Groundnut Drought-simulation Studies at ICRISAT Sahelian Center

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Although it has been shown that there is a greater probability of drought at the beginning and at the end of the rainy season in the Sahel, potentially damaging drought spells often occur at any time during the cropping season. Variability in the rainfall pattern may well be at least as important a factor as total moisture shortage. Under these conditions, recovery and return to active growth and development, after exposure to varying periods of drought, may be more important than drought avoidance or drought tolerance.

We ran two deficit irrigation trials at ICRISAT Sahelian Center (ISC) during the 1987/88 dry season. Both these trials tested the performance of many groundnut lines irrigated every 1, 2, or 3 weeks, with each irrigation giving 20 mm or 40 mm of water. In the first trial, during Sep-Dec 1987, we found no difference in the yields of the four groundnut lines. Reducing the frequency and amount of irrigation reduced the yields of both haulms and pods as expected (Table 1). We observed that growth almost ceased under the cold temperatures in December and there seemed to be hardly any visual signs of foliar drought stress at this time, even in the treatments which received little water. We, therefore, consider that it is not desirable to screen for drought tolerance late in the year at ISC.

We repeated the trial during Feb-Jun 1988, during the much hotter weather, using the same irrigation treatments and nine groundnut lines. In this trial, the treatments with irrigation every 3 weeks effectively gave no pods for any of the groundnut lines, so we ignored these treatments in the further analysis of the data. Genotypes ICGV 87123 and 55-437 gave the highest pod yields over all irrigation treatments, but at the same time gave very low haulm yields. It seems that under drought-stress conditions at ISC the plants may be able to produce reasonable haulm yields or reasonable pod yields, but not both. There were no significant interactions between genotype and irrigation treatment for pod or haulm yield. We found that one of the genotypes in this trial gave somewhat anomalous results and we removed its data from further analyses. ICG 1697 is a leafy valencia line that has been identified as drought tolerant at ICRISAT Center. It produces high haulm yields but few pods at ICRISAT Sahelian Center (Table 2), and as such may not be successful in these transitional regions of West Africa. We made weekly determinations of soil-moisture content with neutron probes, and took daily measurements of crop canopy - air temperature differences with infra-red thermometers on all plots in the trial. There were

Table 1. Effect of different drought periods on four groundnut genotypes, Sadoré, Niger, postrainy season 1987.

Period between irrigations	Irrigation dose	Genotype	Yield (t ha^{-1}) Haulm	Yield (t ha^{-1}) Pods	Shelling %	Late season plant - air temp. diff.	Mean soil moisture total (mm)
1 week			1.60	1.64	72	-1.66	54.8
2 weeks			1.32	1.05	69	0.62	48.4
3 weeks			1.33	0.70	66	1.46	44.9
SE			±0.09	±0.16	±2	±0.54	±1.1
	40 mm		1.59	1.45	69	-0.85	51.4
	20 mm		1.24	0.80	68	1.13	47.3
SE			±0.07	±0.13	±2	±0.44	±0.9
		55-437	1.11	1.10	72	0.19	48.6
		47-16	1.74	1.14	67	0.34	48.5
		ICGS(E) 13	1.19	1.20	70	0.30	49.8
		ICGS(E) 22	1.63	1.08	67	-0.27	50.7
SE			±0.06	±0.08	±1	±0.20	±0.5

large differences in mean soil-moisture content in the 0-210 cm horizon between irrigation treatments (Table 2) with lower soil-moisture content where less water was applied, as would be expected. However, we found no differences in soil-moisture content between genotypes. We found considerable differences between genotypes in crop canopy - air temperature difference. This value is related to leaf water potential and it is considered that drought-tolerant genotypes should have a high leaf water potential or a more negative value of the crop canopy - air temperature difference. A strong negative correlation ($r = -0.822$, $P = 0.012$) was found between midseason crop canopy - air temperature difference and pod yield under intermediate stress conditions (20 mm of water each week), whereas no correlation was found when there was not much drought stress (40 mm of water each week), or when there was extreme stress (20 mm of water every 2 weeks). It would appear that under intermediate drought-stress conditions the genotypes that maintain a higher leaf water potential are able to support higher pod yields. We consider that measurements of crop canopy - air temperature differences at times when the rainfed crop is showing some drought stress could give us a useful indication of potential drought tolerance, and we plan to test further the effectiveness of this method as a screening technique in future trials.

Table 2. Effect of frequency and rate of irrigation on nine groundnut genotypes, Sadoré, Niger, dry season 1988.

Period between irrigations	Irrigation dose	Genotype	Haulm yield (t ha^{-1})	Pod yield (t ha^{-1})	Seed yield (t ha^{-1})	Shelling %	Early season plant-air temp. diff.	Mid season plant-air temp. diff.	Late season plant-air temp. diff.
1 week			1.75	0.61	0.35	55	-4.92	-3.83	1.39
2 weeks			1.70	0.22	0.11	34	-3.26	-1.30	3.48
SE			±0.07	±0.08	±0.05	±3	±0.06	±0.30	±0.52
	40 mm		1.84	0.57	0.31	51	-4.24	-4.13	1.65
	20 mm		1.61	0.26	0.15	38	-3.94	-1.00	3.23
SE			±0.07	±0.08	±0.05	±3	±0.06	±0.30	±0.52
1 week	40 mm		1.91	0.76	0.44	56	-5.17	-5.26	0.89
1 week	20 mm		1.60	0.47	0.26	53	-4.67	-2.40	1.89
2 weeks	40 mm		1.78	0.39	0.19	46	-3.31	-3.00	2.40
2 weeks	20 mm		1.61	0.05	0.03	22	-3.22	0.41	4.57
SE			±0.10	±0.11	±0.07	±4	±0.09	±0.43	±0.74
		55-437	1.28	0.57	0.34	57	-3.45	-2.77	2.43
		47-16	1.64	0.30	0.17	39	-3.17	-1.14	3.29
		ICG 1697	1.93	0.24	0.11	31	-4.76	-2.30	2.28
		TS 32-1	1.97	0.27	0.15	41	-4.15	-1.84	2.65
		J 11	1.60	0.45	0.28	48	-3.63	-2.62	2.12
		ICGV 87123	1.46	0.58	0.34	55	-4.41	-3.32	2.49
		ICGV 87141	1.37	0.47	0.27	49	-4.52	-3.73	2.15
		ICGV 86529	2.26	0.41	0.19	39	-4.24	-2.69	2.03
		ICGMS 64	2.01	0.45	0.21	38	-4.50	-1.97	2.49
SE			±0.19	±0.06	±0.04	±4	±0.22	±0.21	±0.10