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Response Of Selected Groundnut Genotypes To Irrigated And Non-Irrigated Conditions

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ABSTRACT: Groundnut is among the most important crops for smallholder farmers in semi-arid regions, providing both food, feed and income for households. The main objective of this study was to strengthen groundnut production by smallholder farmers in Zimbabwe using available improved genotypes. The specific objectives of this study were to evaluate morphological traits of groundnut genotypes under irrigated and non-irrigated conditions and to assess various groundnut yield parameters under these conditions. Selected qualitative and quantitative characters were assessed during the development of the groundnut crop under irrigated and non-irrigated conditions in sandy soils. A Randomized Complete Block Design was used in the field experiment and data subjected to a two way analysis of variance using Genstat 13th Edition. ANOVA was done at 5% least of significant difference (LSD) to check for the differences between the 12 genotypes across the irrigated and non- irrigated conditions. Prior to analysis, data were subjected to normality using the Shapiro-Wilk test and normal square root transformation was done where necessary. From the analyses, there were significant differences across the 12 genotypes for quantitative characters plant height, pod length and number of pods per plants. For all the genotypes yield was higher under irrigated conditions for both unshelled and shelled weight. Most genotypes exhibited dynamic stability with higher yields under irrigated conditions except for SC Orion that out yielded all the genotypes with 2.8 t /ha shelled weight under non-irrigated conditions. Accordingly, SC Orion is recommended for production by farmers in sandy soils of Natural Region IV.
Key Words: *Arachis hypogaea*, characterization, drought, peanut

INTRODUCTION

Groundnut is the fourth most important source of edible oil and third most important source of vegetable protein (Taru *et al* ., 2010). It is among the most important crops for smallholder farmers in Zimbabwe, providing both food and income for households. Groundnut is a nutritious source of fats, protein, carbohydrates, vitamins and minerals for human consumption and part of the crop can be used for feeding livestock. It can be eaten raw, roasted or cooked and the flour is an ingredient in many foods. According to FAOSTAT (2013), their average productivity in Asia is 1.50 t /ha and Africa 0.83 t/ ha which is significantly lower than in the USA (2.99 t/ ha). Traditionally, the bulk of Zimbabwe's groundnut is produced by smallholder farmers with yield below 1 t/ ha and as a result any constraints that affect groundnut production are likely to negatively affect the livelihoods of numerous rural households (FAO, 2012). Zimbabwe's small rural farmers are responsible for producing about 75 % of the groundnuts and moslty use Spanish cultivars that are grown in light soils. It is also important to note that groundnut production across the country has gone down by about 40% since 2005 due to a number of challenges such as shortage of quality seeds and poor agronomic practices. Groundnut is currently produced on about 4700 hectares and the yields have declined from 0.67t/ha from 2004 to 2005 to 0.23t/ha in 2012 and 2013 (FAO, 2012).

Drought is a common occurrence that limits crop production particularly in marginal areas of Zimbabwe. Groundnut is a key crop, grown by smallholder farmers in marginal areas with limited inputs. However, drought is a critical factor that limits groundnut productivity in the semi-arid tropics particularly in developing countries (Gorbet *et al*., 1999). Moreover, farmers do not have access to improved groundnut varieties hence they use landraces which give average yields even under periods of good rainfall. Improved varieties give relatively higher yields hence should be made available and accessible to all farmers including the communal based ones. Most selections for improved varieties are done under ideal conditions which are not representative of the smallholder conditions. In addition, most farmers do not have adequate information on the performance of improved available Zimbabwean groundnuts in their environments. Varieties perform differentially in different environments and hence the need to be fully aware of their performance. Most of the research work done prior to the release of these new groundnut varieties is done under ideal conditions with adequate water yet on farmers' environment they are rainfed. Thus, in order to identify and recommend groundnut varieties that do well under the farmers' environment it is imperative to understand the response of groundnut varieties to irrigated and non-irrigated conditions which will enable farmers to identify groundnut varieties that are ideal for their production systems. Therefore the objectives of the study were to evaluate morphological traits and yield parameters of groundnut genotypes under irrigated and non-irrigated conditions.

