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ORIGINAL ARTICLE **OPEN ACCESS**

Effect of Imposed drought Stress conditions on Genetic variation of Physiological traits related to water use efficiency and pod yield traits in Recombinant inbred lines of groundnut (*Arachis hypogaea* L.)

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ABSTRACT
Two hundred and fifty RILs in F_8 generations, their parents and checks (TMV 2 and KCG 2) were evaluated for their performance and genetic variability forphysiological traits viz., SLA and SAPD chlorophyll meter reading related to water use efficiency and pod yield related traits under well watered and water stress condition at 60 DAS for the period of twenty days during summer 2015. Pod yield per plant and kernel yield per plant recorded maximum genotypic and phenotypic coefficient of variation (GCV and PCV), heritability and genetic advance as per cent of mean indicating the involvement of additive gene action and less environment influence. Whereas, SLA, pods per plant, shelling per cent and sound mature kernel per cent were indicating high GCV, PCV, heritability and GAM in water stress condition and moderate GCV, PCV and high heritability and GAM in well watered condition that shows the involvement of additive and non-additive gene action in controlling of these traits respectively and considerable amount of environmental influence was under well watered condition. Low GCV, PCV, high heritability and moderate genetic advance as per cent of mean was observed for SCMR.
***Key words**: Groundnut, SLA, SCMR, RILs, Water use efficiency.*

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop and major sources of dietary protein, minerals and vitamins for vegetarians in India. Productivity is low in the arid and semiarid regions mainly because of drought caused by low and erratic rainfall. Identification of genotypes that have a greater ability to use limited available water is important to enhance productivity of the crop. 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), Carbon Isotopic Discrimination ($\Delta^{13}C$) and transpiration efficiency ($\delta^{18}O$) and these traits have been suggested as surrogate traits in selecting for WUE in groundnut [1,8,5]. $\Delta^{13}C$ and SLA are inversely related to WUE and yield. SCMR and $\delta^{18}O$ are positively related to yield and WUE [5, 7, 14]

In order to improve pod yield of groundnut, the plant breeder must have knowledge on the nature of gene action in different biometrical traits which contribute for enhanced yield under water limited condition. The genetic variability has to be looked into for planning suitable measures for the crop improvement. This necessitates a thorough knowledge of variability owing to genetic factors, actual genetic variation heritable in the progeny and the genetic advance that can be achieved through selection for yield. An attempt has been made in this study to estimate the genetic variability parameters in recombinant inbred line population of cross GKVK 4 X NRCG 12473 in groundnut for traits related to WUE, pod yield and yield related traits.

MATERIAL AND METHODS

The present experimental material consisted of 250 F_8 RIL population developed through single seed descent method using parental lines GKVK 4 and NRCG12473 which are diverse for trait carbon isotopic discrimination and SLA and SCMR. These were grown in an augmented design, one experiment provided with well watered condition (WW) and in another experiment water stress (WS) imposed at 60 days after sowing (DAS)for the period of 20 days with spacing of 30 x 10 cm^2 during Rabi summer 2015 in UAS, GKVK, Bengaluru. Observations were recorded on five randomly chosen plants from each RIL. Ten characters viz., Days to 50 *per cent* flowering (DFF), plant height (PH), number of branches per plant (NB/P), number of pods per plant (NP/P), kernel yield per plant (KY/P), shelling percentage (SH %), sound mature kernel percentage (SMK %), SLA , SCMR and pod yield per plant (PY/P) were recorded. The genotypic and phenotypic coefficient of variations were computed as suggested by Robinson *et al*., [10]. Heritability and genetic advance were worked out as per the method outlined by Hanson *et al*. [3].

RESULTS AND DISCUSSION

Table 1: Analysis of variance for growth parameters, traits related to WUE, yield and its component traits in F8 recombinant inbred lines of the cross GKVK 4 × NRCG12473 in groundnut under water stress (WS) and well watered (WW) conditions.

