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Review Article

Correlation and Path Coefficient Analysis for Yield and its related traits in Groundnut - A Review

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Abstract: 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.Pod yield in groundnut is a complex and depends upon the interplay of number of components attributes. Primary yield components of groundnut *viz.*, number of pods per plant, pod yield per plant, shelling percentage and 100-kernel weight would result in rapid improvement of kernel yield in groundnut. Path coefficient analysis helps in formulating the selection criteria based on these direct and indirect effects. In order to achieve the goal of increased production by increasing the yield potential of groundnut crop, the knowledge of direction and magnitude of association between various traits is essential for plant breeders.

Keywords: Correlation, Path Coefficient Analysis, Yield, Groundnut.

CORRELATION

Genetic improvement of yield is the primary concern to plant breeder but yield is a complex, quantitatively inherited character and is highly influenced by the environment. Pod yield is being a complex character; direct selection for this character would not be a reliable approach. Hence, a sound knowledge on the extent of association of yield components among themselves and with yield is essential for improving yield. Character association analysis measures the actual relationship between various plant characters and helps the plant breeder in fixing selection criteria for pod yield. Correlation coefficient reveals the type, nature and magnitude of correlation between any pair of characters. Phenotypic correlation is the association between two characters, which can be directly observed and is subjected to changes in the environment. It measures the environmental deviations together with non-additive gene action. Genotypic correlation is the correlation of breeding values i.e. additive + additive x additive gene action.

The presence of variability in crop is important for genetic studies and consequently used for improvement and selection. Thus, effectiveness of selection is dependent upon the nature, extent and magnitude of genetic variability present in material and the extent to which it is heritable. An insight into the nature and degree of distribution present in population is of utmost importance as it forms the basis for selection in any crop improvement programme (Prabhu *et al.*, 2015 b). Yield is a complex entity associated with many characters, which are they inter-related (Dhillon *et al*., 1992). In any plant breeding program, it is essential to know the association among yield and yield related traits in the material generated, for effectual selection. Selection based on simply inherited and highly heritable yield attributes is most effective and reliable approach as compared to direct selection on yield itself. Understanding the nature and extent of association of different yield components with yield and inter relationship among themselves is an essential pre requisite for the formulation of breeding procedure for effective improvement of yield (Prabhu *et al.*, 2016). The correlation coefficients between any two characters would not give a complete picture of a complex situation like yield of plant which is jointly determined by a number of traits either directly or indirectly. In such situations, path coefficient analysis would be useful, as it permits the separation of direct effect from indirect effects through other related traits.

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A brief review of literature on the association of characters in groundnut is presented here under.

Ferreira and Almida (2005) estimated the genetic parameters for agronomic traits of three cultivars and six lines of groundnut and also estimated relationship between weight of 100-kernels, number of pods per plot, kernel yield, number of kernels per pod and pod yield. They noticed that kernel yield was positively influenced by the number of pods per plot and weight of 100-kernels and negatively by the number of kernels per pod. They found that number of pods per plot was the trait of greatest direct influence on kernel yield. Patil *et al.* (2006) studied that pod yield per plant had significant positive association with number of pods per plant, shelling per cent and sound mature kernel per cent. John *et al.* (2009) studied variability and character association in spanish bunch groundnut and reported that pod and kernel yield per plant showed significant and positive association with number of secondary branches per plant, number of mature pods per plant, sound mature kernel weight, sound mature kernel number and 100-kernel weight. They advocated that these characters could be considered in formulating selection indices for the improvement of kernel and pod yields per plant.

Korat *et al*. (2010) reported that pod yield per plant exhibited significant positive association with biological yield per plant, 100-kernel weight and harvest index. Hiremath *et al.* (2011) found that pod yield was positively and significantly associated with number of primary branches, pod weight per plant, 100-kernel weight, sound matured kernel per cent and oil yield. Thus, indicating the possibility of indirect selection for yield in groundnut through simultaneous improvement of these yield components. Mukhtar *et al*. (2011) assessed association between pod yield and quantitative characters in groundnut and reported that pod yield of groundnut was positively and significantly correlated with all the components *viz.*, number of mature pods, number of pods per plant, pod yield per plant, seed yield per plant, haulm yield per plant, 100-kernel weight and total dry matter except shelling percentage.

