

Association and Path Coefficient Studies for Traits Related to Water Use Efficiency, Yield and Its Components in RILs of Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Keywords

Groundnut, Recombinant Inbred Lines (RILs), Water use efficiency (WUE), Soil Plant Analysis Development (SPAD), Chlorophyll Meter Reading, Specific Leaf Area (SLA), Correlation and Path analysis.

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The extent of association between pod yield and other relevant traits was estimated in the RILs of groundnut. Significant positive association of pod yield per plant with primary branches per plant, SCMR, pods per plant and kernel yield per plant was observed. Also significant negative association of pod yield per plant with SLA and sound mature kernel *per cent* was noticed. The physiological traits related to Water Use Efficiency, SLA and SCMR were negatively associated to each other with the latter being associated positively and the former associated negatively with pod yield. Pods per plant, kernel yield and primary branches per plant also had positive direct effect indicating that the correlation between these characters with pod yield is due to direct effect of the characters and reveals the true relationship between them.

Introduction

India is now facing a water situation that is significantly worse than any of those previous generations have had to face. All Indian water bodies within and near population centres are now grossly polluted with organic and hazardous pollutants.

By 2030 nearly 60% of Indian aquifers will be in a critical condition thus posing a threat to agriculture (Biswas *et al.*, 2017). Hence it becomes necessary to breed crops with higher water use efficiency for sustenance.

Peanut addressed as one of the world's most important legumes both in subsistence and commercial agriculture holding a good stand both in arid and semi-arid regions of the world also suffers from lower water availability.

Thus development of peanut cultivars with resistance to drought and more efficient use of water offer the best long term and cost effective solution to the drought problem. One such approach includes physiological

estimation and evaluation of genotypes. However, physiological traits associated with drought tolerance are complex as well as difficulties associated with their measurements in segregating populations inhibited their use in the past in developing water-use efficient genotypes in breeding programmes. With new knowledge of easily measurable surrogates of transpiration efficiency (TE), a trait which is associated with drought tolerance like specific leaf area (SLA) and soil plant analytical development (SPAD) chlorophyll meter reading (SCMR), it is now possible to integrate TE through the surrogates in breeding and selection schemes in groundnut.

So far many studies on the surrogate traits for WUE in peanut have been focused on SLA and SCMR. A strong and positive relationship between SCMR and WUE was reported (Sheshshayee *et al.*, 2006). SCMR and SLA are negatively correlated (Nageswara Rao *et al.*, 2001; Upadhyaya, 2005) and genetic variation for SCMR has also been reported (Upadhyaya, 2005).

Most of the characters of breeder's interest are complex and are the result of interaction of a number of components. Understanding the relationships among yield and yield components is of paramount importance for making the best use of these relationships in selection. The correlation coefficient may be confounded with indirect effect due to common association inherent in trait interrelationships. Therefore information derived from the correlation coefficients can be augmented by partitioning correlations into direct and indirect effects by path coefficient analysis.

Materials and Methods

The experiment was carried out in the interim of *kharif* 2014-2015 at GKVK, Bangalore.

Experimental material consisted of mapping population of 230 RILs of cross NRCG 12568 × NRCG 12326 (Table 1) segregating for Water Use Efficiency and the checks included TMV-2 and KCG-2 genotypes. The 230 F₇ generation RILs were sown in augmented design with 4 checks including parents during *kharif* 2014 for phenotypic evaluation. Each RIL sown in a single row of 1.5m with a spacing of 30 cm between rows and 10 cm between plants within the row. Recommended fertilization application and agronomic practices as per the package of practices mentioned for this region were followed. Data were recorded on randomly selected five plants from each RIL and average value was used for the statistical analysis for 10 characters viz., days to 50% flowering, plant height (cm), number of primary branches per plant, number of mature pods per plant, pod yield per plant (g), sound mature kernel (SMK) percentage, kernel yield per plant (g), shelling percentage, SPAD chlorophyll meter reading and specific leaf area (cm²/g).

Observations of above quantitative traits were recorded in F₇ generation and were subjected to statistical analysis (Sapra and Agarwal, 1991). Further the data was analysed using WINDOSTAT for augmented design.

Results and Discussion

Pod yield is a complex character which is governed by several contributing traits. Hence, it necessitates understanding the association of different traits with pod yield for enhancing the usefulness of selection criterion to be followed while developing varieties.

The study revealed that there is a strong positive association between pod yield per plant with traits such as primary branches per plant, SCMR, pods per plant and kernel yield per plant and strong negative association with

SLA and sound mature kernel *per cent* (Table 2). It suggests that the individual plant selection can be practiced for plants with higher number of primary branches and higher number of pods which ultimately leads to improvement in both pod and kernel yield in the later generations. It also suggests that plants with higher SCMR and lower SLA can be selected to choose plants with high water use efficiency coupled with higher yield.

The significant positive association of pod yield per plant with pods per plant and kernel yield per plant in the RILs are in accordance with the results of Sharma and Varshney (1995), Moinuddin (1997), Singh and Singh (1999), Nagda *et al.*, (2001), Kalmeshwar *et al.*, (2006), John *et al.*, (2007), Mane *et al.*, (2008) and Sudhir *et al.*, (2008) suggesting that pod yield can be improved by selecting plants with higher pods per plant and higher kernel yield.

