FUDMA Journal of Agriculture and Agricultural Technology
ISSN: 2504-9496
Vol. 7 No. 1, June 2021: Pp80-86

CHARACTER ASSOCIATION AND PATH COEFFICIENT ANALYSIS FOR YIELD COMPONENTS AND POD YIELD OF GROUNDNUT [*Arachis hypogaea* (*L.*)] IN SUDAN SAVANNA OF NIGERIA

*Omar, G. and Aisha, A. M.
Department of Soil Science, Faculty of Agriculture, Bayero University Kano, Nigeria
*Corresponding author; email omargarba1@yahoo.com Tel. +2348069593170

ABSTRACT

A multi-locational field experiment was carried out during the 2018 raining season at the Teaching and Research Farm of Bayero University Kano and Bunkure town in Bunkure Local Government Area of Kano State, Nigeria to investigate the nature and extent of the associations of some yield attributing characters on pod yield of groundnut. The study consisted of six treatments laid out in a Randomized Complete Block Design (RCBD) replicated three (3) times using SAMNUT 24 as the test variety of groundnut. Results of the study indicated that haulm yield, kernel weight and biomass were highly significantly ($P < 0.01$) and positively correlated with pod yield at BUK with r values of 0.972, 0.891 and 0.708 respectively. Shelling percent was also significantly ($P < 0.05$) and positively correlated with pod yield at the same location with an r value of 0.646. 100 seed weight was positively but non-significantly correlated with pod yield ($r = 0.445$). At Bunkure, highly positive and significant ($P < 0.01$) correlations existed between haulm yield ($r = 0.972$), kernel weight (0.950) and 100 seeds weight ($r = 0.776$). Similarly, there were significant variations, at $P < 0.05$ between shelling percent and biomass with pod yield with respective r values of 0.536 and 0.696. Results also indicated that haulm yield gave the highest total contribution (334.493 %) to pod yield over and above kernel weight (101.53 %), 100 seeds weight (233.053 %), shelling percent (286.083 %) and biomass (236.60 %). The order of individual direct contributions to pod yield was kernel weight (310.28 %) > Shelling percent (109.24 %) > haulm yield (1.265 %) > biomass (0.0073 %) > 100 seeds weight (0.00 %). Results also indicated that the combination of haulm yield and kernel weight had the highest effect (33.565 %) on pod yield than all the other combinations. In conclusion the result indicated that haulm yield and kernel weight must be given highest priority for improved and sustainable production of groundnut in the Sudan Savanna region of Nigeria using SAMNUT 24 variety.

Key words: Character Association, Path Coefficient Analysis, Yield Components, Pod Yield, Groundnut.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the most important oil seed crops cultivated all over the world, particularly in tropical and subtropical areas (Shiyam, 2010). It is a legume that ranks fourth among the oilseed crops and thirteen among the food crops of the world (Ganesh *et.al*, 2015). Groundnut provides high quality edible oil (48-50%), easily digestible (26-28%), and about half of the thirteen essential vitamins and more than a third of the twenty essential minerals necessary for human growth and maintenance. Nigeria is the largest groundnut producing country in West Africa and central Africa accounting for 51% of the production in the region with 3.27 million tons of production annually (FAOSTAT, 2014).

Correlation analysis is initiated aimed at observing mutual relationship of different parameters along with the extent of their contributions to yield. Comprehensive studies had been carried out to assess the link between the characters on which the selections for high yields can be made. The heritability ranged from 29.37% for seed yield and significantly correlated with all characters except pod height (Khan and Khan, 2000).

The number of pods, 100 seed weight and number of seeds per pod have been reported to have positive correlation with yield (Shahid *et al.*, 2003).

Yield is complex quantitative trait determined by many growth and physiological processes (Adeniji and Peter, 2005). Appropriate knowledge of the inter-relationships between the grain yield and its contributing yield components can enhance the efficiency and use of appropriate selection indicators in breeding for higher yield. For this reason direct selection for yield is unlikely the most efficient way for crop improvement. Path coefficient analysis and correlation are therefore conditions for crop enhancement. It is also a measure of the association between yield determinants as well as other traits information of which can be improved by partitioning into direct and indirect effects providing meaningful basis for allocation of appropriate weight to various yield and its components.

