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Studies on variability and genetic association of drought and yield related traits in advance breeding lines of groundnut (*Arachis hypogaea* L.)

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Abstract
Advance breeding lines of groundnut from ICRISAT and UAS Dharwad were evaluated at regional agricultural research station (RARS) at Vijayapur for the study of genetic parameters and relationship between drought related traits *viz.,* relative water content (RWC), specific leaf weight (SLW) and SPAD chlorophyll meter reading (SCMR) and pod yield associated characters under normal rainfed condition. Analysis of variance revealed significant differences among advance breeding lines and indicate existence of considerable genetic variability for drought and pod yield related traits. The magnitude of PCV, GCV, heritability and genetic advance as *per cent* of mean were high for number of primary branches per plant (NPBP), number of secondary branches per plant (NSBP), number of immature pods per plant (NIMP), number of mature pods per plant (NMPP) and moderate for pod yield, hundred kernel weight (HKW) and SLW recorded at 45th days after sowing (DAS) and 75th DAS. This indicate traits are mainly governed by additive gene action, less of environment influence and response to selection. RWC at 75th DAS, SLW at 45th DAS and SCMR showed significant positive association with pod yield. Therefore, better scope exists for these characters for improvement under drought or water deficit conditions in advance breeding lines of groundnut.

Keywords: Groundnut, RWC, SCMR, SLW and heritability

Introduction
Groundnut (*Arachis hypogaea* L.) is the 13th most important food crop and fourth most important oilseed crop of the world. Over two third of the global production occurs in rainfed regions and in India, about 80% of groundnut area in the country lies in the area where erratic and insufficient rainfall is a major constraint (Wright and Nageswara Rao, 1994) [15]. Drought is by far the most important factor contributing to a yield loss in semi-arid tropics (SAT) and has depressive effects on groundnut productivity (Songsri, 2008a, b) [12, 13]. Drought tolerant varieties have been used to stabilise peanut productivity under moisture limited conditions. Breeding for drought resistant has been an important strategy in alleviating the problem.
The past effects, based on empirical approach, to develop drought tolerant genotypes have been inefficient and tardy where, yield has been a primary target trait of drought resistant breeding and selection for yield has slow progress because of the complex nature of the trait that causes high genotype by environment interactions (Jongrungklang, 2008) [5]. Therefore, alternative selection strategy in order to breed for drought tolerance are worth exploring. Recently, the focus in tolerance breeding has shifted towards physiological traits associated with drought. Many physiological traits are associated with drought tolerance in groundnut. These includes, RWC (Songsri. 2008b) [13], SLW (Madhava, 2003 and Boontang, 2010) [6, 1] and SCMR (Puangbut, 2011). The present study was conducted with the objective to evaluate advance breeding line of groundnut for drought tolerance and to estimate the amount of genetic variability and association of physiological traits with pod yield and yield related parameters under rainfed condition.

Material and methods
Hundred advance breeding lines of groundnut which includes released varieties and advanced breeding lines of groundnut from ICRISAT and UAS Dharwad. Advance breeding lines were evaluated in randomised block design with two replication at RARS, Vijayapur, Karnataka during *kharif* 2011 (June – Oct) under normal rainfed condition. The total amount of rainfall received by area was 407.2mm and there is frequent moisture stress conditions occurs during crop growth period due to low and erratic distribution of rainfall, because of these reasons, location was selected to test genotype for drought tolerance. The plot size was 3m length.

The inter- and intra-row spacing was 30cm and 10cm, respectively. It was protected from foliar diseases and foliar pests during the cropping period, as and when necessary, to avoid damage to the leaves. Plots were kept damage free through manual weeding. Observations on drought related traits viz., RWC, SLW at 45th and 75th DAS and SCMR at 75th DAS were recorded and also pod yield per plot and the yield contributing characters, *viz.*, days to fifty per cent flowering (DFF), days to maturity (DM), NPBP, NSBP, NIMP, NMPP, pod yield per plot (g/plot), shelling percentage (SH%), hundred kernel weight (HKW) and sound mature kernel percentage (SMK%) were recorded. Genotypic and phenotypic coefficient of variability (GCV and PCV) and heritability percentage (broad sense) were worked out as per Singh and Chaudhary (1977). The expected genetic advance per cent over mean (GAM %) was worked out according to Johanson. (1955) [4].

