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Moisture-extraction pattern, phasic water use and phasic growth in groundnut *(Arachis hypogaea)* under varying moisture regime and groundwater-table condition

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ABSTRACT

An experiment conducted during summer 1992 and 1993 with groundnut (*Arachis hypogaea* L.) on moisture-extraction pattern, phasic water use and growth at Chiplima showed that moisture-extraction increased with lowering of groundwater-table. On an average, crop extracted 18.6 cm water from 60 cm profile under 50 ± 10 cm water-table depth which increased to 25.2 cm and 26.7 cm at 90 ± 10 and 110 ± 10 cm water-table depth respectively. Extraction was the maximum (9.12 cm) at surface layer of 0–15 cm which accounted for 39.9% of the total extraction. It reduced to 7.31 cm (31.6%), 4.53 cm (18.7%) and 2.54 cm (9.8%) with increase in profile depth by 15 cm up to 60 cm profile respectively. Groundnut used the maximum water of 3.11 cm/day, with maximum growth in terms of crop-growth rate (10.18 g/m^2/day) and net assimilation rate (3.31 g/m^2/d) during 56–90 days of its growth. Water-use showed significant positive correlation with pod yield at lowest water-table depth, 'r' value of 0.994** being the maximum.

Key words : Moisture-extraction pattern, Phasic water use, Groundnut, CGR, NAR, Groundwater-table

Water relations are among the most important physical phenomena that influence gradual increase in plant growth over time as expressed by its development. Periodic use of profile moisture and its reflection through various growth phenomena are temperature, available moisture and genetic make up dependent (Boote, 1983). Such relationships attain greater significance in groundnut due to its indeterminate nature of growth. Present investigation attempts to study the phasic water use and its influence on growth characters in groundnut grown under fluctuating groundwater on terraced land in Hirakud command during post winter season.

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MATERIALS AND METHODS

A field experiment was conducted during summer 1992 and 1993 at Chiplima, on a sloppy terraced clay-loam soil characterized by 21–23% moisture at field capacity and 8–10% at permanent wilting point, bulk density of 1.5–1.56 g/cc and hydraulic conductivity of 1.33 to 1.36 cm/hr. Groundnut 'OG 85-1, a spanish bunch, was sown during the second fortnight of January with 25 cm × 10 cm spacing and fertilized with 20, 40 and 40 kg N, P_2O_5, and K_2O/ha respectively. Six IW:CPE ratios such as 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 were laid out in randomized block design with 4 replications on each of the 3 sites having 3 different groundwater-table conditions of 50 ± 10 cm (W_1), 90 ± 10 cm (W_2) and 110 ± 10 cm (W_3). To monitor the moisture extraction (cm), its use and requirement by the crop and moisture loss data were collected by gravimetric sampling at the beginning, before and after each irrigation and at harvest of crop from 60 cm profile depth.

Recognisable phenological events for the crop were observed and the entire crop-growth period was divided into 5 phenophases such as germination to flower initiation (S_1, 26 days), flower initiation to maximum flowering (S_2, 14 days), flowering to peg formation (S_3, 15 days), peg formation to pod development (S_4, 35 days) and pod development to maturity (S_5 28 days). Boote (1983) observed that spanish cultivars have shorter intervals between various phenological events but all events occur in order unless the crop life-cycle is terminated.

Few days overlapping of the phases may be attributed to indeterminate growth habit of the crop.

RESULTS AND DISCUSSION

Moisture extraction

Moisture extraction increased with the lowering of groundwater-table and was up by 35.5 and 43.5% at groundwater-table condition of 90 ± 10 and 110 ± 10 cm below the surface respectively over the shallow water-table-situation of 50 ±10 cm where the crop extracted, on an average over irrigation, 18.6 cm moisture from 60 cm profile. Moisture extraction increased with the increase in IW:CPE ratio. At lowest ratio of 0.2 the extraction was 12.3 cm which increased to 34 cm at the highest ratio of 1.2. Similarly, the mositure extraction was the maximum (9.12 cm) from surface layer of 0–15 cm, accounting for 39.9% of the total extraction from 60 cm profile depth. Extraction decreased almost linearly with increase in depth by 15 cm up to 60 cm profile. The corresponding contribution was 31.6, 18.7 and 9.8% of total water extracted by the crop (Table 1). Root-system of crop is largely responsible for exploring the soil profile for water with their inherent ability to extract water from the soil reservoir (Ketering and Reid, 1993). The maximum configuration of groundnut roots in the top 30 cm of soil profile (Robertson *et al.*, 1980) explains the moisture-extraction pattern by the crop in present study.