The main objective of this study was to provide information on yield related character associations and path coefficient analysis for use as a criterion for selection in the improvement of groundnut pod yield in the Sudan savanna zone of Nigeria.

MATERIALS AND METHODS

The research was conducted at the Teaching and Research Farm of Bayero University Kano (BUK) and Bunkure village in Bunkure L.G.A of Kano State. The study was conducted to know the relationships between grain yield and some yield components in groundnut.

The experiment consisted of six (6) treatments as presented in Table 1. The treatments were laid out in a Randomized Compete Block Design (RCBD) replicated three (3) times. SAMNUT 24 was used as the test variety of groundnut.

Table 1: Description of the treatments for the study

Code	Treatment	Description
T1	Control	No fertilizer application. Used to measure grain yield as an indicator of the effective indigenous Ca, P, S, N, B, Fe and Zn supply from soil, rain water, crop residue and or atmosphere.
T2	Ca, P, S, N	Ca, P, S,N applied at recommended rate ;used to estimate the nutrient limited yield gap and evaluate agronomic use efficiencies of Ca, P, S and N
T3	Ca, P, S ,N+B	This treatment estimates the effect of B as micro nutrient on groundnut productivity in addition to Ca, P, S and N to allow evaluating the combination of B to nutrient yield gap.
T4	Ca, P, S ,N + Fe	This treatment estimates the effect of Fe as micro nutrient on groundnut productivity in addition to Ca, P, S and N to allow evaluating the combination of Fe to nutrient yield gap.
T5	Ca, P, S, N + Zn	This treatment estimates the effect of Zn as micro nutrient on groundnut productivity in addition of Ca, P, S and N to allow evaluating the combination of Zn to nutrient yield gap.
T6	Ca, P, S + N + B+ Zn + Fe	This treatment was used to assess the interactive effects of Ca, S, P, N, B, Zn, and Fe and their contribution on groundnut productivity.

Starter dose of N and all the nutrients were applied at planting stage. Nutrients applied at the two (2) sites were as follows: macro and micronutrients, 20kg N ha^{-1}, 54kg P ha^{-1} 20kg Ca ha^{-1},40kg S ha^{-1}, 5kg Zn ha^{-1}(Singh 2010), 10kg Fe ha^{-1}(Singh 2010), and 1kg B ha^{-1}. N, P, Ca, S were applied in the form of urea, triple superphosphate, and gypsum. Sulphates of Zn and Fe were used as sources of Zn and Fe. Elemental S was used to balance S. Borax was used as source of B.

Data were collected on plant height, chlorophyll content, total biomass, haulm yield, kernel weight, shelling percentage, 100 seed weight, and pod yield. Simple correlation coefficients between grains yield (y) and yield components (x) and within the yield characters themselves were calculated using the following equation:

$$Rxy = SPxy \quad ssx.ssy$$

Where y = correlation coefficient; SPxy = sum of products of x and y; ssy = sum of squares of y.

The calculated coefficients were further used to develop the following simultaneous equations so as to partition the correlations into cause and effect by calculating the path coefficients (P*i*). P1, P2, P3, P4, and P5 as presented in Figure 1, are the path coefficients (direct), while r is the correlation coefficients. The individual and combined percentage contributions of any two characters were also calculated using the following relation as described by Gomez and Gomez (1984).

$$E = (pi)^2 \times 100$$

$$E_{ij} = 2_{pipjrij} \times 100$$

Where E = percent individual contribution; E_{ij} = combined percent contribution of characters i and j;

P_i and P_j = path coefficients of characters i and j.

The residual factor (R*x*) = 1 – (P_1r_{16} +P_2r_{26}+P_3r_{36}+P_4r_{46}+P_5r_{56}); while the sum of percent contribution (individual and combined) as well as the residual should add up to 100.

