

Original Research Article

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## Study of Genetic Variability and Character Association for Water Use Efficiency (WUE) and Yield Related Traits Advance Breeding Lines of Groundnut (*Arachis hypogaea* L.)

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### ABSTRACT

#### Keywords

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Genetic variation and association among nine characters were studied in 34 advanced breeding lines of groundnut for WUE and yield related traits during summer 2015. Higher estimates of PCV and GCV were recorded for Pod Yield per plant followed by Kernel Yield per plant and Pods per plant indicating the presence of sufficient variability between advanced breeding lines. High heritability with high GAM was observed for yield related traits and SLA; high heritability and low GAM for SCMR, days to first flowering and primary branches per plant indicated the involvement of additive and non-additive gene action. SCMR and yield related traits had strong positive association with pod yield per plant where as SLA exhibited strong negative association with pod yield per plant. Sixteen advance breeding lines superior to parent and checks TMV-2 and KCG-2 in their mean performance having higher pod yield and pods per plant were selected out of eight crosses.

### Introduction

Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crops of the world that belongs to the family: Fabaceae and sub family Papilionoidae with a chromosome number of  $2n=40$ . Extreme climatic conditions, of which drought is one of the most important abiotic stress that poses a major threat to groundnut production, Since over two third of groundnut area in India is grown under rainfed conditions where frequent dry spells is a major limiting factor among the abiotic factors for productivity as compared to other countries (Birthal *et al.*,

2012). Even though several agronomic interventions to conserve the soil moisture and enhance the water use efficiency (WUE) are available, tailoring groundnut varieties tolerate to drought and efficient in water use offers the best option for long term and cost effective solution to encounter the uncertainty of monsoon and limited availability of irrigation water in country. The use of drought tolerant varieties is an important strategy to combat (or minimize) the drought problem.

Off late, a number of easily measurable traits having high correlation with WUE have been identified as surrogates traits. Water Use

Efficiency is one such important trait which is correlated with Specific Leaf Area (SLA), Soil Plant Analysis development (SPAD) Chlorophyll Meter Reading (SCMR) and Carbon Isotopic Discrimination ( $\Delta^{13}\text{C}$ ) (Shashidhar, 2002). Nageswara Rao *et al.*, (2001) and Sheshashayee *et al.*, (2006) reported positive correlations of SCMR and negative correlation SLA with WUE in groundnut, suggesting that SLA, SCMR can be used as a surrogate trait to measure WUE in groundnut. The SCMR has been used effectively to determine leaf nitrogen content non-destructively in a number of crops including groundnut (Nageswara Rao *et al.*, 2001). Nageswara Rao *et al.*, (2001) reported significant and high negative interrelationship among SLA and SCMR.

In order improve pod yield of groundnut, the plant breeder must have knowledge on the type of gene action in different biometrical traits which contribute for enhanced yield. The plant breeder must consider genetic variability for planning suitable measures for the crop improvement.

This necessitates a thorough knowledge of variability owing to genetic factors, actual heritable genetic variation in the progeny and the genetic advance that can be achieved through selection. The present study has been undertaken to determine the estimates of variability, heritability and genetic advance for yield and physiological traits related to Water Use Efficiency in Thirty four advance breeding lines derived from eight different crosses of groundnut.

### **Materials and Methods**

Thirty four advance breeding lines were selected based on their yield performance, WUE and disease reaction during *kharij*2014 from eight crosses viz., NRCG12473  $\times$  ICG12370, NRCG12274  $\times$  ICG12370,

ICG12370  $\times$  NRCG12473, GKVK-8B  $\times$  GPBD-4, GKVK-5  $\times$  GPBD-4, ICG 12370  $\times$  NRCG12274, GKVK-8B  $\times$  KCG-2 and GKVK-5  $\times$  KCG-2. These lines along with two checks TMV-2 and KCG-2 were evaluated for yield and WUE during summer 2015. Selected advance breeding lines were evaluated in Randomized Complete Block Design with two replications for yield and WUE. Each selected line was grown in different blocks with spacing of 30  $\times$  15 cm in the plot size of 2  $\times$  2.1 sq. m. Observations were recorded on 10 plants selected at random for water use efficiency traits viz., days to 50% flowering, SPAD chlorophyll meter reading at 60 DAS, specific leaf area ( $\text{cm}^2\text{g}^{-1}$ ) at 60 DAS, plant height (cm), Primary branches per plant, pods per plant, pod yield per plant (g), kernel yield per plant (g), sound mature kernel percentage (%) and Shelling (%). The phenotypic and genotypic coefficients of variation for all the characters were estimated using the formulae of Burton and De Vane (1953) and Heritability, genetic advance were worked out as per the method outlined by Hanson *et al.*, (1956) respectively.