Strong positive association of primary branches per plant with pod yield per plant indicates by selecting for higher number of primary branches improvement in yield can be achieved similar to the results of Vasanthi *et al.*, (2015), Chandola *et al.*, (1973), Prasad (1981), Balkishan (1979), Bhargava *et al.*, (1970), Khangura and Sandhu (1972), Sandhu and Khera (1977).

SCMR witnessed a significant positive association with pod yield per plant and same was reported by Pavan *et al.*, in 2014, indicating that this association can be utilized to select high yielding plants by selecting those plants scoring higher for SCMR values.

Significant negative association of pod yield per plant with SLA suggests that selection of plants with lower SLA leads to selection of plants with high water use efficiency coupled with higher pod yield per plant similar to the results of Nandini and Savithamma in 2012. A significant positive association of SCMR and significant negative association of SLA with pod yield per plant imply that selecting genotypes having lower SLA coupled with higher SCMR values implies higher water use efficiency along with higher pod yield per plant.

Though correlation coefficient measures the relationship existing between pairs of characters, dependent character is an interaction product of many mutually associated component characters and change in any one component will disturb whole network of cause and effect system this is taken care by path coefficient analysis which takes into account both the cause and effect relation between the variables.

The path coefficient analysis also measures the relative importance of causal factors involved. It is simply a standardized partial regression co-efficient analysis that separates the correlation co-efficient into components of direct and indirect effects and measures the relative importance of each factor involved in contributing to the final product of correlation between dependent and independent characters.

It reflects the association between them. Selection for such characters will be rewarding to improve dependent characters.

Table.1 Salient features of parental genotypes

Parental Genotypes	Varietal type	13C	SLA(cm ² /g)	SCMR
NRCG 12568	Fastigiata	16.90	Low	High
NRCG 12326	Vulgaris	21.50	High	Low

Table.2 Estimates of phenotypic correlation coefficients among growth, yield and surrogate traits related to WUE of 230 F₇ RILs of the cross NRCG 12568 × NRCG 12326 in groundnut

	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀
X ₁	1.000	0.048	0.049	0.012	-0.014	-0.028	-0.124	-0.107	0.211**	-0.113
X ₂		1.000	-0.065	-0.045	-0.101	0.048	0.019	-0.089	-0.068	0.026
X ₃			1.000	0.134*	-0.032	0.062	0.147*	-0.078	0.023	0.165*
X ₄				1.000	-0.351**	0.327**	0.326**	-0.047	-0.082	0.296**
X ₅					1.000	-0.094	-0.315**	0.0532	0.121	-0.302**
X ₆						1.000	0.514**	-0.009	-0.131*	0.550**
X ₇							1.000	-0.003	-0.186**	0.879**
X ₈								1.000	-0.156*	-0.118
X ₉									1.000	-0.203**
X ₁₀										1.000

* Significant at 0.05 probability level
 ** Significant at 0.01 probability level

X₁: Days to 50 % flowering X₂: Plant height (cm) X₃: Primary branches/plant X₄: SCMR X₅: SLA (cm²/ g)
 X₆: Pods/plant X₇: Kernel yield/plant (g) X₈: Shelling percentage X₉: SMK (%) X₁₀: Pod yield/plant (g)

Table.3 Estimates of direct and indirect effects of yield components and surrogate traits related to WUE on pod yield in 230 F₇ RILs of the cross NRCG12568 × NRCG12326 in groundnut

	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	“r” (Pod yield / plant)
X ₁	0.1444	0.0089	0.0473	-0.0136	0.0743	-0.0189	0.5505**
X ₂	0.0028	0.0446	0.0060	-0.0014	0.0066	0.0010	0.1655*
X ₃	-0.0111	-0.0046	-0.0340	0.0119	-0.0111	0.0028	0.2956**
X ₄	0.0044	0.0015	0.0163	-0.0464	0.0146	-0.0056	-0.3025**
X ₅	0.4053	0.1158	0.2571	-0.2485	0.7882	-0.1465	0.8793**
X ₆	0.0047	-0.0008	0.0030	-0.0044	0.0067	-0.0363	-0.2035**

X₁: Pods/plant X₂: Primary branches/plant X₃: SCMR X₄: SLA (cm²/ g) X₅: Kernel yield/plant (g) X₆: SMK (%)

Maximum positive direct effect of kernel yield on pod yield per plant was observed suggesting selection for kernel yield would contribute greatly towards enhancing pod yield per plant (Table 3).

These results are in accordance with the reports of Abraham (1990), Moinuddin (1997), Gomes *et al.*, (2005), Kalmeshwar *et al.*, (2006), Praveen Kumar (2006) and Kumar *et al.*, (2012) in groundnut.

Other traits such as pod per plant and primary branches per plant also had positive direct effect.

It reveals that the correlation between these characters and pod yield is due to direct effect of the characters such as primary branches per plant, kernel yield and pod per plant and it reveals the true relationship between the these characters with pod yield.

Hence selection for higher primary branches per plant, kernel yield and pod per plant will forthwith increases the pod yield.

So, as a concluding remark, by practicing simultaneous selection with higher number of primary branches per plant, pods per plant, higher kernel yield, higher values of SCMR and lower estimates of SLA, genotypes with both high water use efficiency and higher yield can be achieved.

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