RESULTS AND DISCUSSION

Correlation Coefficient (r) showing association between pod yield and some yield components of groundnut.

Table 2 shows the correlation coefficient (r) between pod yield and some yield components of groundnut at BUK. There were highly significant (P<0.01) positive associations between kernel weight and haulm yield and also between shelling percent and kernel weight (P<0.01) with r values of 0.8468 and 0.9193, respectively implying that kernel weight increased with increase in haulm yield and that shelling percent also increased with an increase in kernel weight. Similar trend was observed at Bunkure (Table 3). At both locations, biomass was positively correlated with haulm yield and kernel weight (Tables 2 and 3).

At both locations, haulm yield, kernel weight, 100 seed weight (except at BUK), shelling percent and biomass were positively correlated with pod yield. This implies that the yield of groundnut was increased with increase in these yield components in the study area. This finding is in agreement with comprehensive reports by researchers (Shahid *et al*., 2003; Singh *et al.*, 2017; Nelson *et al.*, (2020) in which they reported that there was significant correlation between seed yield and 100 seed weight and kernel weight and that pod yield of groundnut was directly associated with plant height, number of pods per plant, hundred seed weight.

Similarly, this result corroborates the finding of Katoch *et al.* (2016) who reported positive and significant correlation between pod yield and number of pods per plant, pod length and number of seeds per pod in garden peas. Pandey *et al.* (2016) also reported a positive correlation in biological yield per plant of pigeon pea with pods per plant and seeds per pod. Mahesh *et al.*, (2018) also reported that kernel and haulm yield per plant had significant positive correlation with dry pod yield per plant and that the kernel yield had high direct effect on dry pod yield of groundnut. This indicates an improvement in biological yield which could be achieved if selection imparted may enhance the performance of these characters as also reported by Trivikrama *et al.* (2017) and Nelson *et al.*, (2020).

Table 2 Correlation coefficient(r) showing association between pod yield and some yield components of groundnut at BUK.

Character	HY ($kgha^{-1}$)	KW ($kgha^{-1}$)	100SW (g)	Shelling %	Biomass (g)	PDY ($kgha^{-1}$)
HY ($kgha^{-1}$)	1.00					
KW($kgha^{-1}$)	0.8468**	1.00				
100 SW(g)	0.2590	0.5591*	1.00			
Shelling%	0.6567*	0.9193**	0.5423	1.00		
Biomass(g)	0.6839*	0.5104*	0.2159	0.7084	1.00	
PDY($kgha^{-1}$)	0.9725**	0.8917**	0.4456	0.6460*	0.7084**	1.00

HY=Haulm yield, KW=Kernel weight, 100SW=100 seed weight, PDY=Pod yield.

Table 3. Correlation coefficient (r) showing association between pod yield and some yield components of groundnut at Bunkure.

Character	HY ($kgha^{-1}$)	KW ($kgha^{-1}$)	100SW (g)	Shelling %	Biomass (g)	PDY ($kgha^{-1}$)
HY ($kgha^{-1}$)	1.00					
KW($kgha^{-1}$)	0.8424^{**}	1.00				
100 SW(g)	0.6818^{*}	0.7181^{**}	1.00			
shelling%	0.4791^{*}	0.7713^{**}	0.3607	1.00		
Biomass(g)	0.6559^{*}	0.7347^{**}	0.4943^{*}	0.5836^{*}	1.00	
PDY($kgha^{-1}$)	0.9725^{**}	0.9500^{**}	0.7762^{**}	0.5362^{*}	0.6965^{*}	1.00

HY=Haulm yield, KW=Kernel weight, 100SW=100 seed weight, PDY=Pod yield,

Direct, indirect and total contributions of some yield attributing components to pod yield of groundnut.