MATERIALS AND METHODS

Description of the Study Site

The study was carried out at Khami Prison Farm, during the 2014-2015 cropping season. The farm is located in Matabeleland North province under Umguza district and lies in Natural Region IV characterised by mean annual rainfall of 450 mm. Geographically, the site is found on latitude 28`39``S, longitude 20`06``E. The rainfall received in this region is recommended for drought tolerant crops like sorghum, pearl millet, finger millet as well as fodder crop production. The natural region is said to be semi-intensive and hence livestock production is also recommended on a larger scale. The site is characterized by sandy soils which have poor water holding capacity, low cation exchange capacity and good aeration (Nyamapfene, 1991).

Planting Materials

Twelve groundnut genotypes were planted in the field of experiment and they were obtained from the Crop breeding institute and Seed Co (Table 1).

Table 1.Groundnut genotypes evaluated in the sandy soils for morphological traits and yield parameters under irrigated and non-irrigated conditions

Genotype	Season Length	Genotype status	Type
Nyanda	Short	Commercial variety	Spanish
Falcon	Short	Commercial variety	Spanish
SC Orion	Long	Commercial variety	Spanish
SC GV00004	Long	Breeding line	-
Teal	Short	Commercial variety	-
Ilanda	Short	Commercial variety	Spanish
Tern	Short	Commercial variety	Spanish
Mwenje	Short	Commercial variety	Spanish
Flamingo	Long	Commercial variety	Spanish
Jesa	Short	Commercial variety	Spanish
Makulu Red	Long	Commercial variety	Virginia
CG7	Long	Commerical variety	-

Experimental Design and Field Layout

Groundnut genotypes were planted on raised experimental units (beds) with each bed consisting of twelve plants of each genotype. A randomized complete block design (RCBD) with a 12 by 2 factorial arrangement of treatments was used. Twelve genotypes were replicated twice and blocking done according to the slope of the land.

Field operations

The groundnut genotypes were planted in section 5 which was previously under green pepper as a rotational crop plant during the 2014/2015 season. The land was deeply ploughed to a depth of 300 mm to bury trash. Planting stations were made on each experimental unit prior to planting and an interow spacing of 0.45 m and in row spacing of 0.15 m was used. After crop emergence, the field was kept weed free and irrigation was applied to the irrigated plot according to need until physiological maturity. Earthing was done twice so as to promote peg penetration. The first earthing was carried out after four weeks from emergence while the second one was done on the sixth week respectively.

Data collection and analysis

The observations on both qualitative and quantitative traits were taken on five random plants in each experimental unit. Quantitative traits evaluated were 50% days to flowering, 50% days to emergence, plant height (cm), number of pods per plant, leaflet length (cm), leaflet width (cm) and 80 grain weight (g). Qualitative traits evaluated were disease prevalence, growth habit seed colour, stem hairiness and pigmentation (IBPGR and ICRISAT, 1992). Data recorded from the field experiment was tabulated on Microsoft Excel first and was later subjected to a two way analysis of variance using Genstat version 13. The mean experimental unit values of the quantitative traits measured was subjected to analysis of variance. Analysis of variance was done at 5% Least of Significant Difference (LSD) to check for the differences between the 12 genotypes across the irrigated and non-irrigated conditions. Prior to analysis, data were subjected to normality using the Shapiro-Wilk test and where data was found not to be normal it was square root transformed.

RESULTS

Morphological Traits of Groundnut Genotypes

All of the genotypes assessed were either Decumbent 3 or Erect in growth habit. Leaflet shape presented more variation of the selected qualitative traits evaluated (Table 2). Disease symptoms of *Cercospora arachidicola* were also noted under non-irrigated conditions and were more pronounced on genotype Nyanda. Cotyledon colour was monomorphic for all the twelve genotypes (Table 2).