Vekariya *et al*. (2011) reported highly significant positive correlation with number of mature pods per plant, 100-pod weight, 100-kernel weight, kernel yield per plant, biological yield per plant and harvest index on pod yield per plant in 50 diverse genotypes of bunch groundnut. Zaman *et al.* (2011) indicated that seed yield per plant showed highly significant and positive association with nut size, number of nuts per plant, kernel size and days to 50 per cent flowering. Kumar *et al.* (2012a) noticed highly significant positive association of kernel yield per plant, mature pods per plant, total pods per plant, harvest index, 100-kernel weight, root weight, plant height and shoot weight with pod yield and also found genotypic correlation co-efficient were relatively higher than phenotypic correlation co-efficients indicating a strong inherent association between the characters.

Shoba *et al*. (2012) noticed kernel yield was significant and positively correlated with number of pods per plant, pod yield per plant, shelling percentage and 100-kernel weight. Further, they suggested that selection based on the characters like number of pods per plant, pod yield per plant, 100-kernel weight and shelling per cent would result in rapid improvement of kernel yield in groundnut. Rao *et al*. (2014) studied inter-relationships among 50 groundnut genotypes and revealed significant positive correlation of dry pod yield with kernel yield, number of pods per plant, 100-kernel weight and dry haulm yield. Sadeghi and Niyaki (2012) studied interrelationships among various agronomic traits in 23 groundnut genotypes under irrigated and drought stress conditions and found highly significant positive correlation of 100-kernel weight, total number of kernels per plant, total number of pods per plant and biomass with seed yield.

Makinde and Ariyo (2013) studied correlation analysis in 22 genotypes for 10 characters under two environments. They found that number of pods per plant showed significant positive correlation with yield per plant in both environments and also had the largest direct positive effect on yield per plant (0.66 and 0.70). On contrary, Days to maturity showed the largest direct negative effect of -0.33 and -0.36. They observed significant genotype and genotype x environment interactions on yield per plant. Thakur *et al.* (2013) studied correlation among pod yield and yield component traits in groundnut and recorded highly significant positive association of days to maturity, sound matured kernel per cent, pod length, pod width and kernel length on pod yield. On the contrary, highly significant negative association of days to flowering, pods per plant, shoots length, shelling per cent and specific leaf area on pod yield.

Kumar *et al*. (2014) studied correlation analysis in 66 groundnut genotypes and revealed that kernel yield was significant and positively associated with pod yield per plant, number of mature pods per plant, shelling per cent, harvest index, sound mature kernel per cent, specific leaf weight at 60 DAS, protein content and oil content. Yadlapalli (2014) reported that pod yield exhibited significant and positive genotypic correlation with all the characters except with plant height. Number of pods per plant showed positive direct effect on pod yield per plant followed by 100-kernel weight, number of branches per plant and days to 50 per cent flowering. Selection of characters showing high heritability coupled with high genetic advance, positive and high significant correlation and high direct effects would be helpful in the improvement of yield in the groundnut.

Vinutha *et al*. (2015) studied the interrelationship among the yield attributing traits and physiological traits in 6 F_2 crosses. The phenotypic correlation coefficients revealed the association of pod and kernel yield with other yield attributing traits like number of pods per plant and sound mature kernel. On the contrary, SPAD chlorophyll meter reading at 60 DAS and specific leaf area at 60 DAS were significantly and negatively correlated with each other in all the crosses except in cross GKVK- 5 × GPBD- 4. Bhargavi *et al*. (2015) revealed that pod yield per plant had significant positive association with days to maturity, number of mature pods per plant, harvest index, 100-kernel weight, kernel yield per plant, kernel yield per hectare, oil yield per hectare and pod yield per hectare.