Table 4 presents the direct, indirect and total contributions of some yield attributing components to pod yield of groundnut. Results of this investigation showed that the total contribution of haulm yield to pod yield was 334.49 %. Out of this, the direct contribution of haulm yield was 1.2659 %. Similarly, the indirect contribution of haulm yield via kernel weight, 100 seed weight, shelling percent and biomass were 310.28 %, 0.000 %, 109.24 %, and 0.0073 %, respectively. This implied that these yield components were significant in contributing to pod yield as earlier observed.

Results of the study also revealed 101.36 as the total contribution of kernel weight to pod yield with 1.0719 as its direct contribution to pod yield while its indirect contribution to pod yield via haulm yield, 100 seed weight, shelling percent and biomass were 262.75, 0.3278, 0.83131 and 0.8595 respectively. These positive values are indicative of the contribution of these yield components to the pod yield. This result is in conformity with the report of Archana *et al.* (1999) and Ball *et al.* (2001).

Table 4. Direct, indirect and total contributions of some yield attributing components to pod yield of groundnut

Yield character	Effect Through					
	HY	KW	100SW	Shelling	Biomass	Total
HY	1.2659	310.286	0.0000	109.243	0.0073	334.493
KW	262.75	1.0719	0.3278	0.83131	0.8595	101.536
100 SW	0.0000	0.0000	173.481	285.24	158.37	233.053
Shelling%	71.739	100.42	59.242	0.0000	0.0000	286.083
Biomass	0.0049	0.0372	0.00157	0.0051	77.387	236.60

HY=Haulm yield, KW=Kernel weight, 100SW=100 seed weight, PDY=Pod yield, Underlined = Direct effects.

Direct and combined contributions (%) of yield components to pod yield in groundnut

The direct and combined contributions (%) of yield components to pod yield in groundnut are presented in Table 5. When the individual percentage contributions of the yield components were examined (Table 5), it was noted that percentage (direct) contribution of kernel weight was highest (310.28 %) and this was followed by shelling percent (109.24 %), haulm yield (1.2659 %) and biomass (0.0073 %). The lowest direct contribution was observed from 100 seed weight (0.000)

These results are expected due to the positive and significant correlations between kernel weight ($P < 0.01$; r = 0.891 at BUK and r = 0.950 at Bunkure) and pod yield as earlier observed (Tables 2 and 3). Shelling percentage also showed similar pattern with the pod yield at $P < 0.05$ and a mean r value of 0.591 as earlier observed and indicated in Tables 2 and 3. This finding is in agreement with the report of Yahaya and Ankrumah (2017) in which they reported positive relationships between numbers of seeds per pod and grain yield of soybean in the Sudan Savanna of Nigeria. Combination of haulm yield and kernel weight contributed, by far, more to pod yield (33.565 %) (Table 5). This was followed by the combination of biomass and 100 seed weight (0.4441 %) and then combination of kernel weight and100 seed weight (0.05301) to pod yield. The combined effects of haulm yield and 100 seed weight was 0.0015 %. Negative combined effects of haulm yield and shelling percent (-15.4336), Haulm yield and biomass (-0.1319), kernel weight and biomass (-1.5408), 100 seed weight and shelling percent (-0.0301), 100 seed weight and biomass (-0.0001) and kernel weight and shelling percent (-338.505) were observed as presented in Table 5. Out of all these contributions, 0.723 % could not be accounted for as residuals (Figure 1). This may not be unconnected with variations in the effect of nutrients applied. Shehu and Ankrumah (2017) and Majid *et al.* (2009) reported effect of N and P fertilization as possible reasons for uncounted residuals of up to 64.3391 % in soybean.

Table 5. Direct and combined contribution (%) and residual effects of some yield components to pod yield of groundnut.

