ISSN 1313 - 8820 (print)
ISSN 1314 - 412X (online)

Volume 11, Number 1
March 2019

AGRICULTURAL SCIENCE AND TECHNOLOGY

2019

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 11, No 1, pp 3 - 7, 2019
DOI: 10.15547/ast.2019.01.001

Genetics and Breeding

Genetic interrelationship among quantitative traits and path analysis of some West African okra (*Abelmoschus caillei*) genotypes

P.M. Jonah*, Y.M. Kwaga

Department of Crop Science, Adamawa State University, PMB 25, Mubi, Nigeria

(Manuscript received 5 July 2018; accepted for publication 30 November 2018)

Abstract. *Thirty-six entries of a half diallel cross were evaluated at the Teaching and Research Farm, Adamawa State University, Mubi in 2012 and 2013 under rain fed conditions. The investigation was conducted to study inter-character correlations and path coefficient analyses of yield related traits in West African okra. Fresh pod yield exhibited highly significant (P≤0.01) positive correlation with pods/plant, pod length, branches/plant, pod diameter and leaves/plant. Pod length recorded a highly significant positive correlation with plant height, pod diameter, number of leaves/plant, branches/plant and pods/plant. Similarly, pod diameter had a highly significant positive correlation with plant height, number of leaves, branches and pods/plant. Furthermore, number of pods/plant and branches/plant recorded highly significant positive correlation among yield related traits except plant height. The path coefficient analysis of fresh pod yield and yield related traits showed that number of pods/plant gave the highest direct contribution and percentage yield contribution of 47.83%, followed by pod diameter which contributed 4.58%. Also the highest combined contribution of 14.43% came from pods/plant and pod diameter. Residual percentage contribution was 30.64% revealing that pod yield attributes in this study explained 69.36%. This investigation suggests that pods/plant and pod diameter can be considered as selection criteria for the improvement of West African okra genotypes.*

Keywords: *Abelmoschus caillei*, pod yield, path analysis, correlation, direct effect

Introduction

Okra, also known as "lady's finger", is one of the most important nutritious vegetables extensively grown throughout the tropical and warm temperate regions around the world for their fibrous pods. The two most important okra cultivated are *Abelmoschus esculentus* (Common okra) which is a native of Asia and *Abelmoschus caillei* (West African okra) which has 130 and 194 chromosomes, respectively (Adeniji and Kehinde, 2003). The two species of okra belong to the family Malvaceae, order Malvales and genus Abelmoschus (Shippers, 2000). Pod yield of okra is a polygenic trait, governed by number of gene action; therefore, direct selection for yield alone is usually not very effective. Hence, selection based on its contributing traits could be more efficient and reliable (Kumar et al., 2013). Optimizing fresh pod yield is one of the most important goals for most okra growers and consequently most okra breeding programmes. To improve any crop through conventional breeding and selection, adequate knowledge of association that exists between yield and yield related traits is essential for the identification of selection procedure. Correlation is the degree of association between traits, which can be strong or weak, positive or negative (Hayes et al., 1955; Eckebil et al., 1977). Correlation studies between yield and yield components are a pre-requisite to plan a meaningful breeding programme (Rafique et al., 2004). Path coefficient is an important method for estimating the association between traits with cause and effect, i.e. the direct and indirect basis of association.

Simon et al. (2013) observed that seed yield and pod yield recorded a significantly negative correlation coefficient with day to flowering, while pod yield had highly significant positive correlation with pod length and pod weight. This implied that selection based on these characters could significantly improve pod yield in okra. A field trial of Medagam et al. (2013) on correlation coefficient analysis revealed that plant height, pod length, pod diameter, fruit weight, number of pods/plant and day to 50% flowering had significant negative correlation with pod yield/plant. Aminu et al. (2016) reported that days to 50% flowering were positive and had highly significant correlation with plant height, number of pods/plant and fresh weight/pod. Correlations are only helpful in determining the components of a complex trait such as yield, but they do not provide an exact picture of the relative importance of the direct and indirect influence of each of the components on yield. The description of the technique of path-coefficient analysis or partial regression coefficient for partitioning of correlation coefficient into direct and indirect effects was first published by Wright (1921). The method was further illustrated as a means of analyzing correlation coefficients by Dewey and Lu (1959). According to Akinyele and Osekita (2006), path coefficient analysis revealed that number of pods/plant and height at flowering had the highest direct effect on seed yield in okra. This suggests that the two traits have a strong influence on seed yield and are the main determiners of seed yield/plant. In the investigation of Med-

*e-mail: peterjonah2005@yahoo.com

agam et al. (2013), path coefficient analysis revealed that pod weight and number of marketable pods/plant had a positively high direct effect on marketable pod yield/plant. Path coefficient analysis by Aminu et al. (2016) further revealed that number of pods/plants exhibited positive and direct influence on the pod yield. Previous researchers (Bendale et al., 2003; Bello et al., 2006; Mohapatra et al., 2007 and Rashwan, 2011) reported that plant height, branches/plant, intermodal length, fruit length, fruit weight and pods/plant were identified as the yield contributing components in okra. The survey on these yield components through correlation and path coefficient analyses could improve the efficiency of okra breeding.