Source of variation	Expt	DF	SPAD	SLA (cm^2/g)	DFF	PH (cm)	NB/P	SH%	SMK%	NP/P	KY/P (g)	PY/P (g)
Block	WW	9	2.262	59.064	4.068	19.85**	0.83	48.85	65.19	35.88**	11.28***	1.15
	WS	9	3.30	92.33	4.06	45.16***	5.78	3.73	20.08	40.00	2.21	4.65
Entries	WW	253	23.382***	880.75***	12.27**	27.33***	5.353 **	89.03 **	193.65***	57.66***	14.88***	6.86 ***
	WS	253	30.16***	1105.11***	12.27**	39.32***	8.51***	536.2***	241.80***	72.46**	8.41***	16.83***
Checks	WW	3	72.74***	655.864***	38.73**	36.29**	15.36***	258.64**	240.14**	98.91***	22.26***	14.78***
	WS	3	65.91***	1254.43***	38.73**	232.29***	16.73**	336.71***	223.46***	226.23***	43.91***	92.17***
Varieties	WW	249	20.03***	872.87 ***	11.85**	23.75***	5.13**	85.54**	176.04***	50.70***	13.21***	6.50***
	WS	249	26.76 ***	1089.50***	11.85**	37.13 ***	8.20***	540.69***	239.38***	70.11**	7.81***	15.75***
Checks vs. Varieties	WW	1	709.54***	3518.97 ***	38.16*	893.73***	30.08***	447.32**	4437.34***	1667.8***	407.8***	71.18***
	WS	1	770.47***	4541.18***	38.16*	6.05	61.54 ***	26.16	899.37***	197.10*	51.07***	58.97 ***
ERROR	WW	27	1.83	26.37	5.36	5.97	2.07	37.12	33.12	9.79	1.78	0.85
	WS	27	1.96	41.71	5.36	6.64	2.78	6.93	17.28	26.83	1.42	2.41

*Significant @ P =0.05 ** Significant @ P = 0.01
SCMR- SPAD chlorophyll meter reading; **SLA**-Specific leaf area (cm^2/g); **DFF**-Days to fifty *per cent* flowering ; **PH**-Plant height (cm); **NB/P**- Number of branches per plant ; **NP/P**- Number of pods per plant ;**SMK (%)** - Sound mature kernel *per cent;* **SH (%)** - Shelling *per cent***PY/P** – Pod yield per plant (g) **KY/P** – Kernel yield per plant (g)

Analysis of variance in RIL population of the cross GKVK 4 X NRCG12473 revealed significant differences among the RILs for all the characters studied indicating the presence of genetic variability (Table 1) [8,9]. This was further supported by the fact that range was quite wider and high standardized range in F_8 RILs under WS condition for SLA, SCMR, NP/P, SH%, SMK%, KY/P and PY/P suggesting that these traits may be improved by individual plant selection and also pointing out extreme genotypes for selection under WS condition respectively [8, 4].26

The PCV and GCV estimates were relatively high for specific leaf area, number of branches per plant, number of pods per plant, sound mature kernel percentage, kernel yield per plant and pod yield per plant under both WS and WW condition suggesting presence of considerable variation. The close correspondence between the estimates of GCV and PCV indicate the less influence of environment in expression of these traits hence, individual plant selection can be practiced for the above mentioned characters to get higher yield and high Water Use Efficiency genotypes using SLA as a surrogate trait [13, 14].

Moderate estimates of PCV and GCV were observed for the characters like plant height, shelling percentage in WW condition, but had a high PCV and GCV under WS condition indicating presence of variability for these characters Therefore, a better scope exists for this character for improvement under drought or limited water condition [12, 14]. Whereas days to 50 *per cent* flowering and SPAD chlorophyll meter reading recorded lower PCV and GCV in cross GKVK 4X NRCG 12473.

On the whole, co-efficient of variation values indicated considerable amount of variability for most of the characters except for days to 50 *per cent* flowering and SPAD chlorophyll meter reading. As there is considerable variability in RIL population they can be further used in identification of QTLs related to surrogate traits of WUE and yield attributing traits and to select some good genotypes with high yielding and Water Use Efficiency.

Heritability is a measure of the genetic relationship between parents and progeny and widely used in determining the degree to which a character may be transmitted from parents to off-springs. Heritability value alone cannot provide information on the amount of genetic progress that would result from selection of best individuals. Heritability estimates along with genetic gain would be more useful than the former alone in predicting the effectiveness of selecting the best individuals [6]. Therefore, it is essential to consider the predicted genetic advance along with heritability estimate as a tool in the selection programme for better efficiency in the selection.

High heritability coupled with high genetic advance as *per cent* of mean was reported for characters like SLA, plant height, sound mature kernel *per cent*, kernel yield per plant and pod yield per plant under both WW and WS conditions, whereas number of branches per plant and shelling *percent* showed high heritability and genetic advance as percent of mean under WS condition and number of pods per plant under WW condition(Table 2). This shows that these characters are under the control ofadditive gene action and less influence of environment in expression of these traits hence, there is lot ofscope for improvement of these traits in the further breeding programme and single plant selection can be followed to breed for high yielding and Water Use Efficient genotypes in groundnut [13, 4]. Various other studies reported high broad sense heritability coupled with high genetic advance for pod and kernel yield [2,5] reported high heritability coupled with GAM for sound mature kernel percentage along with kernel yield and pod yield in groundnut. High heritability coupled with high genetic advance as *per cent* of mean was reported for characters like plant height, pod yield per plant, sound mature kernel *per cent* and kernel yield per plant and SLA in groundnut [8, 9].