Character		Percent contribution
Direct contributions	**$(P)^2 \times 100$**	
Haulm yield	$(P_1)^2$	1.2659
KW	$(P_2)^2$	310.2868
100 Seed	$(P_3)^2$	0.0000
Sp%	$(P_4)^2$	109.2431
Biomass	$(P_5)^2$	0.0073
Combined contributions (2rijpipj) × 100		
H-KW	$(2r_{12}p_1p_2)$	33.5657
H-100s	$(2r_{13}p_1p_3)$	0.0015
H-SP	$(2r_{14}p_1p_4)$	-15.4336
H-BM	$(2r_{15}p_1p_5)$	-0.1319
KW-100S	$(2r_{23}p_2p_3)$	0.0523
KW-SP	$(2r_{24}p_2p_4)$	-338.5056
KW-BM	$(2r_{25}p_2p_5)$	-1.5408
100s-SP	$(2r_{34}p_3p_4)$	-0.0301
100s-BM	$(2r_{35}p_3p_5)$	-0.0001
BM-100	$(2r_{45}p_4p_5)$	0.4441
Residual	$1- (p_1r_{16}+p_2r_{26}+p_3r_{36}+p_4r_{46}+p_5r_{56})$	0.7753
Total		100.0000

H; Haulm yield, KW; kernel weight,100s;100 seed weight, SP; Shelling percent; BM; Biomass

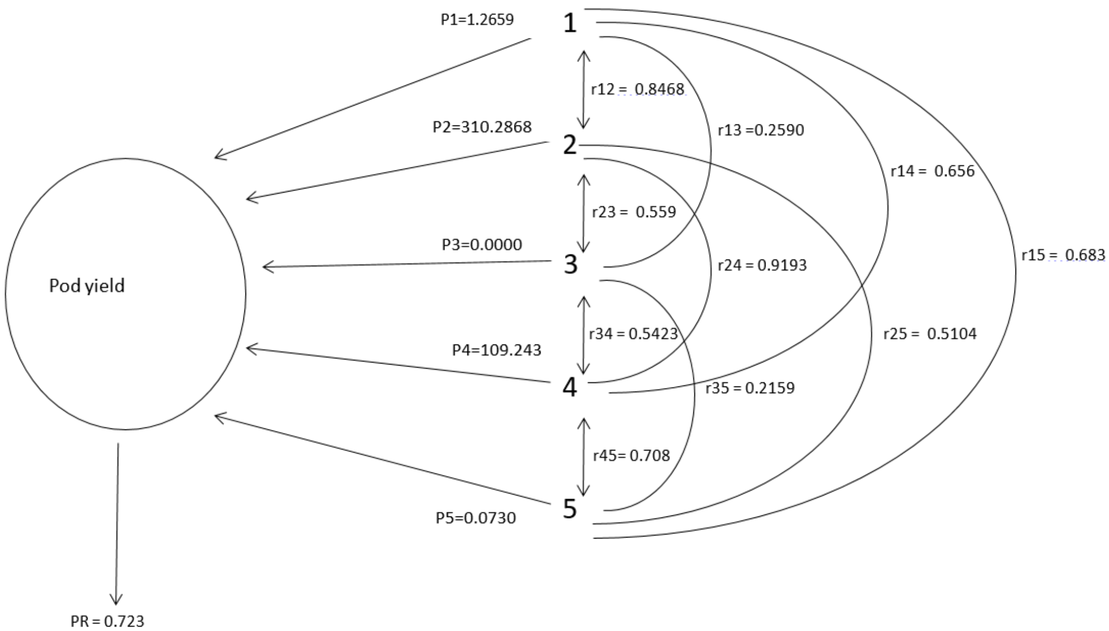

Figure 1: path diagram showing association of some yield characters to pod yield of groundnut.

1=Haulm yield; 2= Kernel weight; 3=100seed weight; 4=Shelling percent; 5= Biomass
→ = Direct effect; ↔ = indirect effect.

CONCLUSION AND RECOMMENDATIONS

Based on the results, it was concluded that haulm yield, kernel weight, 100 seed weight, shelling percent and biomass should be considered important in the genetic varietal selection since they can increase of groundnut pod yield. More specifically, haulm yield and kernel weight must be given highest priority for improved and sustainable production of groundnut in the Sudan Savanna region of Nigeria using SAMNUT 24 variety.

