



## GENETIC VARIATION OF GROUNDNUT (*Arachis hypogaea* L.) GENOTYPES IN SEMI-ARID ZONE SUDAN

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### Abstract

Twelve genotypes of groundnut (*Arachis hypogaea* L.) were executed under rain-fed conditions in a semi-arid zone at the Research farm of El Fasher Research Station, Sudan for two consecutive seasons 2006 and 2007. Genotypic and phenotypic variability, heritability in a broad sense and genetic advance were estimated in a randomized complete block design with four replications. High heritability estimate (above 95 %) was recorded by hay yield (kg/ha) in both seasons and 100- seed weight in season 2006. Moreover, the high genetic advance was recorded for hay yield (kg/ha) and pod yield (kg/ha) in both seasons. However, a day to 50% flowering was expressed low genotypic coefficient of variation with low genetic advances in both seasons. Highly significant different among genotypes were found for days to 50% flowering, hay yield (kg/ha), shelling (%), while pod yield (kg/ha) and 100- seed weight were observed non-significant. The high yielding genotype was ICGV93260 with a pod yield of 1389.1 kg/ha. Pod yield (kg/ha) was highly significantly and positively correlated with hay yield (kg/ha), shelling (%) and 100- seed weight, while non-significant and negative correlated with days to 50% flowering. Based on the results the characters hay yield (kg/ha), shelling (%), 100- seed weight and days to 50% flowering to be the important characters which would be used in selection for groundnut improvement. The promising genotype identified in this study could provide valuable sources of resistance to climate-change-related stresses and for other consequent breeding activities in groundnut improvement.

Key words: Groundnut, genetic, variability, heritability, correlation

## Introduction

Groundnut (*Arachis hypogaea* L.) is annual legume allotetraploid species with  $2n = 40$  (Dwivedi *et al.*, 2001) widely cultivated under rain-fed conditions in arid and semi-arid regions of the world (Thakur *et al.*, 2013). It is an important crop used for a source of food, edible oil, feed, digestible proteins, vitamins, minerals, phytosterols, fuel, cosmetics and green manuring crop for improvement of soil validity (Reddy *et al.*, 2003; Ronghua *et al.*, 2007; Shoba *et al.*, 2010; Sudhir *et al.*, 2010; Zaman *et al.*, 2011). Reduced of rainfall over various regions and there is a strong fluctuation from year to year results decreased in yield of crops (Bhandari, 2014). Groundnut is sensitive to drought stress during the all growing stages; cause the greatest reduction in yield and quality (Gowda *et al.*, 2009; Prathima *et al.*, 2011; Ramesh *et al.*, 2007).

Sudan is one of most an important countries producer groundnut in the world (Zaman *et al.*, 2010). It is a major oilseed and cash crop, used for food, forage and the enhancement of soil fertility. The majority of groundnut crop cultivated under rain-fed conditions and sandy soil, it has been reduced due to severely affected by drought stress and depending on traditional subsistent farming systems (Fadl and Gebauer, 2004). Several studies on groundnut have been carried out, but has a few attentions and there is limited information regarding its genetics, breeding and production, especially genetic improvement under rain-fed conditions, due to groundnut has a narrow genetic base due to its monophyletic origin, self-pollination and lack of gene flow (Meta and Monpara, 2010). Moreover, to improve and sustain the yield of groundnut under rain-fed condition, plant breeders should have a better understanding of the genetic variability of yield and its components and development of high yielding cultivars with drought tolerant at different stages of crop growth (Reddy *et al.*, 2003; Zaman *et al.*, 2010). Therefore, the objectives of this study were to estimate the genotypic and phenotypic variability, broad sense heritability, morphological and yield associated traits of groundnut genotypes under rain-fed conditions in the semi-arid region of Sudan. The result of this investigation may provide good information for advance understanding of genetic variability, suitable selection criteria for predicting the pod yield in groundnut and further breeding program.

## Materials and Methods

### Study site and experimental design

The experiment was conducted under rain-fed conditions in a semi-arid zone at El Fasher Research Station Farm located on (13°37'N 25°20'E, 748 msl) North Darfur State, Western Sudan, in sandy soil without fertilizer, non-pesticide nor irrigation for two consecutive cropping seasons 2006 and 2007. The total amount of rainfall received during the growing season was 256 and 278.1 mm for 2006 and 2007, respectively (Table 1). Twelve genotypes of groundnut (*Arachis hypogaea* L.) were used for the study, obtained from the national program, Agricultural Research Corporation, Sudan. These genotypes were ICG221, ICGV92121, ICGV92126, ICGV86744, ICGV93955, ICGV89171, ICGV89104, ICGV93260, ICGV93261, ICGV93269, SODIRI and BARBERTON. The experiment was planted on the 9 July 2006 and 13 July 2007. The study was laid out in a Randomized Complete Block Design (RCBD) with

four replications. Each genotype was planted in 5 rows of 4 meter length, with spacing of 60 cm between rows and 20 cm between plant holes. The total plot size was 12m<sup>2</sup> the net harvested plot size was 6.48m<sup>2</sup> (3middle rows of 3.6 meters length). Three to four seeds were planted in each hole and seedlings were thinned to two plants per hole, two weeks after planting. Each row contained 20 plants. Weeding was performed by hand two times per season.