In this paper, an attempt was made to study the interrelationship among traits, the direct and indirect effects of some important yield components on pod yield of West African okra by adopting correlation and path coefficient analysis.

Material and methods

The experimental material comprised 36 entries of West African okra (8 parents and 28 F1 hybrids) using Griffing's half diallel mating design. The 36 entries were evaluated in a randomized complete block design with three replications at the Teaching and Research Farm, Adamawa State University, Mubi, Nigeria in 2012 and 2013 under rain fed conditions. The experimental field was ploughed and harrowed in order to bury plant residues and to break soil clods before ridging. In each replication, each entry was planted in a five-row plot of 3m long, with rows spaced at 0.60m apart and intra-row spaced at 0.40m apart. Three seeds of each entry were planted per hill and later thinned to one plant per stand at two weeks after sowing (WAS) to give a total plant population of 41.667 plants/ha. To control Flea beetles and other insects associated with okra, Cymbush (Cypermetrin) 10% EC was sprayed at the rate of 50ml/10 liters of water at vegetative growth stage at three weeks interval after planting and repeated at flowering stage. Weeding was carried out manually with hoe at 3 and 6 WAS to control weeds.

Data were collected on plant height, pod length, pod diameter, number of leaves/plant, branches/plant, pods/plant and pod yield. In each plot, five plants were randomly selected, tagged and used as representative samples. The degree and direction of relationships between yield and yield attributes were done using Pearson's correlation coefficients using SAS 9.1.3 (2005) version. The correlation coefficients were further partitioned to measure the direct and indirect effects as described by Rangaswamy (2010).

Results and discussion

The correlation coefficients for seven traits are presented in Table 1. Plant height recorded highly significant positive correlation with pod length (0.344**), pod diameter (0.527**) and leaves/plant (0.447**) and a non-significant correlation with branches/plant, pods/plant and fresh pod yield. The pod length showed highly significant positive relationship with pod diameter (0.637**), leaves/plant (0.558**), branches/plant (0.592**), pods/plant (0.635**) and fresh pod yield (0.574**). Similarly, pod diameter showed significant positive association with leaves/plant (0.738**), branches/plant (0.532**), pods/plant (0.488**) and fresh pod yield (0.509**). Leaves/plant also exhibited highly significant positive correlation with branches/plant (0.577**), pods/plant (0.512**) and fresh pod yield (0.470**). Number of branches and pods/plant recorded a significant and positive correlation with fresh pod yield of 0.569** and 0.819**, respectively. The inter relationship among component traits of yield could provide selection criteria for simultaneous improvement of desirable traits. In the correlation study, pods/plant recorded significant and positive correlation with fresh pod yield, suggesting that the higher the number of okra pods/plant, the higher would be the fresh pod yield. These implies that okra genotypes that exhibit higher number of pods/plant should be selected as useful genetic material for improving okra pod yield.

The present study revealed that plant height exhibited significant and positive correlation with pod length, pod diameter and number leaves/plant. Sangaranamoni et al. (2016) and Neeraj et al. (2017) reported similar results in okra trial. In contrast with this study, Akinyele and Osekita (2006) established a significant, but negative association between height of plant with pod length and pod diameter. Pod length

Table 1. Correlation coefficients of yield and its contributing traits in West African okra grown at Mubi 2012 and 2013

Traits	Plant height	Pod length	Pod diameter	Leaves/ plant	Branches/ plant	Pods/ plant	Fresh pod yield
Plant height	1.000						
Pod length	0.344**	1.000					
Pod diameter	0.527**	0.637**	1.000				
Leaves/plant	0.447**	0.558**	0.738**	1.000			
Branches/plant	0.068^{ns}	0.592**	0.532**	0.577**	1.000		
Pods/plant	-0.002^{ns}	0.635**	0.488**	0.512**	0.632**	1.000	
Fresh pod yield	0.005^{ns}	0.574**	0.509**	0.470**	0.569**	0.819**	1.000

