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Yield and Grade Response of Five Peanut Genotypes to Drought Stress at Different Stages

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ABSTRACT

Drought is a major factor in reducing productivity in peanut (*Arachis hypogaea* L.). Adaptive techniques associated with irrigation management and agronomic practices can be used to aid the development of drought-related traits through breeding selection and transgenic crops for drought tolerance. The objectives of this study were to: 1) examine the main effects and interactions of five drought stress treatments (Full Irrigated, drought stress at 30, 60, and 90 Days After Planting (DAP), and Non- Irrigated) on five peanut genotypes and 2) indentify the most and least drought tolerant genotypes to be used for further genetic study and breeding program. Five peanut genotypes (AP3, C76-16, A104, Georgia Green, 08T-12) were planted in split plot design, with irrigation treatment (main split) by genotype with three replications in 2010 and 2011. This project was completed using rain-out control shelters. Peanut yield and grade were determined and adjusted to 7 percent moisture. Yield and TSMK were significantly different for peanut genotypes both years. There was no yield interaction of irrigation treatment x genotype for either year, but there was an interaction for TSMK in 2011. T-test analysis indicated the greatest difference for yield and TSMK were for Irrigation Treatment (ranged 3272 to 5236 kg/ha and 71% to 75%, respectively) and Genotype (ranged 3874 to 4810 kg/ha and 70% to 76%, respectively). The genotype with the best drought tolerance was ‘C76-16’ while ‘AP-3’ had the least drought tolerance. Comparison between irrigated and non-irrigated regimes showed that stress occurring at 60 DAP had the greatest effect on yield and TSMK followed by 90 then 30 DAP. These data imply that ‘C76-16’ could be used as a drought tolerant parental donor and drought stress treatment at 60 DAP could be used as screening tool in breeding programs.

INTRODUCTION

Drought is a major factor in reducing productivity in peanut (*Arachis hypogaea* L.). Based on USDA estimates, cost and lost revenue caused by drought in peanuts in the USA is about $57.7 million per year. Yield and grade response to drought stress will be essential for phenotyping drought tolerance trait in peanut. A lack of information of the phenotypic response of crop genotypes to drought environments can dramatically hinder breeding efforts for such stress. The objectives of this study were to: 1) examine the main effects and interactions of five drought stress treatments (Full Irrigated, drought stress at 30 60, and 90 Days After Planting (DAP), and Non- Irrigated) on five peanut genotypes, and 2) indentify the most and least drought tolerant genotypes to be used for further genetic study and breeding program.

MATERIALS & METHODS

Five genotypes were selected for the study. **‘Georgia Green’** (Branch, 1996) had been the accepted agronomic standard and was planted on a majority of acres in the Southeast because of its moderate tolerance to drought in late 1990’s and early 2000’s. **‘AP-3’** (Gorbet, 2007) showed a weak drought tolerance in previous studies. **‘C76-16’,** and **‘A104’** were selected for late season drought stress to reduce aflatoxin contamination. **‘08T-12’** was selected under non-irrigated condition for drought tolerance in Brownfield, TX.

Irrigation treatments were designed as five regimes: **full irrigation**, **30 DAP** stress, **60 DAP** stress, **90 DAP** stress, and **non-irrigation**. For the drought treatment, water was completely withheld for 3 wks, and then re-irrigated. Control plots were fully irrigated throughout the season. Peanuts were planted in environmental controlled rainout shelters (Blankenship et al. 1989) in May of 2010 and 2011 at the National Peanut Research Laboratory, Dawson, GA, USA (Fig. 1). Each genotype was planted in a single row plot of 5.5 m long and 0.76 m wide using seed rate of 20 seeds/m. A split-plot design was adopted with each shelter assigned one irrigation regime (main plot) and each peanut genotype (subplot) was replicated three times per shelter. Yield (kg/ha) and total sound mature kernel (TSMK %) grade characteristics were reported in this study. Data were analyzed in SAS (version 9.1) with PROC GLM under the general linear model. The genotype x year and treatment x year were significant so each year was reported separately. Treatment effect F-tests were carried out against their specific error source. Means were separated using Fisher’s Protected LSD at $p<0.05$.

