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IDENTIFICATION OF DROUGHT TOLERANT GROUNDNUT (*ARACHIS HYPOGAEA L.*) GENOTYPES

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ABSTRACT

In order to identify groundnut genotypes suited for cultivation under limited rainfall conditions, around 130 genotypes/crosses from different breeding trials were screened for higher yield then local check varieties under simulated drought conditions in summer season for three years i.e. 1995, 1996 and 1997. Total twelve promising crosses/genotypes (the crosses were sixth generation crosses) including three check varieties were selected for study. They were evaluated for pod yield in comparison with three check varieties in *kharif* seasons of the years 1999, 2000 and 2001 at four naturally drought prone locations in addition to Junagadh. The crosses GG-2 X NCAC 17135, GG-2 x PI 259747, J-11 x PI 259747 and S 206 x FESR-8, kisan x FESR-S-PI-B1-B and the genotypes JB 223 and 224 recorded consistently superior and stable yield for the three years at all the locations. Hence, it is suggested that these lines/genotypes could be grown under regions of limited rainfall. These lines may be used as parents in breeding programmes for developing drought tolerant groundnut cultivars.

INTRODUCTION

Groundnut (*Arachis hypogaca L.*) is cultivated predominantly in the tropics and subtropics, where the availability of water is a major constraint on yield (Viramani and Singh, 1986). In Gujarat, *kharif* groundnut is cultivated on an area of about 20 lakh hectares with an average production of 16 million tones. During the entire season, the crop is subjected to water deficit stress at one stage or another leading to drastic reduction in productivity. This necessitates development of cultivars which can withstand water stress, and still can be productive. Several attempts have been made in this direction by various researchers (Nageswara Rao, 1991) either through breeding for drought resistance (Branch and Kvien, 1992) or through agronomic improvements for developing varieties adapted to rainfall constraints (Gautreau, J. 1982). Crop water relationships and the physiological responses of groundnut to drought stress during different phenophases have also been worked out (Stansell and Pallas, 1976; 1985; Harris, *et al.*, 1988; Joshi *et al.*, 1988; and Nautiyal *et al.*, 1999, 2002). Recently, Taiz and Zeiger (2002) have extensively reviewed water relations of crops with special reference to parameters for screening stress tolerant plants. However, the extreme variability in timing, intensity and duration of drought between years and sites have made it difficult to define plant attributes required for improved performance under all drought situations. Hence, identifying groundnut genotypes suited for cultivation under scarce rainfall seems to be the best alternative. In order to do this, the present investigation was planned to be carried out in two phases. Screening of genotypes under controlled drought stress in the first phase and assessment of selected genotypes at the locations where drought occurs frequently in the second phase in order to identify an alternative to local groundnut cultivars suited for cultivation under conditions of low rainfall (average annual rainfall 620 mm).

MATERIAL AND METHODS

In the first phase of investigation, around 130 genotypes/crosses from different breeding trials (these were identified as potential drought tolerant with the help of visual observations such as retention of greenness at harvest, thickness of foliage, dwarfness

combined with greenness etc.) were screened for higher yield than local check varieties under simulated drought conditions in summer season of 1995, 1996 and 1997 at Main Oilseeds Research Station, Gujarat Agricultural University, Junagadh. The screening was done under assured irrigation facilities and withholding irrigation at 45 and 75 days after sowing for 20 days, thus imposing mid season and end-of-the season drought. For this, two lines, each of 5 m length for each genotype were sown. Irrigation and other recommended agronomic practices were followed. Pod yields were measured at harvest; higher pod yield than local checks GG-2 and GG-5 under both normal and drought conditions were used as selection criteria of germplasm screening. Nine genotypes/crosses with consistently good yield performance over the three consecutive years were selected (Table 1). The crosses were the sixth generation crosses. The seed of selected crosses/genotypes were simultaneously multiplied in 1995, 1996 and 1997 *kharif* season.

In the second phase of investigation, yield performance of these selected crosses/ entries was assessed in comparison with three varieties GG-2, GG-5 (local checks) and J-11 (national check) at Main Oilseeds Research Station, Junagadh and at three naturally drought prone locations *viz.*, at Targhadia (Main Dry Farming Research Station), Manavadar, Nanakandhasar and Jamkhambhalia in terms of pod yield. The basic advantage in selecting yield as the selection criteria is that it integrates all the additive effects of many underlying mechanisms of drought tolerance. Seven crosses and two genotypes with three controls (check varieties) were grown in a randomized complete block design with four replications for three consecutive *kharif* seasons – 1999, 2000 and 2001. The net plot area was 12.96 m^2 (4.8 x 2.7 m) with an inter-row spacing of 45 cm and an intra-row spacing of 10 cm. The recommended agronomic practices were adopted. Data on pod and haulm yield were recorded.