**Table 1. Monthly and seasonal rainfall during growing season of 2006 and 2007 at El Fasher Research Station in North Darfur, Sudan**

Month	Season 2006	Season 2007
April	-	-
May	-	13.5
June	6.0	-
July	68	42.9
August	122.8	207.5
September	59.2	14.2
Total annual rainfall	256 mm	278.1 mm

### Data collection

Data were recorded on days to 50% flowering (days from sowing to a time when 50% of the plants start to flower), 100 seed weight (g), shelling (%), hay yield (kg/ha) and pod yield (kg/ha).

### Statistical analysis

Analysis of variance (ANOVA) was carried out on the data to assess the genotypic effects and their interaction using a general linear model (GLM) procedure for randomized complete block design in SAS (version 8). Based on the analysis of variance, phenotypic and genotypic variances, heritability, genotypic coefficient of variation, genetic advance and phenotypic correlation between pod yield and traits were estimated. Means for each season and two seasons were used to compute simple linear correlation coefficients.

### Results and Discussion

The results showed highly significant variation among the genotypes for most of the trait studies in both seasons (Table 2), a similar conclusion was reported by Thakur *et al.* (2013); Zaman *et al.* (2011). They had suggested that selection based on these characters will be meaningful in predicting for pod yield in groundnut. The high genotypic coefficient of variation and genetic advance were recorded for pod yield (kg/ha) in both seasons (Table 2). High heritability estimate (above 95 %) was recorded by hay yield (kg/ha) in both seasons and 100-seed weight in season 2006. This finding is in agreement with the results obtained by Ayub Khan *et al.* (2000); Meta and Monpara (2010), indicating participation of additive gene action for these traits. Moreover, the high genetic advance was recorded for hay yield (kg/ha) and pod yield

(kg/ha) in both seasons, have been also reported in previous studies by Golakia *et al.* (2005); Parmeshwarappa *et al.* (2008); Venkateswarlu *et al.* (2007), indicating that this character was under the control of additive genetic effects. However, days to 50% flowering were expressed low genotypic coefficient of variation with low genetic advances in both seasons (Table 2). They suggested that the trait is less an expression of environmental influence.

**Table2. Estimates of heritability in the broad sense ( $h^2B$ ), (GCV) and (PCV) coefficients of variation, genetic advance (GA) as a percentage of the mean for 5 traits in 12 Groundnut grown at the FRS, seasons 2006 and 2007**

Traits	Seasons	Range	Means	F value	H <sup>2</sup> B	GCV	PCV	GA
Pod yield (kg/ha)	2006	1244-943	1066.75	9.24***	90.2	9.8	10.3	92.7
	2007	1643- 1266	1501.08	1.13 <sup>ns</sup>	53	8.22	11.29	85.2
Days to 50% flowering	2006	37-36	36.35	4.57***	82.1	1.5	1.7	1.04
	2007	37- 34	35.27	3.08**	75.5	2.21	2.54	1.4
100- seed weight (g)	2006	32.0-26.8	28.96	53.97***	98	6.27	6.34	3.7
	2007	37.0- 28.8	33.81	2.39*	50.5	6.3	8.92	3.11
Shelling (%)	2006	73.1-66.1	70.17	2.57*	72	2.91	3.43	3.56
	2007	75.6 - 69.5	72.49	2.20*	68.8	2.05	2.48	2.54
Hay yield (kg/ha)	2006	2556- 2136	2291.54	38.0***	97.4	5.71	5.8	93.1
	2007	4586- 3269	3892.44	40.07***	97.6	9.67	9.79	96

\*, \*\*, \*\*\* Significant at 0.05, 0.01 and 0.001 probability level, respectively

The combined analysis showed that the genotypes were differed highly significantly for hay yield (kg/ha), shelling (%) and days to 50% flowering (Table 3). Similar patterns of variability also reported by Zaman *et al.* (2011). While non-significant for pod yield (kg/ha) and 100- seed weight was observed (Table 3). The early flowering genotypes were ICGV93261 and ICGV93269 however; the late flowering genotype was BARBERTON. The high yielding genotype was ICGV93260 with a pod yield of 1389.1 kg/ha (Table 3). The promising genotype identified in this study could provide valuable sources of resistance to climate-change-related stresses and for other consequent breeding activities in groundnut improvement.