### **Results and Discussion**

Analysis of variance was carried out for traits related to growth, water use efficiency and yield in selected advance breeding lines of groundnut. Analysis of variance (Table 1) revealed that the mean squares due to genotypes were significant indicating the presence of sufficient amount of variability among the advanced breeding lines for all the traits studied. This was further supported by the fact that range was quite wider for all the characters studied. The magnitude of the genetic variability was indicated by the parameters viz., mean, range, phenotypic and genotypic coefficients of variability, heritability estimates and predicted genetic advance as per cent mean were computed for all the are given in Table 2.

Less difference observed between GCV and PCV indicates the greater role of genetic components and less influence by environment. Highest GCV and PCV was recorded for Pod Yield per plant (25.16 & 27.13) followed by Kernel Yield per plant (23.10 & 25.59) and Pods per plant (20.74 & 23.00). Hence, individual plant selection can be practiced for the above mentioned characters to get higher yields. Concomitant results were obtained by Dandu *et al.*, (2012), Narasimhulu *et al.*, (2012), Priyadharsini (2012), Anitha (2013), John *et al.*, (2013), Narasimhulu *et al.*, (2013), Mukesh *et al.*, (2014) and Thirumala *et al.*, (2014); Prabhu *et al.*, (2015 a); Hugar and Savithramma, 2016; Divyadharsini *et al.*, 2017 for pod yield per plant and Kernel Yield per plant, for Pods per plant Dandu *et al.*, (2012), Narasimhulu *et al.*, (2012), Priyadharsini (2012), Anitha (2013), John *et al.*, (2013), Narasimhulu *et al.*, (2013), Mukesh *et al.*, (2014); Kadam *et al.*, 2016; (Rajarathinam *et al.*, 2017); Divyadharsini *et al.*, 2017.

Moderate GCV and PCV were observed for Plant height (16.32 & 17.11), Primary branches per plant (12.71 & 17.57) and SLA (15.56 & 17.63). Similar results have been reported by Nandini *et al.*, 2011; Zaman *et al.*, (2011), Vishnuvardhan *et al.*, (2012) and Mukesh *et al.*, (2014) for plant height and primary branches, for SLA (John *et al.*, 2011; John and Reddy, 2014). Shelling percentage (12.18 & 13.29) also registered moderate GCV and PCV. Similar results were for Shelling percentage by Nandini *et al.*, 2011; John *et al.*, 2011; Zaman *et al.*, 2011; John *et al.*, 2013; Hugar and Savithramma, 2016; (Rajarathinam *et al.*, 2017).

The low GCV and PCV was observed for SMK% (9.51 & 12.82), SCMR (8.21 & 9.91) and 50% flowering (4.72 & 6.28). Same results were observed by (MakhanLal *et al.*, 2003) for days to fifty *per cent* flowering and for SCMR

(Nandini *et al.*, 2011); Hugar and Savithramma, 2016, for SMK John *et al.*, 2011; Mukesh *et al.*, (2014); Shridevi *et al.*, (2014); Ashutosh and Prashant *et al.*, (2014); Kadam *et al.*, 2016; Balaraju and Kenchanagoudar, (2016); Divyadharsini *et al.*, 2017. Days to 50 % flowering recorded lower PCV and GCV which is analogous to the results obtained by John and Reddy, 2014; Padmaja *et al.*, 2015; Sabiel *et al.*, 2014; Thirumala, 2014; Nandini *et al.*, 2010; Nandini *et al.*, 2011; Patil *et al.*, 2014 which indicates the presence of narrow genetic variability for this trait (Gupta *et al.*, 2015); Kadam *et al.*, 2016.

Heritability value alone cannot give information on the amount of genetic progress that would result from selection of best individuals. Johnson *et al.*, (1955) pointed that heritability estimates along with genetic gain would be more useful than alone in predicting the effectiveness of selecting the best individuals. Therefore it is necessary to consider the predicted genetic advance along with high heritability estimates as a tool in selection programme for better efficiency in the selection.

High heritability coupled with high genetic advance as percent of mean was registered for the traits *viz.*, Plant height (90.90 & 32.05) followed by Pod Yield per plant (86.02 & 48.09), shelling percentage (84.00 & 22.99), Kernel Yield/plant (81.45 & 42.95), Pods/plant (64.00 & 31.70) and SLA (77.80 & 28.27). This indicates that these characters are gene action and selection for genetic improvement will be worthwhile and may rapidly contribute yield. Therefore, it was amply clear that these traits were less influenced by the environmental changes and hence improvement in these traits would be more effective through single selection owing to their additive gene effects and with simple phenotypic selection.