RESULTS AND DISCUSSION

The average rainfall and rainy days at Junagadh, Targhadia, Nanakandhasar, Jamkhambhalia and Manavadar during *kharif* seasons of 1999, 2000 and 2001 are presented in Table 2. The total rainfall was half the average rainfall (620 mm) of the region during *kharif* 1999 at all the centres; during *kharif* 2000, rainfall at Targhadia and Nanakandhasar was very less compared to Junagadh and Manavadar. *Kharif* 2001 could be considered as comparatively better year with all the centres except Targhadia receiving rainfall higher than the average rainfall.

Data on pod yield obtained at four locations and the pooled means during *kharif* 1999, 2000 and 2001 are depicted in Table 3.

The total rainfall received during *kharif* 1999 was very scanty (Table 2) and this explains the low yield levels obtained in that year. In pooled analysis, there were significant differences among the genotypes/crosses with respect to pod yield (Table 3). The highest pod yield was obtained in the cross Kisan x FESR-S-PI-B1-B followed by S 206 x FESR-8 and JB-224. However, they remained at par with each other and with JB 223, GG-2, GG-5 and J-11 x PI 259747. At individual centres, the yield differences were significant except Manavadar. Data from Targhadia was not available. The cross Kisan x FESR-S-PI-B1-B performed well at all the centres. However, the cross S 206 x FESR, genotypes JB-223, 224 and varieties GG-2 and GG-5 performed equally well.

During the year 2000, due to very poor yield, pod yield data from Nanakandhasar were not considered. Data from the remaining centres were analyzed, which revealed

Table 1. List of selected crosses/genotypes

Sr. No.	Chrossess/varieties	Progeny/source
1.	GG-2 x NCAC-17135	S-85-30-1-1-B-B-B
2.	J-11 x PI-259747	S-85-1-7-B-B-B-B
3.	GG-2 x PI 259747	S-85-22-7-B-B-B
4.	GG-2 x PI 259747	S-85-4-8-4-B-B-B
5.	GG-2 x PI 259747	S-85-5-6-B-B-B-B
6.	S-206 x FESR-8	1-1-B-B-B
7.	Kissan x FESR-S-PI-B1-B	1-1-2-B-B
8.	JB-223	SSVT
9.	JB-224	SSVT
10	GG-2	
11	GG-5	
12	J-11	

Table 2. Average Rainfall and rainy days at Junagadh, Targhadia, Jamkhambhalia, Nanakandhasar and Manavadar during kharif 1999, 2000 and 2001

	Total rainfall			Rainy days		
	1999	2000	2001	1999	2000	2001
Junagadh	394	595	848	32	29	52
Targhadia	224	372	425	17	18	35
Jamkhambhalia	155	496	765	11	16	24
Nanakandhasar	-	316	1053	-	14	28
Manavadar	232	407	715	20	19	34

significant differences among crosses/ genotypes. In pooled analysis, the highest pod yield (1927 kg/ha) was obtained in the cross GG-2 x NCAC 17135, and it was at par with the cross no. 3, 4 i.e. GG 2 x PI 259747, S 206 x FESR-8, Kisan x FESR-S-PI-B1-B, JB-223, 224, and local checks GG-2 and GG-5. At individual centres also, the cross GG-2 x NCAC 17135 was topper at all the centres. Compared to check varieties all crosses and genotypes exhibited higher pod yield at Manavadar, Targhadia and Jamkhambhalia centres. At Junagadh, GG 5 ranked first with respect to pod yield. This evidently points out the superiority of selected crosses/genotypes over the check varieties in view of the fact that despite the deficit in rainfall, they could exhibit their potential as drought tolerant crosses/ genotypes with sustained yield levels. *Kharif* season of the year 2001 was comparatively better. In pooled mean, differences in pod yield were statistically non-significant; which proves compatibility of selected crosses/genotypes with popular cultivated varieties. Variety GG-5 fared best at Targhadia, Junagadh and Nanakandhsar. However, the crosses GG-2 x NCAC 17135, GG-2 x PI 259747, S 206 x FESR-8, Kisan x FESR-S-PP-B1-B and genotypes JB 223 and 224 were at par with GG-5 again exhibiting their potential as drought tolerant material.

The data on haulm yield for the *kharif* seasons of the years 1999, 2000 and 2001 are presented in Table 4. Statistically significant differences were observed in haulm yield at individual centres and in the pooled analysis during *kharif* 1999. Variety GG-5 recorded the highest yield. Cross S 206 x FESR was the next best at Nanakandhasar and Junagadh.

