Legume Research, 23(1): 37-41, 2000

SCREENING OF FOUR GROUNDNUT CULTIVARS FROM NIGERIA FOR DROUGHT RESISTANCE

J.K. Mensah and Vera E. Okpere
Department of Botany
Edo State University, Ekpoma, Nigeria

ABSTRACT

Germination studies on the seeds of four groundnuts (*Arachis hypogea* L., cultivars: Ex-Dakar RRB 12, RMP 12, RMP 91) under different osmotic solutions in the laboratory as a means of screening for drought resistance is reported. These laboratory results have also been compared to some agronomic and yield parameters of plants grown under simulated drought conditions in the field. Maximum germination percentage, radicle length and dry weight measurements were attainted in two cultivars, viz: RMP 91 and Ex-Dakar and were therefore identified as the drought resistant cultivars. Susceptibility of the cultivars to drought was shown by the relatively greater reduction in yield per plant compared to the resistant cultivars. The laboratory results showed that germination of seeds in polyethylene glycol (PEG), glucose or sodium chloride (NaCl) solutions at 1.2 Mpa and 1.8 Mpa could be reliably used as a quick and cost effective procedure for screening groundnut cultivars for drought resistance at an early stage of their growth and development.

INTRODUCTION

For the successful establishment, growth and yield of any plant, it is necessary for the plant to withstant various environmental factors including water stress. According to Hurd (1976), improved drought resistance has been one of the major goals in crop breeding in the semi-arid agro-ecological zone. Hence the inability to effectively screen for drought resistance in the existing cultivars has resulted in under exploitation of the yield potentials of crops cultivated in this zone. A common procedure for evaluating drought resistance is to relate yield to a standard cultivar over several years at locations where drought is likely to occur (Anderson and Reinberg, 1985). This procedure is dependent on year to year changes in weather and it is extremely time consuming. There is therefore the desire to develop simple and rapid measurement techniques for use on early generation material to identify potential drought resistance. The value of screening for drought resistance in crop improvement has not been fully utilised. Nevertheless, screening for drought resistance has led to the identification of drought resistant cultivars elsewhere in various crops including groundnuts (William *et al.*, 1967; Younis *et al.*, 1963; Nerson and Paris 1984; Vasudevan and Balasubramanian, 1965; Lutts *et al.*, 1996). The objective of the present study is to evaluate the responses of four groundnut cultivars from Nigeria for drought using laboratory and field procedures. The study would enable the authors to compare the two procedures in order to determine the appropriate laboratory techniques which could be used on early growth stage for rapid screening for drought resistance in groundnut in order to reduce cost and time involved in field trials.

MATERIAL AND METHODS

A. Sources of Materials : Seed of four cultivars (RMP 91, RMP12, RRB12 and Ex-Dakar) were obtained from the

National Seed Service Department, Zaria, Nigeria. These four cultivars are the most commonly cultivated in terms of acreage in Nigeria.

B. Laboratory Studies : Initial viability tests were carried out on the seeds of the selected cultivars to determine whether there were any difference in germination due to genotypes, moisture content or age. One thousand and two hundred seeds of each cultivars with a moisture content of about 15% were selected from freshly shelled pods and treated with 0.2% mercuric chloride solution to surface sterilize the seeds. Hundred seed lots of each cultivar were germinated at 0, 0.6, 0.12 and 1.8 Mpa of each osmotic solution prepared from glucose, sodium chloride and polyethylene glycol in three replicates following the methods of Ashraf and Abu-Shakra (1978). The emergence of radicle was used to score for germination (ISTA, 1978), whereas measurement of radicle length was taken from 10 days old seedlings grown in vermiculite saturated with the test solution.

C. Field Studies : Field plots measuring 5 x 1m were constructed in the Botanical garden of the Edo State University, Ekpoma (6.44^{0}N and 6.04^{0}E) during the dry season of October, 1994 to March 1995. A randomized block design was followed and a spacing of 30 x 30cm maintained during planting. Fourteen day old plants were subjected to different watering regimes.

(a) Watering on alternate days (WA)

(b) Watering once a week (WO) and

(c) Watering once in two weeks (WT), to field capacity until harvest. Plots were covered with moveable shelters of clear heavy duty polythene sheets whenever it rained.

Forty day old plants at pre-flowering stage were used for all analysis except yield which was determined at harvest. The parameters studies in the field were:

Mean plant height, dry weight and yield/plant.

RESULTS AND DISCUSSION

A. Laboratory studies : The results obtained from the laboratory studies are presented in Table 1. From this, it has been observed that the most effective osmotic concentrations are 1.2Mpa and 1.8Mpa. There were decreases in the percentage germination and radicle length with increasing concentrations of three osmotically active solutions used in this study namely; Glucose, Sodium Chloride and Polyethylene glycol. A direct and inseparable relationship is known to exist between osmotic solutions and water stress (Levitt, 1968; Ashraf and Abu-Shakra, 1973). Plant breeders have therefore employed this technique as a simple and effective screening procedure for drought tolerance in many crop plant (Younis *et al.*, 1963; Nerson and Paris, 1984; Akomeah *et al.*., 1995). In the present study, RMP 91 and Ex-Dakar stood out as the most drought resistant cultivars due to their high germination under 1.2 and 1.8 Mpa whereas RMP 12 recorded the least percentage germination at these osmotic concentrations and was therefore considered as the most drought susceptible cultivar.