Phasic use

Phasic moisture use by the crop was minimum at the beginning and increased gradually with the crop growth, attained a

Table 1. Soil moisture-extraction pattern and total water use in groundnut as influenced by irrigation schedule and depth of groundwater-table (mean data of 2 seasons)

Particulars	Moisture extraction (cm)		Total water use (cm)
Watertable-depth (cm)			
W_1	18.6		25.7
W_2	25.2		32.3
W_3	26.7		33.5
Irrigation sschedule (IW:CPE)			
0.2	12.3		15.9
0.4	15.6		20.3
0.6	19.9		26.4
0.8	27.4		35.1
1.0	31.8		40.2
1.2	34.0		44.9
Profile depth (cm)		Phases (DAS)	
0–15	9.12 (39.9)	0–26 days S_1	2.63
15–30	7.31(31.6)	27–40 days S_2	2.67
30–45	4.53 (18.7)	41–55 days S_3	3.67
45–60	2.54 (9.8)	56–90 days S_4	11.86
		91–118 days S_5	9.62

Figures in parentheses denote per cent contribution

peak 56 days after sowing (DAS) and remained higher towards maturity compared to first 3 phases of the growth. On an average, the crop utilized 257 mm water during its life-span of 118 days under W_1 situation and, which increased by 26 and 30% under W_2 and W_3 respectively. In each water-table condition the maximum water was utilized during S_4 (56–90 days after sowing coinciding) with the pod-development stage. It was 101, 124 and 130 mm in W_1, W_2 and W_3 condition respectively. Total water use was the minimum (15.9 cm) at the lowest ratio of 0.2 and it increased with IW:CPE and attained its maximum (44.9 cm) at highest IW : CPE ratio of 1.2 (Table 1).

Correlation study between water use and

Table 2. Two-way table for pod yield (q/ha) as influenced by irrigation schedules and depth of groundwater-table (pooled over 2 seasons)

IW:CPE ratio	Groundwater-table			
	W_1	W_2	W_3	Mean
0.2	9.7	11.4	13.6	11.6
0.4	11.8	14.8	16.6	14.4
0.6	14.9	19.6	18.9	17.8
0.8	17.7	21.9	21.8	20.5
1.0	16.0	24.8	25.1	21.9
1.2	15.9	25.7	25.8	22.5
Mean	14.3	19.7	20.3	
Correlation 'r'	0.837*	0.979**	0.994**	
	Irrigation	*Water-table*	*Irrigation × water-table*	
CD (P=0.05)	0.62	0.44	1.09	

Table 3. Water use and crop development in summer groundnut as influenced by depth of groundwater-table

Water-table depths (cm)	Particulars	Phenophases, (days after sowing)					
		0–26 (S_1)	27–40 (S_2)	41–55 (S_3)	56–90 (S_4)	91–119 (S_5)	Mean
W_1 50 ± 10	Water use (mm/day)	0.90	1.63	2.05	2.90	4.35	2.37
	NAR (g/m²/day)	0.48	1.00	2.10	3.16	0.79	1.51
	CGR (g/m²/day)	0.07	0.38	2.03	5.77	2.63	2.18
W_2 90 ± 10	Water use (mm/day)	1.14	2.02	2.62	3.55	5.61	2.99
	NAR (g/m²/day)	0.33	1.65	3.06	3.31	1.04	1.88
	CGR (g/m²/day)	0.03	0.48	3.32	8.59	5.30	3.54
W_3 110 ± 10	Water use (mm/day)	0.99	2.08	2.69	3.71	6.08	3.11
	NAR (g/m²/day)	0.30	1.17	2.52	3.18	0.95	1.61
	CGR (g/m²/day)	0.05	0.45	2.43	10.18	5.64	3.75

pod yield indicated that coefficient values (r=0.837*) increased from shallow water-table condition (W_1) to 0.979** and 0.994** at medium (W_2) and deep (W_3) water-table conditions (Table 2). Mean per day water use was the minimum (2.37 mm) at W_1 and increased to 2.99 and 3.11 mm at W_2 and W_3 situation, respectively. Peak use of 4.4, 5.6 and 6.1 mm per day was observed during the S_5 stage in W_1, W_2 and W_3 situations, respectively (Table 3). Such trend may be attributed to root-development pattern, its depth and lateral growth. Chapman *et al.* (1993) observed that active root development in groundnut continued even till 84 days after sowing and, size of the root-system prior to this period was found inadequate to supply water and could not support the large cannopy particularly under stress.

Net assimilation and crop-growth rate

Growth as measured by NAR and CGR showed its peak value between 56 and 90 days after sowing. Crop-growth rate apeared to have affected more than the net assimillation rate. From initial slow CGR, the rate increased to its maximum of 5.77, 8.59 and 10.18 g/m²/day compared to NAR of 3.16, 3.31 and 3.18 g/m²/day under W_1, W_2 and W_3 situations, respectively (Table 3). Groundnut is a slow starter in terms of growth (Duncon *et al.*, 1978) and the values of CGR from 10 to 17 g/m²/day during 46–104 days after sowing was also reported by Murthy *et al.* (1983) and Murthy and Rao (1986). Lower values under shallow water-table condition might be due to inadequate aeration and restricted root growth.

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