** = Significant at 1% level of probability, ns = Not significant at 5% level of probability and pod diameter showed positive significant correlation with leaves/plant, branches/plant, pods/plant and fresh pod yield. This agrees with the findings of Niranjan and Mishra (2003) research on okra. From the correlation results pods/plant and pod diameter recorded significant and positive correlation with fresh pod yield, suggesting that any increase in pod length or diameter will lead to a high number of pods/plant and pod yield vice versa. Also, the significant and positive association exhibited by leaves/plant and pods/plant with fresh pod yield corroborates with the findings of Sanganmoni et al. (2016) among okra genotypes. Similarly, number of leaves/plant recorded positive significant correlation with pod yield as earlier reported by Prajna et al. (2015). This indicates the influence of leaves as a source for production of assimilates for enhanced yield.

The direct and indirect contributions of yield attributes to the fresh pod yield of West African okra are presented in Table 2. The direct contribution of plant height to fresh pod yield was -0.1102, whereas the highest indirect contribution came through pod diameter, followed by pod length. The direct contribution of pod length to fresh pod yield was 0.0402, while the highest indirect contribution was exhibited by pods/plant and, secondly, by pod diameter. Direct contribution of pod diameter to pod yield was 0.2139, while the highest indirect contribution was via pods/plant, while other characters showed low contribution. Number of leaves/plant exhibited very low and negative direct contribution to fresh pod yield. In contrast, its indirect contribution through pods/plant was the highest and positive, followed by contribution via pod diameter. Similarly, although the direct contribution of branches/plant to the fresh pod yield of okra was low and positive, its indirect contribution through pods/plant was appreciably high. This was followed by pod diameter. Among the five traits considered, the highest direct contribution was exhibited by pods/plant, while the indirect contributions via other traits were low. The path coefficient analysis showed that number of pods/plant exhibited the highest direct contribution and percentage yield contribution to fresh pod yield of West African okra; which was greater than all the contributions of the other traits. This is in agreement with the findings of Akinyele and Osekita (2006), Sanganamoni et al. (2016) and Neeraj et al. (2017). Cowpea experiments conducted by Udom et al. (2006), Muktar et al. (2011) and Kwaga (2014a) established that number of pods/plant was a major contributor to the yield of cowpea.

In experiments conducted on groundnut, Kwaga (2004), Sadeghi and Noorhosseini-Niyaki (2012) reported similar results of the high contribution of pods/plant to grain yield. Therefore, in this study it can be inferred that the highest pod yield determinant in okra is the number of pods/plant. The second to the highest contribution to pod yield was observed from pod diameter. Similarly, in path analysis trial conducted by Neeraj et al. (2017) on okra, pod diameter had maximum direct contribution towards fresh pod yield. Furthermore, Akinyele and Osekita (2006) and Prasath et al. (2017) reported that pod diameter was among the major contributors to pod yield in okra. Therefore, pod diameter could also be an important trait which should be viewed in selection program for the further improvement of okra, since it contributed remarkably to pod yield. However, plant height and number of leaves/plant recorded the low negative direct contribution to fresh pod yield. Similar results were established by Oyiga and Uguru (2011) and Sanganamoni et al. (2016). This implies that profuse foliage in okra plants does not favor fresh pod yield.

Table 2. Direct and indirect contribution of yield attributes to fresh pod yield of okra at Mubi combined across 2012 and 2013

Traits	Plant height	Pod length	Pod diameter	Leaves/ plant	Branches/ plant	Pods/ plant	Total contribution
Plant height	-0.1102*	0.0138	0.1127	-0.0107	0.0011	-0.0015	0.0051
Pod length	-0.0379	0.0402*	0.1363	-0.0134	0.0093	0.4391	0.5736
Pod diameter	-0.0581	0.0256	0.2139*	-0.0177	0.0083	0.3373	0.5093
Leaves/plant	-0.0492	0.0224	0.1578	-0.0241*	0.0090	0.3542	0.4702
Branches/plant	-0.0075	0.0240	0.1137	-0.0139	0.0156*	0.4367	0.5686
Number pods/plant	0.0002	0.0255	0.1043	-0.0123	0.0098	0.6916*	0.8192

* Marked figures are direct contributions

The percentage contribution by the different traits are presented in Table 3. The highest percentage yield contribution was recorded by number of pods/plant. This accounted for about 50% of the total percentage yield contribution. This was followed by pod diameter. Similarly, the highest combined percentage contribution was exhibited by pod diameter and pods/plant. The residual value (30.64%) obtained shows that there are other traits that contribute to okra fresh pod yield which were not considered in this study. Muktar et al. (2011) and Kwaga (2014b) reported similar results with respect to residual values for groundnut and Adekoya et al. (2014) in okra trials.