Table 2: Genetic variability parameters for growth, traits related to WUE, yield and its component traits in F_8 recombinant inbreed line population of the cross GKVK 4 × NRCG12473 in groundnut under well watered (WW) and water stress (WS) conditions.

Characters	Experiments	Mean	Range		Standardized range	GCV (%)	PCV (%)	h^2_{bs} (%)	GAM (%)
			MIN	MAX					
SCMR	WW	42.27	29.50	53.60	0.57	9.24	9.75	89.83	18.03
	WS	44.72	7.96	57.56	1.11	10.03	10.46	91.83	19.79
SLA (cm^2/g)	WW	137.38	44.16	252.12	1.62	18.59	18.97	96.62	43.73
	WS	128.86	51.18	260.11	1.62	23.24	23.76	95.72	46.85
DFF	WW	39.10	32.00	47.00	0.38	6.25	8.67	52.58	9.27
	WS	37.30	30.00	45.00	0.40	6.59	9.15	55.85	9.77
PH (cm)	WW	37.00	18.00	43.00	0.68	13.03	15.16	72.56	23.34
	WS	30.90	13.00	41.00	0.91	10.01	21.13	80.32	32.26
NB/P	WW	6.40	2.00	10.00	1.56	29.03	38.51	56.81	45.07
	WS	5.30	2.00	14.00	2.26	35.19	44.22	63.33	57.69
NP/P	WW	17.50	4.30	39.60	2.02	29.95	33.72	78.79	54.76
	WS	21.56	1.40	42.00	1.88	31.97	41.65	58.92	50.55
SH (%)	WW	55.50	26.00	76.00	0.90	12.02	16.65	53.70	18.41
	WS	54.44	8.77	92.52	1.54	41.57	41.87	98.56	85.02
SMK (%)	WW	59.76	28.26	90.74	1.05	22.33	23.29	79.33	32.03
	WS	63.89	8.42	96.67	1.38	17.46	19.06	91.95	44.12
KY/P (g)	WW	6.37	0.68	22.40	1.84	37.09	40.11	85.49	70.65
	WS	8.03	0.38	26.00	1.95	36.67	41.01	79.97	67.56
PY/P (g)	WW	19.83	3.00	38.95	1.72	28.73	31.21	85.07	54.53
	WS	23.20	4.02	43.04	1.67	21.07	34.08	83.11	58.34

SCMR- SPAD chlorophyll meter reading; **SLA**-Specific leaf area (cm^2/g); **DFF**-Days to fifty *per cent* flowering
PH- Plant height (cm) ; **NB/P**- Number of branches per plant; N**P/P**- Number of pods per plant
SMK (%) - Sound mature kernel *per cent;* **SH (%)** - Shelling *per cent* **PY/P** – Pod yield per plant (g)
KY/P – Kernel yield per plant (g)

High heritability coupled with moderate genetic advance as *percent* of mean was observed for SCMR in both WS and WW condition. This moderate value may be due to moderate values for phenotypic standard deviation as the heritability is high for this character and selection differential is always constant. Moderate heritability and high genetic advance is being observed for the characters number of branches per plant in normal and number of pods under WS condition. Moderate heritability coupled with moderate genetic advance is being observed for the character shelling *percent* under WW condition which indicated considerable influence of environment apart from that both additive and non-additive gene action involved which indicates lower to moderate variability in these characters and hence in further breeding program separate hybridization can be followed by selecting superior sergeants. Days to fifty *percent* flowering shows moderate heritability and low genetic advance as *percent* of mean indicated the prevalence of narrow range of variability, high G x E interaction or non-additive gene action therefore selection will not be effective for these characters in further generation.
Among the surrogate traits studied SLA was found to better trait for selecting high WUE genotypes compared to SCMR because of additive gene action and also parents of the cross also different for SLA hence could be used in further breeding program.

CONCLUSION

Groundnut is mainly grown in arid and semi-arid regions of the world where drought is the major constraint for productivity. So, to develop varieties resistant to drought condition it is necessary to identify genotypes having high Water Use efficiency. Hence, in our present study we evaluated RIL population for Water Use Efficiency based on surrogate traits like SLA and SCMR. High PCV and GCV were found for WUE related traits and also for yield and yield attributing traits indicating individual plant selection can be followed. Among surrogate traits of WUE, Specific Leaf Area was found to be better to select high WUE genotypes because additive gene action governing for this trait.

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