No significant differences were recorded in haulm yield in pooled analysis of *kharif* 2000. However, GG-5 was the best at Manavadar; at Targhadia and Jamkhambhalia, the cross S 206 x FESR-8 ranked first.

Table 3. Pod yield (kg/ha) of selected crosses/genotypes at various locations

S. No.	Entry	Year	Manavadar	Nana Kandhasar	Targhadia	JamKhambhalia	Junagadh	Pooled
1	GG-2 x NCAC-17135	1999	607	139	-	-	480	409
		2000	3655	-	1011	1273	1767	1927
		2001	2400	1481	3489	1620	1379	2074
2	J-11 x PI-259747	1999	740	361	-	-	592	552
		2000	2530	-	489	706	1474	1250
		2001	2838	1463	2581	1713	1605	2040
3	GG-2 x PI-259747	1999	623	165	-	-	478	422
		2000	3286	-	756	1076	1416	1633
		2001	3183	870	3289	1366	1412	2024
4	GG-2 x PI-259747	1999	581	200	-	-	432	404
		2000	3084	-	592	1146	1489	1578
		2001	2877	1000	3436	972	1456	1948
5	GG-2 x PI-259747	1999	629	173	-	-	438	413
		2000	3778	-	831	1100	1456	1791
		2001	2392	1444	3506	787	1140	1854
6	S-206 x FESR-8	1999	727	422	-	-	604	584
		2000	2707	-	634	1007	1555	1475
		2001	2975	1686	3022	1574	1622	2164
7	Kisan x FESR-S-PI-BI-B	1999	768	367	-	-	679	604
		2000	3208	-	664	764	1597	1558
		2001	3279	1537	3414	1620	1707	2312
8	JB-223	1999	694	386	-	-	617	566
		2000	2784	-	675	938	1399	1449
		2001	3289	1426	3239	1828	1533	2263
9	JB-224	1999	758	359	-	-	604	571
		2000	2904	-	647	845	1489	1471
		2001	3061	1537	3694	1689	1464	2289
10	GG-2	1999	723	375	-	-	590	565
		2000	2682	-	617	949	1541	1447
		2001	2918	1463	3238	1342	1740	2141
11	GG-5	1999	671	385	-	-	623	560
		2000	3107	-	553	590	1613	1466
		2001	3125	1685	3522	1389	1630	2270
12	J-11	1999	713	269	-	-	581	531
		2000	2616	-	403	671	1533	1306
		2001	2980	1629	2933	1551	582	2191
	S.Em. +/-	1999	72.42	30.04	-	-	44.85	28.79
	C.D. at 5%		NS	88.18	-	-	129.13	80.61
	C.V. %		21.12	20.62	-	-	16.02	20.21
	S.Em. +/-	2000	229.18	-	32.62	93.24	54.96	94.88
	C.D. at 5%		659.79	-	93.91	268.42	158.22	273.15
	C.V. %		15.14	-	10.21	20.23	7.20	16.71
	S.Em. +/-	2001	64.78	125.53	178.75	138.48	52.65	111.92
	C.D. at 5%		186.51	361.38	512.88	398.66	151.56	NS
	C.V. %		4.41	17.49	10.78	19.04	6.97	11.39
	Interaction (L X T)							
	S.Em. +/-	1999	-	-	-	-	-	52.15
	C.D. at 5%		-	-	-	-	-	NS
	S.Em. +/-	2000	-	-	-	-	-	127.78
	C.D. at 5%		-	-	-	-	-	357.10
	S.Em. +/-	2001	-	-	-	-	-	121.36
	C.D. at 5%		-	-	-	-	-	336.39