Among the three solutions used in the present study, PEG was recorded as the most effective solution for screening for drought resistance. Williams *et al.*, (1967); Johnson and Asay (1979), Sharma, (1973) showed that germination of seeds of some pasture species decreased in the order PEG>NaCI>Glucose. The

Table 1. Effect of three osmotic solutions on germination of percentage and root length of four groundnut cultivars.

Cultivars	Parameters	Osmotic Concentrations (MPa)													
		Glucose					Sodium Chloride				P.E.G.				
		0	0.6	1.2	1.8	LSD	0	0.6	1.2	1.8	LSD	0	0.6	1.2	1.8	LSD
Ex-Dakar	Germination	95.0	83.2	65.3	37.6	15.5	95.0	78.2	49.5	34.7	14.5	95.0	66.3	44.6	25.7	10.5
RMP 12	Percentage	96.0	67.4	44.6	24.5	14.8	96.0	62.4	34.8	23.8	12.7	96.0	49.5	27.7	19.8	9.8
RMP 91		94.1	85.1	64.4	39.6	15.2	94.1	79.2	51.5	31.7	13.8	94.1	62.4	41.6	23.9	10.9
RRB 12		98.0	68.3	42.6	26.7	20.4	98.0	61.4	34.7	29.7	12.5	98.0	52.5	33.7	20.8	12.5
LSD (0.05)		NS	10.0	12.5	6.5	-	NS	10.0	8.5	5.5	-	NS	9.0	7.5	3.0	-
Ex-Dakar	Seedling root	14.3	13.9	8.9	5.4	4.4	14.3	12.8	7.7	5.1	3.8	14.3	11.9	7.0	4.8	3.5
RMP 12	length (10)	12.5	8.7	6.0	3.2	4.0	12.5	7.8	4.8	4.2	3.6	12.5	7.2	4.8	2.8	3.7
RMP 91	DAP (cm)	14.9	13.2	7.3	5.8	3.2	14.9	9.5	8.2	5.4	3.8	14.9	12.4	8.5	5.2	3.1
RRB 12		13.8	9.2	6.1	3.6	3.0	13.8	7.4	5.2	4.5	3.4	13.8	6.9	4.9	3.0	1.7
LSD (0.05)		NS	2.6	1.4	1.6	-	NS	2.8	1.3	1.2	-	NS	1.9	1.4	1.1	-

PEG = Polythlene glycol, MPa = Mega Pascal

present report is in agreement with these esarlier reports.

According to Hurd(1974) varieties germinated in osmotically active solutions and subsequent selection for those with the highest percentage germination has been shown to give the most reliable results for screening for drought resistant varieties. He emphasized that such experiments also give results which highly correlate with field performance of the verieties under water stress.

The four groundnuts cultivars differed in their radicle length measurement under different osmotic concentrations at 10DAP. RMP 91 was the least affected by the various concentrations of the solutions whereas RMP 12 was the most adversely affected (Table 1). The observations recorded in the present studies agree with the earlier contributions by various authors in crops such as wheat (Sandhu and Laude, 1958; Hurd, 1974) and Sorghum (Sullivan and Ross, 1979; Nour and Weibel, 1978). These authors reported that when the osmotic concentrations were increased there were decreases in the root length of the various cultivars studied by them. The order of resistance of the four cultivars to drought based on the germination and radicle length measurement is RMP 91, Ex-Dakar, RRB 12 and RMP 12.

B. Field Studies : It has been observed from the present study that the plant height and dry matter accumulation of the four cultivars decreased under drought conditions and the decrease was proportional to the extent of drought conditions imposed on the plants (Table 2). This is because under drought, the plants loose their turgidity and the cells are unable to expand or absorb materials. David and Park (1979) have earlier

Table 2. Effect of water stress on mean plant height, dry matter and yield in four groundnut cultivars from Nigeria.

Cultivar	Parameter	Rate of watering			
		WA	WO	WT	LSD (.05)
Ex-Dakar		32.5	28.7	23.0	5.3
RMP 12	Plant	32.8	24.6	17.2	6.5
RMP 91	Height	33.8	28.9	24.8	6.8
RRB 12	(cm)	31.8	23.4	21.0	6.4
LSD (.05)		NS	4.9	4.6	--
Ex-Dakar		7.9	6.5	4.2	1.9
RMP 12	Dry	7.8	6.2	3.6	1.2
RMP 91	Weight	7.6	5.6	4.3	1.6
RRB 12	(g)	8.2	6.2	3.1	1.2
LSD (.05)		NS	NS	0.98	--
Ex-Dakar		3620	3340	2800	300
RMP 12	Yield	3755	2825	2250	350
RMP 91	(kg/ha)	3650	3120	2840	205
RRB 12		3550	2450	2310	355
LSD (.05)		NS	450	350	--

WA = Watering on alternate days, WO = Watering once a week,
WT = Watering once in two weeks

observed decreases in the dry weight of *Phaseolus vulgaris* under drought conditions and this is in line with the results of the present study. Similarly, Lutts *et al.*, (1996) and Ungar, (1996) have observed decreases in dry matter under drought conditions simulated by high salinity.

The ultimate aim of groundnut cultivation is the grain yield which depends on many factors including water stress. It has been revealed from present study that there is a high correlation between grain yield and water stress and the cultivars which were least affected by increasing concentrations in osmotic solutions (RMP 91 and Ex-Dakar) were also least affected by increasing duration of water stress. it could therefore be concluded that the field procedures were effective in identifying the drought resistant cultivars isolated from laboratory procedures. Hence the decrease in germination percentages and radicle length with increasing concentrations of osmotically active solutions could be reliably used as a quick and effective methods for screening groundnut cultivars for drought resistant at an early stage of their growth and development to save time and cost.

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