REFERENCES

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RESULTS

Peanut yield and TSMK were highly significant for year, genotype, treatment, and year x genotype, and year x genotype. There was no yield interaction of irrigation treatment x genotype for either year, but there was an interaction of irrigation x genotype for TSMK in 2011. T-test analysis indicated the greatest difference for yield and TSMK were for Irrigation Treatment (range 3272 to 5237 kg/ha and 71% to 75%, respectively) and Genotype (range 3875 to 4810 kg/ha and 70% to 76%, respectively) (Table 1). The most significant yield difference occurred at 60 DAP for yield and TSMK in 2010 compared with the other irrigation treatments. The greatest yield difference occurred between non-irrigation and full irrigation in 2011 (Table 2). Yield and TSMK showed reductions in three drought stress treatments but the most significance was in 60 DAP, indicating that stress occurring at 60 DAP had the greatest effect on yield and TSMK followed by 90 and 30 DAP. ‘C76-16’ showed the best yield performance among five tested genotypes in five treatments, while ‘AP-3’ was the least and showed a consistent low in TSMK as well. These data imply that ‘C76-16’ could be used as a drought tolerant parental donor and drought stress treatment at 60 DAP could be used as screening tool in breeding programs.

Table 1. T-tests for mean yield and TSMK at five treatments and five genotypes in two years.

Variable		N	Yield (kg/ha)	TSMK (%)
Treatment	IRR	30	5237 a	75 a
	30DAP	30	4913 a	73 b
	90DAP	30	4026 b	74 a
	60DAP	30	3480 c	71 d
	Non-IRR	30	3272 c	72 c
Genotype	C76-16	30	4811 a	73 c
	Georgia Green	30	4264 b	76 a
	08T-12	30	3999 bc	72 c
	A104	30	3979 bc	74 b
	AP-3	30	3875 c	70 d
$LSD_{0.05}$			289	1.1

* Means with the same letter are not significantly different.

Fig. 1. Environmental controlled rainout shelters at the NPRL, Dawson, GA

Table 2. Yield (kg/ha) performance and TSMK (%) of five genotypes at different treatments in 2010 and 2011.

Genotype	Year	30DAP		60DAP		90DAP		Non-IRR		IRR	
		Yield	TSMK	Yield	TSMK	Yield	TSMK	Yield	TSMK	Yield	TSMK
08T-12	2010	4746	71	2022	67	3661	74	3236	72	4283	74
	2011	5078	74	4653	74	3816	71	2140	70	6353	74
	Mean	4912	73	3338	70	3738	73	2688	71	5318	74
A104	2010	4540	75	2979	71	4040	74	3275	71	4380	75
	2011	4910	74	4014	73	3607	76	3279	74	4764	75
	Mean	4725	75	3497	72	3823	75	3277	73	4572	75
AP-3	2010	4408	70	2953	66	3114	71	2561	67	4335	70
	2011	4518	71	3926	72	3955	73	3292	72	5686	74
	Mean	4463	71	3440	69	3535	72	2926	69	5010	72
C76-16	2010	5206	71	3422	71	4770	74	4549	70	5467	73
	2011	6347	72	4081	71	4357	77	3700	73	6210	74
	Mean	5776	72	3752	71	4564	75	4125	71	5838	74
Georgia Green	2010	4240	76	3403	73	4629	78	3841	75	4988	78
	2011	5134	77	3347	74	4308	76	2850	78	5904	79
	Mean	4687	77	3375	74	4468	77	3345	77	5446	78
$LSD_{0.05}$ for mean		474	1.2	405	3.3	349	2.6	428	1.3	483	1.1