Table 2. Qualitative characters evaluated for the twelve groundnut genotypes under irrigated and non-irrigated conditions

Genotype	Growth habit	Stem hairiness	Leaflet shape	Stem pigmentation	Branching pattern	Cotyledon colour
SCGV00004	Erect	Scarce	Wide	Present	Sequential	Light yellow
Ilanda	Decumbent 3	Abundant	Wide	Present	Sequential	Light yellow
CG7	Decumbent 2	Scarce	Orbicular	Present	Irregular with flowers on main stem	Light yellow
SC Orion	Decumbent 3	Scarce	Narrow elliptic	Present	Irregular without flowers on the main stem	Light yellow
Nyanda	Erect	Scarce	Wide	Absent	Sequential	Light yellow
Mwenje	Erect	Scarce	Wide	Present	Sequential	Light yellow
Teal	Erect	Scarce	Elliptic	Present	Sequential	Light yellow
Flamingo	Erect	Abundant	Wide	Present	Irregular without flowers on the main stem	Light yellow
Makulu Red	Decumbent 3	Abundant	Elliptic	Present	Irregular with flowers on the main stem	Light yellow
Tern	Decumbent 3	Scarce	Elliptic	Present	Sequential	Light yellow
Jesa	Erect	Abundant	Elliptic	Present	Sequential	Light yellow
Falcon	Decumbent 3	Scarce	Elliptic	Present	Sequential	Light yellow

Across all 12 genotypes, plant height, pod length and number of pods per plant were significantly different. There was no significant difference on the interaction between genotype and irrigation with regard to plant height, pod length as well as number of pods per plant (Table 3).

Table 3. Mean squares for selected morphological characters for the twelve groundnut genotypes

Source	df	Mean squares Plant height	Pod length	Number of pods per plant
Genotype	11	9.003^{***}	0.849^{*}	200.73*
Irrigation × Genotype	11	0.840^{ns}	0.085^{ns}	21.98^{ns}
Error	24			

Yield parameters of groundnut genotypes under irrigated and non-irrigated conditions

In general, the average means of grain weight for irrigated genotypes were higher for both unshelled and shelled weights. For the unshelled weight it was 0.279 kg while for the shelled weight was 0.036 kg. There was no significant difference between the shelled and unshelled weight of all the 12 genotypes under irrigated and non-irrigated conditions. The unshelled varieties had the highest coefficient of variation 28.8% while for the shelled varieties was 15.8% (Table 4).

Table 4. Comparison of means of unshelled and shelled weight of 12 groundnut genotypes under irrigated and non-irrigated conditions

	Unshelled weight (kg)		Shelled weight (kg)	
Genotype	Irrigated	Non-irrigated	Irrigated	Non-irrigated
CG7	0.193	0.094	0.031	0.030
Falcon	0.310	0.200	0.035	0.031
Flamingo	0.141	0.083	0.023	0.020
Ilanda	0.385	0.309	0.048	0.043
Jesa	0.352	0.313	0.035	0.033
Makulu Red	0.210	0.150	0.030	0.029
Mwenje	0.421	0.335	0.038	0.034
Nyanda	0.388	0.318	0.038	0.034
SC GV0004	0.275	0.150	0.045	0.033
SC Orion	0.200	0.224	0.039	0.053
Teal	0.182	0.096	0.034	0.029
Tern	0.291	0.258	0.032	0.030
Mean	0.279	0.211	0.036	0.033
F Probability	<.001		<.001	
LSD	0.103		0.007	
CV%	28.8		15.8	

There was a strong positive significant correlation between the shelled and unshelled weight for the genotypes though on shelled weight the relation was not as strong though it was significant. Compared to Mwenje and Nyanda, it can be seen that Ilanda has the highest shelling percentage for irrigated and non-irrigated shelled weight. Ilanda had a yield advantage of 300% more than Flamingo for unshelled weight under irrigated conditions (Table 5).