**Table 3. Mean performance of 12 Groundnut genotypes grown at the FRS Farm (combined over two seasons, 2006 and 2007)**

Genotypes	PY	DF	SW	SH	HY
ICG221	1290.9ab	36.0abcde	31.4ab	72.0ab	3035.3d
ICGV92121	1138.1b	35.3de	32.3ab	69.6bc	2831.3e
ICGV92126	1280.9ab	36.2abcd	29.9b	69.0c	3451.3a
ICGV86744	1188.3ab	36.4ab	31.4ab	70.6abc	2738.6f
ICGV93955	1224.3ab	35.6bcde	31.5ab	72.0ab	3036.8d
ICGV89171	1272.3ab	35.4cde	33.1a	70.9abc	3231.3b
ICGV89104	1235.5ab	35.4cde	31.0ab	71.2abc	3197.8bc
ICGV93260	1389.1a	36.5ab	31.0ab	69.2bc	3377.0a
ICGV93261	1360.0ab	35.1e	31.8ab	73.0a	3040.0d
ICGV93269	1351.4ab	35.1e	30.4ab	72.9a	3150.6bc
SODIRI	1316.4ab	36.3abc	31.0ab	72.7a	3112.9cd
BARBERTON	1360.0ab	36.6a	33.1a	73.0a	2901.3e
CV%	15.8	2.4	7.7	3.5	2.9
SE	25.9	0.2	0.6	0.6	22.3
Pr>F	1.13 ns	3.4***	1.0 ns	2.9**	44.3***

\*, \*\*, \*\*\* Significant at 0.05, 0.01 and 0.001 probability level, respectively

Means followed by the same letter(s) within a column are not significantly different at 0.05 probability level According to LSD test. PY: Pod yield (kg/ha); DF: Days to 50% flowering; SW: 100 grain weight (g); SH: Shelling (%); HY: Hay yield (kg/ha).

These results exposed that the pod yield was positively correlated and highly significantly associated with hay yield kg/ha ( $r = 0.76$ ), 100- seed weight ( $r = 0.62$ ) and shelling % ( $r = 0.51$ ) and confirmed those previously recorded by Ayub Khan *et al.* (2000); Meta and Monpara (2010) in groundnut, and Shegro *et al.* (2013) in Bambara groundnut, suggests that selection on the basis of the phenotypic of these characters will lead to high pod yield in groundnut. However, negative and non-significant association between pod yield (kg/ha) and days to 50% flowering ( $r = -0.12$ ) was exhibited (Table 4). This finding is in agreement with reported by Ibrahim *et al.* (2013) in Guar; Meta and Monpara (2010) in groundnut. Indicated that late flowering plants would tend to produce more pod yield and selection based on days to 50% flowering alone will be depressing pod yield in groundnut. The results from this study lead to the hay yield (kg/ha), shelling (%), 100- seed weight and days to 50% flowering should be considered during selection for pod yield in groundnut. Therefore, suggested that it may be the important characters selection for the improvement of the pod yield in groundnut.

**Table 4. Simple linear correlation coefficients between 5 pairs of traits in Groundnut at the FRS Farm (combined over two seasons, 2006 and 2007)**

Traits	PY	DF	SW	SH	H Y
PY	1	-0.122	0.622***	0.513***	0.755***
DF	-0.122	1	-0.225*	-0.045	-0.414***
SW	0.622***	-0.225*	1	0.438***	0.542***
SH	0.513***	-0.045	0.438***	1	0.348***
HY	0.755***	-0.414***	0.542***	0.348***	1

\*, \*\*, \*\*\* Significant at 0.05, 0.01 and 0.001 probability level, respectively

PY: Pod yield (kg/ha); DF: Days to 50% flowering; SW: 100 grain weight (g); SH: Shelling (%); HY: Hay yield (kg/ha).

### Conclusion

It could be concluded from this study that there is adequate genetic variability present in the material studied. In the broad sense heritability, genetic advance and correlation among traits found that the selection for hay yield (kg/ha), shelling (%), days to 50% flowering and 100- seed weight would be more effective traits in boosting pod yield performance of groundnut genotypes. Among the evaluated, the high yielding genotype was ICGV93260 with a pod yield of 1389.1 kg/ha, and has the greatest potential to adapt in semi-arid region, climatic conditions and to enhance groundnut production under rain-fed condition in the Western Sudan, and for other consequent breeding activities in groundnut improvement.

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