John and Reddy (2015) carried out an investigation to determine relationship between pod yield and its components in early segregating population of groundnut and revealed highly significant positive association of days to 50 per cent flowering, days to maturity, number of well-filled and mature pods per plant, shelling per cent, sound mature kernel per cent, 100-kernel weight, protein per cent and kernel yield per plant with pod yield per plant. The pod yield per plant showed highly significant positive association with number of pod bearing nodes, number of matured pods per plant, kernel weight per plant and days to 50 per cent flowering. The branches per plant, height of main axis, pods per plant, kernel weight per plant, days to 50 per cent flowering, shelling percentage and days to maturity were identified to be the important characters which could be used in selection for yield was reported by Patil *et al.* (2015). Vasanthi *et al*. (2015a) documented correlation and path co-efficient analysis and indicated that the number of mature pods per plant, number of primary branches per plant and 100-kernel weight should be given major emphasis for the development of high yielding genotypes. Choudhary *et al.* (2016) documented that dry pod yield per plant was positively and significantly correlated with number of pegs per plant, number of mature pods per plant and kernel yield per plant.

Jain *et al*. (2016) documented correlation analysis in 24 genotypes of groundnut and observed that the genotypic correlation coefficient had higher magnitude than the corresponding phenotypic correlation coefficients indicating strong inherent association between the characters. Pod yield per plant displayed significant positive association with kernel yield per plant, mature pods per plant and plant height. Kiranmai *et al.* (2016) noticed positive association between pod yield per plant and kernel yield per plant and oil yield per plant. They also reported that plant height, 100-kernel weight, kernel yield per plant, oil yield per plant, late leaf spot severity, number of matured pods per plant and harvest index were significantly associated with one another and also with pod yield per plant indicating that these characters were important for improvement of pod yield in groundnut.

Correlation and path coefficient analysis for yield and its contributing traits in groundnut germplasm was studied by Bhakal and Lal (2017). The phenotypic and genotypic correlation analysis revealed that plant height at 40 DAS and 100-kernel weight was significantly and positively correlated with pod yield per plant. They also observed that the highest positive direct effect on pod yield per plant was exerted by kernel yield (q/ha) and kernel uniformity. Hampannavar *et al*. (2018) observed that kernel yield per plant, mature pods per plant, sound mature kernel and haulm yield per plant had significant positive correlation with dry pod yield per plant and also the kernel yield had high direct effect on dry pod yield. Wadikar *et al*. (2018) noticed that the pod yield per plant exhibited highly significant positive association with kernel yield per plant followed by harvest index and also revealed that the genotypic correlation coefficients were higher than the phenotypic correlation coefficients suggesting strong inherent association among the character studied.

PATH COEFFICIENT ANALYSIS

Pod yield is a complex dependent character and is contributed by several components. Correlation studies simply measures the association of yield and yield attributes and does not give the actual dependence of yield on the correlated characters. Path coefficient analysis is an effective method to determine the direct and indirect causes of associations and also permits to examine the specific forces acting to produce to a given correlation. Majority of the reports of path analysis are based on variability existing between homozygous cultivars. Path coefficient analysis measures the direct influence of one variable upon another and facilitates the separation of correlation coefficients into components of direct and indirect effects (Dewey and Lu, 1959). Path coefficient analysis, a statistical method developed by Wright (1921) permits a thorough understanding of contribution of various characters by partitioning the correlation coefficient into components of direct and indirect effects. It can be carried out both at phenotypic and genotypic levels considering grain yield as dependent character and yield attributes as independent characters. Thus path coefficient analysis has been used by plant breeders helps in identification of traits that are useful as selection criteria to improve crop yield.

The available literature on path coefficient analysis carried out in groundnut was furnished here under.

Patil *et al.* (2006) studied path analysis in 17 groundnut genotypes and reported that number of pods per plant, shelling per cent and sound mature kernel per cent had maximum direct effect on pod yield per plant. Sumathi and Muralidharan (2007) evaluated 48 diverse groundnut genotypes and reported direct effect of

kernel yield per plant and sound mature kernels on pod yield per plant and inferred that these characters contribute more for pod yield per plant. Korat *et al*. (2010) tested 80 bunch groundnut genotypes and reported highest positive direct effect of biological yield per plant and harvest index on pod yield as well as positive indirect effect of 100-kernel weight contributed via biological yield per plant and harvest index on pod yield. Mukhtar *et al*. (2011) studied path analysis and observed that total dry matter, 100-kernel weight, seed yield per plant, number of mature pods per plant and number of pods per plant had the highest positive direct effect on pod yield. On the contrary, they observed negative direct effect of shelling per cent on pod yield.