Result and discussion

The average rainfall and rainy days at RARS Vijayapur during *kharif* season 2011 is presented in Table 1. The total rainfall was 30% less than the average rainfall (553mm) of the area and its distribution was very scanty. According to the weather data moisture stress was observed at initial and end of season. The analysis of variance revealed significant differences among the genotypes for all the characters indicating the existence of sizable variability for all the characters and considerable improvement can be achieved in these characters by simple selection. However, analysis of variance by itself is inconclusive in explaining all the inherent genetic variability among advance breeding lines. Hence, actual variance has to be estimated for the characters to know the extent of existing variability. The mean, range, standardised range, coefficients of genotypic and phenotypic variation, heritability and genetic advance of various characters are given in the Table 2. The phenotypic coefficient of variability (PCV) and genotypic coefficient of variability (GCV) estimates were relatively high for NPBP, NSBP, NIMP and NMPP. Physiological traits associated with drought tolerance RWC at 75 DAS, SLW at 45 and 75 DAS, SCMR at 75 DAS and pod yield and its related traits HKW and SMK% showed moderate GCV and PCV. These results in accordance with Boontang, (2010) [1] for SLW, in contrast to present results Songsri. (2008b) [13] reported low genetic variability for RWC. Moderate to low GCV and PCV were observed for RWC at 45 DAS, DFF, DM and SH% indicating low amount of variability in advance breeding lines, similar findings were reported for SCMR by Songsri. (2009) [11]. High to moderate magnitude of genotypic coefficient of variation revealed that greater extent of variability is present in these characters, thereby suggesting good scope for improvement through selection. The close correspondence between GCV and PCV indicate less influence of environment in expression of characters.

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 (Gopinath, 2008) [2]. Jonson. (1955) [4] reported that heritability estimates along with genetic gain would be more useful than the former alone in predicting the effectiveness of selecting the best individuals. 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 has been noticed for the characters SLW at 45 and 75 DAS, number of primary and secondary branches, and number of immature and mature pods, pod yield and HSW indicated prevalent of additive gene action and lesser influence of environment in expression of characters. These results were in accordance with Gopinath, (2008) [2], Boontang, (2010) [1] and Songsri, (2009) [11]. Whereas, high heritability coupled with moderate GAM was observed for RWC at 45 and 75 DAS and SCMR at 75 DAS, pod yield, SH% and HKW. This moderate value may be due to moderate values for phenotypic standard deviation as the heritability is high for these characters and selection differential is always constant. For moderate values of genetic advance, both additive and non-additive gene action might be responsible for the expression. Painawadee, (2009) [7] reported heritability estimates were low to intermediate for SCMR and SLW. Venkateswarlu, (2007) [14] eported the predominance of additive gene action in expression of SLW and SCMR. High heritability with low GAM was noticed for days to fifty *per cent* flowering, days to maturity and SMK%. However, oil content (%) in groundnut showed moderate heritability and lower values of GAM indicated the prevalence of narrow range of variability, high genotype and environment interaction or involvement of non-additive gene action in their expression.

Information on the phenotypic and genotypic interrelationship of the pod yield with its components and physiological characters and also among the component characters themselves would be useful to the breeder in developing an appropriate selection strategy. Yield is a complex character and influenced by number of traits and selection based on yield usually not much effective, indirect selection on the basis of desirable component characters could be of great use. In the present study, pod yield per plant had positive correlation with physiological traits RWC at 45 and 75 DAS, SLW at 45 and 75 DAS and SCMR at 75 DAS (Table 3). Pod yield related traits viz., NPB, NSB, NMP, SH%, HKW and oil% showed positive association among advance breeding lines under rainfed conditions. Similar results were reported by Songsri, (2008) [12, 13], Jongrungklang, (2008) [5] and John, (2009) [3]. Paungbut, (2009, 2011) [9] reported that SCMR positively correlated with pod yield. Significant positive interrelationship was observed among the physiological traits RWC and SLW at 45 and 75 DAS, whereas, SCMR showed negative association with RWC at 45 DAS.

The results of genetic parameters and correlation analysis revealed that the considerable genetic variability present in advance breeding lines for the drought and yield related traits. Physiological traits like RWC at 75 DAS, SLW at 45 and 75 DAS and agronomic and yield components viz., NPBP, NMPP, HKW and SMK% were observed to be important yield contributing characters under drought stress or moisture limited conditions.

Table 1: Weekly average weather data for the 2011 *kharif* at RARS Vijayapur.