Table 3. Percentage contributions of some yield attributes to fresh okra yield combined across 2012 and 2013

Yield attributes	Percentage contribution (%)
Plant height	0.21
Pod length	0.16
Pod diameter	4.58
Number of leaves/plant	0.06
Number of branches/plant	0.02
Number pods/plant	47.83
Combined contribution ($2P_{ij}\ r_{ij}$)	
Plant height and pod length	-0.30
Plant height and pod length	-2.48
Plant height and number of leaves/plant	0.24
Plant height and number of branches/plant	-0.02
Plant height and number of pods/plant	0.03
Pod length and pod diameter	1.11
Pod length and number leaves/plant	-0.11
Pod length and number of branches/plant	0.07
Pod length and number of pods/plant	3.53
Pod diameter and number leaves/plant	-0.76
Pod diameter and number of branches/plant	0.35
Pod diameter and number of pods/plant	14.43
Number of leaves/plant and number of branches/plant	-0.04
Number of leaves/plant and number of pods/plant	-1.71
Number of branches/plant and number of pods/plant	1.36
Residual	30.64
Total	100.00

Conclusion

It was found that: (a) many positive correlations exist - between fresh pod yield and pods/plant, pod length, branches/plant, pod diameter and leaves/plant; between pod length and plant height, pod diameter, number of leaves/plant, branches/plant and pods/plant; between pod diameter and plant height, number of leaves, branches and pods/plant; between number of pods/plant and branches/plant and yield related traits except plant height; (b) the number of pods/plant have the highest direct contribution on the yield (47.83%), followed by pods/plant and pod diameter (4.58%); (c) the highest combined contribution on yield (14.43%) render pods/plant and pod diameter. Generally, it can be concluded from this field study that number of pods/plant and pod diameter are important selection criteria in the breeding program of okra for improved fresh pod yield.

References

Adekoya MA, Ariyi OJ, Kehinde OB and Adegbite AG, 2014. Correlation and Path analysis of seed yield in okra (*Abelmoschus esculentus* L., Moench) grown under different cropping seasons. Pertanika Journal of Tropical Agricultural Science, 37, 39-49.

Adeniji OT and kehinde OB, 2003. Genetic variability of seed yield and components of West African Okra [*Abelmoschus caillei* (A. Chev.). Stevels]. ASSET series A, 3, 81-90.

Akinyele BO and Osekita OS, 2006. Correlation and Path coefficient analyses of seed yield attributes in okra (*Abelmoschus esculentus* L. Moench). African Journal of Biotechnology, 5, 1330-1336.

Aminu D, Bello OB, Gambo BA, Azeez AH, Agbolade OJ, Iliya A and Abdulhamid UA, 2016. Varietal performance and correlation of okra pod yield and yield components. Agriculture and Environment, 8, 112-125.

Bello D, Sajo AA, Chubado D and Jellason JJ, 2006. Variability and correlation studies in okra (*Abelmoschus esculentus* L. Moench). Journal of Sustainable Development in Agriculture and Environment, 2, 120-125.

Bendale VW, Kadam SR, Bhave SG and Mehta JI, 2003. Character association and Path Coefficient analysis in okra. Journal of Soils and Crops, 13, 386-388.

Dewey DR and Lu KH, 1959. A correlation and Path Coefficient analysis of components of crested wheat grass seed production. Agronomy Journal, 51, 515-518.

Eckebil JP and Ross MW, Gardner CO and Maranville JW, 1977. Heritability estimates, genetic correlation and predicted gain from S1 progeny testing in three sorghum population. Crop Science Journal, 17, 373-377.

Hayes HK, Immer FH and Smith DC, 1955. Methods of Plant breeding. Mcgraw Hill Book Co., New York.

Kwaga YM, 2004. Effects of genotype, N and P fertilizers and herbicides, seed treatment on the reaction of groundnut (*Ara-*

chis hypogaea L.) to Alectra vogelii (Benth). Thesis for PhD, Department of Agronomy, Ahmadu Bello University, Zaria, pp. 1-19.

Kwaga YM, 2014a. Direct and indirect contribution of Yield Attributes to the Kernel yield of Groundnut (*Arachis hypogaea* L.) grown under Alectra infestation at Samaru, Nigeria. International Journal of Engineering Science (IJRES), 2, 9-11.