**Table.1** Analysis of Variances for growth, pod yield and water use efficiency in 36 advanced breeding lines of Groundnut derived from eight crosses of groundnut during summer 2015

Source of variation	Df	Mean sum of squares									
		DFF	SCMR	SLA (cm <sup>2</sup> /g)	PH (cm)	PB	PP	PYP	KYP	SMK (%)	Shelling (%)
Replication	1	0.68	0.11	84.52	0.20	0.30	47.95	8.78	7.86	4.99	5.29
Advance breeding lines	35	12.46**	31.35**	925.32**	83.17**	0.79**	108.67**	75.80**	23.19**	144.62**	92.94**
Error	35	3.48	5.81	115.33	3.96	0.25	11.19	5.69	3.36	12.58	26.91

\*Significant @  $P=0.05$ , \*\*Significant @  $P=0.01$

df= degrees of freedom,

DFF= Days to 50% flowering,

SLA= specific leaf area

SCMR= SPAD chlorophyll reading,

SLA= specific leaf area,

PH= plant height,

PP= pods per plant,

PYP= pod yield per plant,

KYP=kernel yield per plant,

SMK= sound mature kernel percentage

**Table.2** Estimates of genetic variability parameters for traits related to growth, yield and water use efficiency in 36 advance breeding lines during summer 2015

Traits	Mean	Range		GCV (%)	PCV (%)	$h^2_{(bs)}$ %	GAM
		Min.	Max.				
50% flowering	44.93	39.50	49.00	4.72	6.28	56.30	7.29
SCMR	43.51	30.27	52.51	8.21	9.91	68.70	14.03
SLA(cm <sup>2</sup> /g)	129.38	86.53	169.00	15.56	17.63	77.80	28.27
Plant height (cm)	38.57	21.78	51.12	16.32	17.11	90.90	32.05
Primary branches/plant	4.10	3.00	5.50	12.71	17.57	52.40	18.95
Pods/plant	33.05	19.00	49.00	20.74	23.00	81.33	38.54
Pod Yield/plant (g)	23.02	12.00	34.53	25.16	27.13	86.02	48.09
Kernel Yield/plant (g)	13.80	7.00	19.77	23.10	25.59	81.45	42.95
Shelling percentage	66.72	52.63	84.93	12.18	13.29	84.00	22.99
SMK%	60.39	42.17	75.20	9.51	12.82	55.10	14.55

\*Significant @  $P=0.05$ , \*\*Significant @  $P=0.01$

**Table.3** Phenotypic correlation coefficient for traits related to yield and traits related to WUE in 36 advance breeding lines during 2015

Traits	SCMR	SLA	Pods/ plant	Kernel yield/plant	Shelling (%)	Pod yield/plant
SCMR	<b>1</b>	<b>-0.366*</b>	<b>0.519**</b>	<b>0.442**</b>	<b>-0.374*</b>	<b>0.583**</b>
SLA		<b>1</b>	<b>-0.223</b>	<b>-0.309*</b>	<b>-0.143</b>	<b>-0.234*</b>
Pods/plant			<b>1</b>	<b>0.847**</b>	<b>-0.212*</b>	<b>0.871**</b>
Kernel yield/plant(g)				<b>1</b>	<b>0.049</b>	<b>0.906**</b>
Shelling (%)					<b>1</b>	<b>-0.371*</b>
Pod yield/plant (g)						<b>1</b>

**Table.4** Superior lines selected from 34 advance breeding lines in groundnut

Sl. No.	Advanced breeding lines	SCMR	SLA	Pods/ plant	Pod yield/Plant (g)
1	SS-31	44.95	110.50	42.60	35.62
2	SS-16	42.34	143.50	47.10	34.53
3	SS-4	41.29	118.30	49.00	32.44
4	SS-15	44.06	169.00	44.90	31.64
5	SS-8	43.05	127.40	40.30	31.62
6	SS-13	48.76	127.82	39.60	31.50
7	SS-7	41.92	147.60	39.10	29.70
8	SS-19	40.62	130.60	35.00	28.56
9	SS-9	41.88	86.53	38.10	28.50
10	SS-25	42.58	130.30	37.64	28.27
11	SS-10	42.54	110.00	40.00	27.00
12	SS-29	43.30	148.20	29.20	26.80
13	SS-5	45.25	112.00	33.00	26.00
14	SS-32	43.20	109.20	36.49	25.66
15	SS-34	43.42	122.50	39.00	25.27
16	SS-1	42.50	106.10	38.00	24.00
	<b>Mean</b>	<b>43.50</b>	<b>129.38</b>	<b>33.04</b>	<b>23.01</b>
<b>Check-1</b>	KCG-2	43.82	155.18	23.70	14.15
<b>Check-2</b>	TMV-2	43.89	141.23	30.30	24.05
	SE	1.70	7.59	3.367	3.022
	CV (%)	5.53	8.30	14.40	18.57