Months	Standard meteorological week No.	Air temperature (^{0}c)		Rainfall (mm)	
		Maximum	Minimum	Rainfall (mm)	Rainy days
June	24	32.4	22.0	1.6	0
	25	32.9	22.1	0.0	0
	26	33.0	22.5	0.2	0
July	27	32.1	21.7	31.7	4
	28	30.3	21.1	48.4	3
	29	30.4	22.3	0.6	0
	30	30.9	21.4	69.0	3
August	31	29.7	21.4	22.0	1
	32	31.1	22.1	7.6	1
	33	31.7	21.7	15.6	1
	34	29.7	21.6	63.2	4
	35	28.2	21.7	22.6	3
September	36	30.5	21.5	0.0	0
	37	32.1	21.1	11.8	1
	38	30.9	20.0	0.0	0
	39	31.7	20.0	44.1	4
October	40	31.9	21.5	2.6	1
	41	32.4	21.4	7.5	1
	42	32.7	21.3	60.4	2
	43	31.8	19.8	0.0	0
	44	30.9	19.5	0.3	0
	45	31.8	15.4	0.0	0
Total				407.2	29

Table 2: Genetic variability parameters for physiological traits related to drought tolerance, pod yield and yield related parameters in advance breeding lines of groundnut.

Characters	Mean	Range	GCV	PCV	h^2	GAM
Relative water content (RWC%) at 45 DAS	67.47	32.96-79.98	9.1	9.62	89	17.74
Relative water content (RWC%) at 75 DAS	69.2	40.56-88.77	12.21	12.52	95	24.51
Specific leaf weight (SLW g/cm2) at 45 DAS	17.91	11.22-24.12	14.25	15.31	87	27.32
Specific leaf weight (SLW g/cm2) at 75 DAS	17.81	12.26-24.83	11.6	12.77	83	21.7
SPAD chlorophyll meter reading (SCMR) at 75 DAS	34.55	14.15-52.15	12.88	16.15	64	21.15
Days to fifty per cent Flowering (DFF)	40.23	36.50 -45.50	3.44	4.03	73	6.03
Days to maturity (DM)	102.59	97.00 -106.50	1.4	1.62	75	2.5
Number of primary branches per plant (NPBP)	6.9	2.65 -15.45	20.78	24.69	71	10.26
Number of secondary branches per plant (NSBP)	2.3	0.09 -11.65	44.1	46.33	95	68.75
Number of immature pods per plant (NIMP)	5.78	1.15- 21.45	43.02	46.31	86	82.32
Number of mature pods per plant (NMPP)	25.75	5.65 -58.95	31.34	33.05	90	61.2
Pod yield (g/plot)	625.08	378.0- 944.0	15.46	19.8	61	24.87
Shelling per cent (SH %)	61.62	37.25- 72.65	6.02	7.61	63	9.81
Sound matured kernel per cent (SMK %)	82.07	75.00 -93.48	13.34	13.72	80	6.21
Hundred kernel weight (HKW g)	42.79	31.15 -57.70	11.14	10.6	74	16.23

Table 3: Genotypic correlation for physiological traits related to drought tolerance and yield related parameters with pod yield in advance breeding lines of groundnut.

Characters	RWC at 45 DAS	RWC at 75 DAS	SLW at 45 DAS	SLW at 75 DAS	SCMR at 75 DAS	DFF	DM	NPBP	NSBP	NIMP	NMPP	SH (%)	SMK (%)	HKW (g)	YPP (g/plot)
RWC at 45 DAS	1	0.113**	0.203**	0.149**	-0.176**	0.013	-0.096**	-0.321**	-0.100**	-0.013	-0.117**	0.066**	-0.071**	0.047**	0.093**
RWC at 75 DAS		1	0.184**	0.188**	0.099**	-0.080**	0.021*	0.009	0.035**	0.118**	0.086**	0.160**	0.077**	-0.115**	0.276**
SLW at 45 DAS			1	0.804**	0.197**	0.179**	0.316**	0.012	-0.031**	0.137**	-0.051**	-0.017	0.085**	0.020	0.128**
SLW at 75 DAS				1	0.248**	0.169**	0.294**	-0.076**	-0.057**	0.109**	-0.105**	0.018	0.070**	0.074**	0.122**
SCMR					1	0.111**	0.163**	0.012	0.119**	0.142**	0.132**	0.097**	-0.031**	0.009	0.204**
DFF						1	0.580**	-0.012	-0.021*	0.167**	-0.025*	0.115**	0.015	0.019	-0.042**
DM							1	0.104**	0.230**	0.415**	0.091**	-0.077**	0.028**	-0.045**	0.264**
NIMP								1	0.253**	0.222**	0.287**	0.062**	-0.018	-0.136**	-0.124**
NMP									1	0.355**	0.338**	0.024*	-0.098**	-0.098**	0.217**
NPB										1	0.437**	0.006	-0.098**	-0.022*	0.261**
NSB											1	-0.041**	-0.035**	0.130**	0.355**
SH (%)												1	0.170**	-0.052**	0.114**
SMK (%)													1	0.023*	-0.029**
HKW (g)														1	0.177**
YPP (t/ha)															1

'*'- 5% level of significance '**'- 1% level of significance.

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