Vekariya *et al*. (2011) reported path analysis in 50 diverse genotypes and revealed that the kernel yield per plant, biological yield per plant and harvest index had high positive direct effects on pod yield per plant. Hence, they opined that these characters could be used for selection for rapid improvement of yield. Zaman *et al*. (2011) revealed high positive direct effect of number of mature nuts per plant followed by nut size, shelling per cent, days to 50 per cent flowering and days to maturity on seed yield per hectare. It was also found that branches per plant, plant height, nuts per plant, nut size, kernel size, days to 50 per cent flowering, shelling per cent and days to maturity were identified as important characters which could be used in selection for yield. Barbariya and Dobariya (2012) carried out an investigation to determine the correlation coefficients and direct and indirect effects by path analysis for pod yield per plant and its components in 100 genotypes of Spanish bunch groundnut and revealed that biological yield per plant and harvest index exhibited high positive direct effects on pod yield per plant as well as kernel yield per plant, number of pods per plant and days to maturity showed moderate positive direct effects on pod yield per plant. Kumar *et al.* (2012a) estimated high direct effect of kernel yield per plant, harvest index on pod yield, while studying 50 genotypes of groundnut. Hence, they opined that selection based on these characters results in rapid improvement of pod yield in groundnut.

Sadeghi and Niyaki (2012) studied path analysis and suggested that in irrigated condition total number of kernels per plant, 100-kernel weight and total number of pods per plant and in drought stress condition 100-kernel weight, total number of kernels per plant, total number of pods per plant and biomass had greatest positive direct effects on seeds yield. Kumar *et al*. (2014) reported high positive direct effect of pod yield per plant and shelling per cent on kernel yield. However, they suggested that pod yield per plant and shelling per cent were the major yield contributing characters as they showed positive significant association and high positive direct effect with kernel yield per plant. Hence, these characters could be important for selection in order to improve the kernel yield in groundnut.

The studies of Kalmeshwer *et al*. (2006) showed that number of pods per plant, shelling percentage and sound mature kernel per cent had the maximum direct effect on pod yield per plant. Venkateswarlu *et al*. (2007) observed high positive direct effects of kernel yield per plant, followed by shelling per cent, number of well filled and mature pods per plant on pod yield per plant. Thakur *et al*. (2013) evaluated 25 groundnut genotypes and revealed that days to maturity, root length, pod width, pod length and kernel length had high positive direct effect with pod yield per hectare as well as days to flowering, shoot length, shelling per cent, sound mature kernel per cent and 100-kernel weight had direct negative contribution with pod yield per hectare. Hence they suggested that the characters having positive direct effect could be used in selection for yield.

Rao *et al.* (2014) tested 50 genotypes of groundnut and reported that number of pods per plant and 100-kernel weight contributed high positive direct effect on pod yield. John and Reddy (2015) reported that pod yield per plant had high positive direct effect with kernel yield per plant followed by days to 50 per cent flowering and 100-kernel weight. They also found that the direct effects of dry haulms yield per plant, protein per cent, days to maturity, number of well-filled, mature pods per plant, number of primary branches per plant and oil per cent were found to be positive with kernel yield per plant which had maximum positive direct effect on pod yield per plant indicating the importance of kernel yield in determining the pod yield.

Patil *et al*. (2015) evaluated 49 groundnut genotypes and observed that the number of mature pods per plant had high positive direct effect on pod yield per plant. Hence, they opined that branches per plant, height of main axis, pods per plant, kernel weight per plant, days to 50 per cent flowering, shelling per cent and days to maturity were identified as important characters which could be used in selection for yield. Jain *et al*. (2016) carried out path analysis of yield and its components in a study involving 24 genotypes of groundnut and reported high direct effects of kernel yield per plant, plant height and matured pods per plant on pod yield per plant. Hence, selection for these characters would help in rapid improvement in pod yield per plant.

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