REFERENCES

Adeniji, O. T. and Peter, J. M. (2005). Stepwise regression analysis of pod and seed yield characters in segregating F2 population of West African okra (*Abelmoschus caillei*). *Proceedings of the 30th Conference, Genetic Society of Nigeria,* 250-258.

FAOSTAT, (2014); Available: *HTTP://FAOSTAT.FAO.ORG/*.Accessed on 17th November 2016.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons; USA, 704 pp.

Katoch, V., Singh, P., Devei, M. B., Sharma, A., Sharma, G. D. and Sharma, J. K. (2016). Study of genetic variability, character association, path coefficient analysis and selection parameters for heterotic recombinant inbred lines of garden peas (*Pisum sativum var. Hortense* L.) under mid-hill conditions of Hamachal Pradesh, India. *Legume Research* 39 (2): 163-169.

Khan, A. M. and Khan, A. H. (2000). Heritability and interrelationship among yield determining components of soybean varieties. *Pakistan Journal of Agricultural Research,* 116:5-8.

Mahesh, R. H., Hasan, K., Temburne, B.V., Janila, P. and Amaregouda, A. (2018). Genetic variability, correlation and path analysis studies for yield and yield attributes in groundnut (Arachis hypogaea L.) *Journal of Pharmacognosy and Phytochemistry*; 7(1): 870-874.

Majid, M. T., Abassi, M. K., Nasir, R. K., Abdul and Mushtaq, H. K. (2009). Effect of Rhizobium inoculation and N, P fertilization on growth, yield and nodulation of soybean (*Glycine max* L.) in the sub-humid hilly region of

Rawalakot Azad Jammu and Kashmir, Pakistan. *African Journal of Biotechnology* 8 (22): 6191 – 6200.

Nelson, M.J., Sibiya, J. M., Cousin, M.H. and Charlie, W. M. (2020). Phenotypic correlation, path coefficient and multivariate analysis for yield and yield-associated traits in groundnut accessions. *Cogent Food and Agriculture* 6 (1).

Pandey, P., Kumar, R. and Pandey, V. R. (2016). Genetic association studies for yield and yield related traits in Pigeon pea (*Cajanus cajan (L.)*Millsp). *Legume Research* 39 (2): 189 – 193.

Shahid, I., Tariq, M., Tahira, M., A., Muhammad, A. and Muhammad, S. (2003). Path co-efficient analysis in different genotypes of soybean (*Glycine max L. Merill*). *Pakistan Journal of Biological Science* 6:1085-1087.

Shiyam, J.O. (2010). Growth and yield response of groundnut (Arachis hypogaea L.) to plant densities and phosphorus on an ultisol in southern Nigeria. *Libyan Agriculture Research Centre journal international* 1:211-214.

Singh, P. B., Bharti, B. B., Kumar, A., Singh, R., Kumar, N. and Rathnakumar, A. L. (2017). Genetic Characterization, Character Association for Yield and Yield Component Traits in Groundnut (Arachis hypogaea L.). Electronic Journal of Plant Breeding, 8 (4): 4, 1235 pp.

Taru, V.B., Khagya, I.Z., Mshelia, S.I. and Adebayo, E.F. (2008) Economic efficiency of resources use in groundnut production in Adamawa state of Nigeria. *World journal of Agricultural Science* 56:4896-900.

Trivikrama, A., Reddy, M., Reddi, S., Vijayabharathi, A., Lakshmi, T. P., Lakshmikantha, G. R. and Jayalakshmi, V. (2017). Correlation and Path Analysis of Kernel Yield and its Components in Groundnut (*Arachis hypogaea* L.) *Int.J.Curr.Microbiol.App.Sci* 6 (12): 10-16.

Yahaya, S. U. and Ankrumah, E. (2017). Character association and path coefficient analysis for yield components and grain yield in soybean [*Glycine max* (L.) Merill.]. *Legume Research,* 40 (4): pp. 630 – 634.