Table 5. Means of unshelled and shelled weight of 12 groundnut genotypes under irrigated and non-irrigated conditions in tha^{-1}

	Unshelled weight (t/ha)		Shelled weight (t/ha)	
Genotype	Irrigated	Non-irrigated	Irrigated	Non-irrigated
CG7	10.2	5.0	1.6	1.6
Falcon	16.4	10.6	1.9	1.6
Flamingo	7.5	4.4	1.2	1.1
Ilanda	20.4	16.3	2.5	2.3
Jesa	18.6	16.6	1.9	1.7
Makulu Red	11.1	7.9	1.6	1.5
Mwenje	22.3	17.7	2.0	1.8
Nyanda	20.5	16.8	2.0	1.8
SC GV0004	14.6	7.9	2.4	1.7
SC Orion	10.6	11.9	2.1	2.8
Teal	9.6	5.1	1.8	1.5
Tern	15.4	13.7	1.7	1.6
Mean	14.8	11.2	1.9	1.7
SE	1.43	1.46	0.10	0.12
Correlation	0.910***		0.688**	

SE-standard error of the mean, significant at ***0.001, **0.01

DISCUSSION

Having adequate water throughout the life cycle of groundnut is important for optimal plant growth and development (Okello *et al.,* 2013). Most of the breeding work is normally done under ideal conditions while the farmers' conditions are suboptimal. This experiment replicated the farmer's conditions which rainfed with mimimal inputs. The genotype Nyanda (on non-irrigated condition) was susceptible to Cercospora leaf spot this could be as a result of water stress. Inadequate water supply to the groundnut plants tends to reduce plant vigour and thus high susceptibility to pests (Okello *et al.,* 2013). Under the irrigated conditions there was no genotype susceptible to the disease during the period of evaluation. For the morphological parameters assessed during the development of the crop (irrigated and non-irrigated conditions), there was no significant variation among the genotypes. Upadhyaya *et al.* (2005), presented that the growth habit of Nyanda as erect, seed shape which is wide elliptic and has a sequential stem pigmentation. From the research it was also concluded the same. Most of the qualitative characters were not different hence it was concluded that they are controlled by few major genes that are not affected by the environment.

According to Upadhyaya *et al*. (2005), Nyanda yielded 1.7 and 1.98 t ha^{-1} during 1993 – 96 rainy and post rainy season under 1240^0Cd and 1470^0Cd. This corroborates this study which obtained similar yields of 2.0 and 1.8 t ha^{-1} under irrigated and non-irrigated conditions respectively. Contrary to our study where Falcon yielded 1.9 t ha^{-1}, across 51 trials in Zimbabwe it yielded 1.5 t ha^{-1}. The strong positive correlation of unshelled and shelled weight under irrigated and non-irrigated conditions could suggest that most of the genotypes have dynamic stability and are able to respond to irrigation and equally do well. SC Orion was out yielded by Ilanda under irrigated conditions though it has higher drought tolerance and relatively higher shelling percentage as seen by the highest yield under non-irrigated conditions and relatively low unshelled weight. Among the 12 genotypes of groundnut planted, Flamingo recorded the lowest yield for unshelled and shelled weight that is for irrigated and non –irrigated conditions. This could be an indication that it has low genetic potential under optimal and suboptimal conditions hence it is not recommended for production under sandy soils in Natural Region IV.

CONCLUSION

Nyanda, is more susceptible to diseases under dry conditions. Falcon is the tallest genotype based on quantitative characters. SC Orion gives the highest shelled grain weight under sandy soils. It also has the highest shelling percentage compared to other genotypes evaluated. Flamingo is the lowest yielder in sandy soils.

Recommendations and Future Perspectives

For a more representative country wide conclusion, it is recommended that this set of genotypes be evaluated across all natural regions of Zimbabwe both on farm and station. Furthermore, participatory variety selection has recommended in each region under irrigated and non-irrigated conditions. SC Orion is recommended for production by farmers in sandy soils under rain fed conditions.

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