Kwaga YM, 2014b. Direct and indirect contribution of Yield Components to the Kernel Yield of groundnut (*Arachis hypogaea* L.) under effects of N and poultry droppings in Alectra infested field in Nigerian Savanna. International Journal of Farming and Allied Sciences, 3, 216-219.

Kumar N, Joshi VN and Dagla MC, 2013. Multivariate analysis for yield and its component traits in maize (*Zea mays* L.) under high and low N levels. The Bioscan, 8, 959-964.

Medagam TR, Kadiyala HB, Mutyala G, Reddy KC, Begum H, Reddy RSK and Jampala DB, 2013. Correlation and path coefficient analysis of quantitative characters in okra (*Abelmoschus esculentus* L. Moench). Songklanakarin Journal of Science Technology, 35, 243-250.

Mohapatra MR, Acharyya P and Sengupta S, 2007. Variability and association analysis in okra. Indian Agriculturist, 51, 17-26.

Muktar AA, Tanimu B, Ibrahim B, Abubakar JU and Babaji BA, 2011. Correlation and Path Coefficient analysis between pod yield and some quantitative parameters in groundnut (*Arachis hypogaea* L.). International Journal of Science and Nature, 2, 799-804.

Neeraj S, Dhirendra KS, Pooja P, Ankit P and Monisha R, 2017. Correlation and Path Coefficient Studies in Okra (*Abelmoschus esculentus* L. Moench). International Journal of Current Microbiology and Applied Sciences, 6, 1096-1101.

Niranjan RS and Mishra MN, 2003. Correlation and Path Coefficient analysis in okra. Prog. Horticulture, 35, 192-195.

Oyiga BC and Uguru M, 2011. Interrelationship between pod and seed yield traits in Bambara groundnut (*Voandzia subterranean* L. Verde) in the Derived Savanna agro-ecology of South Eastern Nigeria under two planting dates. International Journal of Plant Breeding, 106-110.

Prajna SP, Gasti VD and Evoor S, 2015. Correlation and Path analysis in okra (*Abelmoschus esculentus* L. Moench). Hortflora Research Spectrum, 4, 123-128.

Prasath G, Ravinder KR and Pidigam S, 2017. Correlation and Path Coefficient Analysis of fruit yield and yield attributes in okra (*Abelmoschus esculentus* L. Moench). International Journal of Current Microbiology and Applied Sciences, 6, 463-472.

Rafique M, Hussain A, Mohmood T, Wadood A and Alvi B, 2004. Heritability and interrelationship among grain yield and yield components in Maize (*Zea mays* L.). International Journal of Agriculture and Biology, 6, 6.

Rangaswamy R, 2010. A Textbook of Agricultural Statistics cited in Reuben SO, WM and Mreme TSK, 1990. A path-coefficient of phenotypic correlations of yield components of advanced groundnut breeding lines in Tanzania. In: Proceedings of the 4th regional groundnut workshop for southern African, 19-23 March, 1990, Arusha, Tanzania, International Crop Research Institute for the Semi-Arid Tropics.

Rashwan AMA, 2011. Study of genotype and phenotypic correlation for some agro-economic traits in okra (*Abelmoschus esculentus* L. Moench). Asian Journal of Crop Science, 3, 85-91.

Sadeghi SM and Noorhosseini-Niyaki SA, 2012. Correlation and Path Coefficient analysis in Peanut (*Arachis hypogaea* L.) under drought stress and irrigation conditions. Annals of Biological Research, 3, 2593-2596.

Sanganamoni M, Revanappa S, Shivashankar BP and Muthaiah K, 2016. Correlation and Path Coefficient studies in okra (*Abelmoschus esculentus* L. Moench). Research in Environment and Life Sciences, 9, 999-101.

Statistical Analysis System (SAS), 2005. Statistical Methods. SAS Institute, Inc., Cary North Carolina, USA.

Shippers RR, 2000. African Indigenous vegetables. In: An overview of the cultivated species. Natural Resources Institute/ACP-EU Technical Centre for Agricultural and Rural Cooperation, Chatham, UK, pp. 103-118.

Simon SY, Gashua IB and Musa I, 2013. Genetic variability and trait correlation studies in okra (*Abelmoschus esculentus* L. Moench). Agriculture and Biology Journal of North America, 4, 532-538.

Udom GN, Fagam AS, Babatunde FE and Mclina IM, 2006. Path coefficient analysis of grain yield in intercropped cowpea grown in Borno. International Journal of Natural and Applied Sciences, 2, 40.

Wright S, 1921. Correlation and Causation. Journal of Agricultural Resources, 20, 557-582.