09
Shelling percentage and total dry matter	-136.67
Residual effect	72.73
Total	100.00

The direct and indirect effects of characters on pod yield are presented in Table 2. The total dry matter exhibited highest positive direct effect (45.698), followed hundred seed weight (0.3589), by seed yield plant^{-1} (0.2098), number of mature pods (0.1484) and number of pods plant^{-1} (0.1041). On the contrary, the correlation of pod yield and pod yield plant $^{-1}$ and haulm yield plant^{-1} was high and positive but the indirect effect was negative. The direct effect of shelling percentage on pod yield was also negative. In these cases, indirect effects seemed to be the cause of correlation so the indirect causal factors (such as number of mature pods, number of pods plant^{-1}, seed yield plant^{-1}, hundred seed weight and total dry matter) should be considered simultaneously for selection.

From the results of path analysis, it appears that total dry matter, hundred seed weight, seed yield plan^{-1}t, number of mature pods plant^{-1} and number of pod plant^{-1} were some of the components for pod yield which had relatively higher and positive direct effects on pod yield. Indirect effects of other characters through these were also high. In separating the correlation coefficients, it was assumed that all associations were linear, and the unknown residual effects of other factors exist (Wright, 1960). The high residual percentage of 72.73% (Table 3) observed in this study indicates the presence of other components influencing pod yield which were not considered in path coefficient analysis. However the overall result suggests that total dry matter, hundred seed weight and seed yield plant^{-1} should be considered the most reliable and effective selection criteria for improvement of yield in groundnut.

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