For plant height, Pod Yield per plant, Kernel Yield/plant, shelling percentage and Pods/plants; similar results were earlier reported by Shinde *et al.*, (2010), John *et al.*, (2013), Narasimhulu *et al.*, (2013), Padmaja *et al.*, (2013), Terkimbi and Terkula (2014)

Ashish *et al.*, (2014), Thirumala *et al.*, (2014) and Prabhu *et al.*, (2015 a); Anusha and Savtramma, 2016; Divyadharsini *et al.*, 2017 Rajarathinam *et al.*, (2017), and for SLA by Nandini, *et al.*, 2011; Savita, *et al.*, 2016. High heritability and moderate genetic

advance as *per cent* mean was observed for SCMR (68.70 & 14.03). Concomitant result was reported by Ramana *et al.*, 2015; Rao, 2016). Moderate heritability and moderate GAM was observed for SMK% (55.10 & 14.55) and Primary branches/plant (52.40 & 18.95). For Days to 50% flowering moderate heritability and low genetic advance as *per cent* (56.30 & 7.29). Similar result for SMK Patil 2015; Rajarathinam *et al.*, 2017, for Primary branches/plant and Days to 50% flowering John *et al.*, (2013); Patil *et al.*, 2014; Prabhu 2015, Patil 2015, savita *et al.*, 2016.

Moderate to low heritability (broad sense) indicates the greater influence of environment in the expression of these traits and genetic advance can help to predict the extent of genetic improvement that can be achieved for the traits. High heritability coupled with low genetic advance indicates the greater role of non-additive genetic variance like epistatic and dominant interaction factors controlling the inheritance of these traits.

Correlation coefficient helps the breeder in determining relative importance of yield component for indirect selection for yield. Understanding the relationships among yield and yield components is of prime importance for making the best use of these relationships in selection. Association among yield attributing characters and traits related water use efficiency is presented in Table 3.

Pod yield per plant exhibited significant positive correlation with SCMR (0.583), pods per plant (0.871), kernel yield per plant (0.906) and significant negative association with SLA (-0.234), shelling percentage (-0.371) Thirumala *et al.*, (2014). Similar result was noticed by Mukhtar *et al.*, (2011), Shoba *et al.*, (2012) for SCMR, pods per plant, kernel yield per plant and for SLA by Nandini *et al.*, (2012). Shelling percentage showed

significant negative association with SCMR (-0.374), pods per plant (-0.212) and negative association but not significant with SLA (-0.143) which is in accordance with Nandini *et al.*, (2012). Kernel yield per plant noticed significant positive association with pods per plant (0.442), SCMR (0.847) and significant negative association was observed with SLA (-0.309). Pods per plant showed significant positive association with SCMR (0.519) and non-significant negative association with SLA (-0.223). SCMR showed significant negative association with SLA (-0.366). Pods per plant showed significant positive association with SCMR and negative non-significant association with SLA. These results are in agreement with Thakur *et al.*, (2013). SCMR showed significant negative association with SLA. Similar results are results were noticed by Songsri *et al.*, (2009), Painwadee *et al.*, (2009), Nandini *et al.*, (2011) and Thakur *et al.*, (2013).

Top Sixteen breeding lines having high pod yield per plant and pods per plant as compare to checks *viz.*, KCG-2 and TMV-2 were selected out of 34 advance breeding lines during summer 2015 (Table 4).

In conclusion, the success of plant breeding programs relies heavily on the existence of genetic variability in breeding for a particular trait. Taken as a whole, high percentage of PCV, GCV, heritability coupled with high GAM were recorded for pod yield per plant, kernel yield per plant, number of pods per plant which indicates the presence of additive gene effect and these traits are expected to respond to selection with greater efficiency. Since SLA scored higher heritability estimates coupled with higher genetic advance as *Per cent* mean among the surrogate traits studied, it could be used for selecting high Water Use Efficient genotypes compared to SPAD chlorophyll meter reading which scored lower genetic advance.

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