Table 4. Haulm yield (kg/ha) of selected crosses/genotypes at various locations

S. No.	Entry	Year	Manavadar	Nana Kandhasar	Targhadia	JamKhambhalia	Junagadh	Pooled
1	GG-2 x NCAC-17135	1999	791	570	-	-	981	782
		2000	3665	-	2014	3796	1948	2856
		2001	2836	1481	4486	2245	1516	2513
2	J-11 x PI-259747	1999	1261	1226	-	-	1012	1267
		2000	3916	-	3070	3912	2604	3376
		2001	3137	2704	5472	2454	2670	3295
3	GG-2 x PI-259747	1999	810	644	-	-	981	816
		2000	3067	-	2750	4005	1968	2947
		2001	2739	796	5152	1967	2006	2532
4	GG-2 x PI-259747	1999	955	549	-	-	1138	881
		2000	3665	-	2222	2986	2161	2759
		2001	3042	1315	5194	1528	1775	2571
5	GG-2 x PI-259747	1999	830	651	-	-	1003	828
		2000	3511	-	2194	3171	1929	2701
		2001	2758	1611	4541	1250	1678	2367
6	S-206 x FESR-8	1999	1090	1130	-	-	1427	1282
		2000	4128	-	3625	3912	2373	3510
		2001	3029	3139	5798	2431	2542	3386
7	Kisan x FESR-S-PI-BI-B	1999	1412	1011	-	-	1944	1162
		2000	4167	-	3194	2848	2759	3242
		2001	3125	2333	5806	2361	2016	3128
8	JB-223	1999	1119	1257	-	-	1279	1215
		2000	3761	-	3347	3287	2131	3207
		2001	3086	2000	5722	2407	2045	3052
9	JB-224	1999	1186	1178	-	-	1215	1066
		2000	3723	-	3153	2893	2296	3016
		2001	3106	2352	5417	2523	1611	3002
10	GG-2	1999	1071	955	-	-	1254	1093
		2000	3897	-	2736	2940	2199	2943
		2001	3048	2130	5181	1991	1638	2797
11	GG-5	1999	1379	1204	-	-	1273	1285
		2000	4475	-	3806	2894	2276	3363
		2001	3202	2667	5667	2037	2344	3183
12	J-11	1999	1273	700	-	-	1485	1153
		2000	4282	-	3778	2870	2238	3292
		2001	3356	3148	6000	2222	2191	3384
	S.Em. +/-	1999	67.65	110.82	-	-	55.71	83.52
	C.D. at 5%		194.75	320.5	-	-	160.3	244.98
	C.V. %		12.41	14.85	-	-	9.09	15.26
	S.Em. +/-	2000	167.32	-	136.67	152.78	106.83	210.68
	C.D. at 5%		481.69	-	393.46	439.84	307.55	NS
	C.V. %		8.68	-	9.14	9.28	9.43	9.2
	S.Em. +/-	2001	53.93	303.04	237.54	165.97	55.83	147.61
	C.D. at 5%		155.26	872.42	683.84	480.7	160.73	420.97
	C.V. %		3.55	28.33	8.85	15.77	5.58	13
	Interaction (L X T)							
	S.Em. +/-	1999	-	-	-	-	-	81.57
	C.D. at 5%		-	-	-	-	-	229.22
	S.Em. +/-	2000	-	-	-	-	-	142.7
	C.D. at 5%		-	-	-	-	-	398.75
	S.Em. +/-	2001	-	-	-	-	-	190.87
	C.D. at 5%		-	-	-	-	-	529.06

During *kharif* 2001, haulm yield exhibited variation at various centres as well as in pooled means. Variety J-11 fared extrememsely well at Manavadar, Targhadia, Junagadh, Nanakandhasar centres as also in pooled mean. However, GG-5, S 206 x FESR-8, Kisan x FESR-S-PI-B1-B and JB 224 were at par with J-11.

The results clearly indicate that the selected crosses/genotypes are at par with the local cultivated varieties of groundnut with respect to pod and haulm yields. In fact, they could even be termed superior because under extreme conditions of water deficit during *kharif* 1999 and 2000 they recorded significantly higher pod yield than the local checks. Hence, the crosses GG-2 x NCAC 17135, GG-2 x PI 259747, J 11 x PI 259747, S 206 x FESR-8, Kisan x FESR-S-PI-B1-B, and the genotypes JB 223 and 224 could be termed as drought tolerant genotypes, as drought tolerance has been defined as "the ability of one genotype to be more productive with a given amount of soil moisture than another genotype (Quizenberry, 1982). Accordingly, yield produced in water-limiting environments could be considered a primary criterion for assessing genotypic performance.

Similar approach of identification of drought tolerant groundnut genotypes was adopted at ICRISAT (Annual Report, 1989) and Reddy *et al*. (1997) in Andhra Pradesh and Maphanyane and Ndunguru (1994) in Botswana, where selected genotypes/crosses for adaptation to drought stress were evaluated for their yield performance with those of locally grown cultivars and identified as drought tolerant. Khan and Rahim (1998) have also evaluated thirteen varieties of groundnut out of which four varieties with drought tolerance and higher yields were identified.

Thus, the crosses GG-2 x NCAC-17135, GG-2 x PI 257747, J-11 x PI 259747, S 206 x FESR-8, Kisan x FESR-S-PI-B1-B and the genotypes JB 223 and 224 showing potentiality of drought tolerance could also be suitable as parents o in crossing programmes aimed at selecting for this trait.

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