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Influence of irrigation on yield and moisture utilization of groundnut (*Arachis hypogaea*)

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ABSTRACT

A field experiment was conducted during 1994–97 on clay-loam soil of medium land with winter groundnut (*Arachis hypogaea* L.). The pod yield increased with increasing irrigation water : cumulative pan evaporation (IW : CPE) and the maximum yield of 22.4 q/ha was obtained at 1.4 IW : CPE with 52.5 cm evapotranspiration (ET), 76.1 cm water requirement (WR) and 42.8 kg/ha/cm crop water-use efficiency (CMUE). It required 12 irrigations of 6 cm depth each with ET:Pan E ratio of 0.87. Most of the ancillary characters, however, showed increasing trend up to 1.2 IW:CPE which also gave pod yield (21.91 q/ha) at par with that of 1.4 IW:CPE. The value of ET, WR, run-off and percolation at 1.2 IW:CPE were 46.95, 65.39, 3.25 and 21.39 cm respectively. The crop water-use efficiency and field water-use efficiency were computed to be 46.69 and 33.81 kg/ha/cm respectively with ET:Pan E value of 0.78 at this moisture regime.

Key words : IW : CPE, Yield, Water balance, Evapotranspiration, ET : Pan E, Groundnut

Conventionally, irrigation is given to restore the soil moisture in the root zone at field capacity and to satisfy the crop evapotranspiration (ET) requirement for maximum yield (Ym) per unit area. Groundnut is an important crop largely grown under unirrigated condition. With increased cropping intensities and irrigation facilities, its area (winter) in Orissa has increased, with an average productivity of 1,460 kg/ha (Agricultural Statistics of Orissa, 1995–96). During winter season, it is cultivated under irrgated condition but its response to irrigation has not been studied. Keeping this in view, the present study was initiated to assess the different irrigation schedules to find out the optimum yield, moisture-utilization pattern and the different components of field water balance in winter groundnut.

MATERIALS AND METHODS

The present experiment was carried out during winter season of 1994–95 to 1996–

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97 at the Regional Research Station, OUAT, Chiplima, Sambalpur, in the Hirakud command area with 7 irrigation schedules (0.2, 0.4, 0.6, 0.8, 1.0, 1.2 and 1.4 IW:CPE, IW=6 cm) in randomized block design with 4 replications. The texture of the experimental soil was clay loam with bulk density 1.52 Mg/m; field capacity 19.8%, wilting point 7.0%, saturated hydraulic conductivity 6.24×10^3 m/sec., pH 6.5, electrical conductivity 0.062 dS/m and organic carbon content 3.4 g/kg. The test crop groundnut ('AK 12-24') was raised with the normal package and practice, i.e. 30 cm × 20 cm spacing with 20, 40 and 40 N, P and K kg/ha. The crop was sown on 18 November 1994, 28 November 1995 and 6 December 1996 and was harvested on 21 April 1995, 20 April 1996 and 5 May respectively. The soil moisture was determined gravimetrically at sowing, before and 48 hr after each irrigation and at harvest from the profile of 15 cm interval up to a depth of 60 cm. The irrigation water was measured by the help of irrigation module. Evaporation, rainfall and other important meteorological parameters were recorded from the nearby meteorological observatory. The evapotranspiration (ET) of the crop was determined by depletion method. With the help of above values of ET, percolation loss was computed as per equation outlined by Hillel (1990). In present investigation, the groundwater contribution has not been accounted, as it fluctuated below 2 m from the surface. Gulati (1995) reported that on clay-loam soil contribution of groundwater to ET of groundnut was substantial only under shallow water-table condition and no contribution was observed when the groundwater table was more than 120 cm below the surface. Surface run-off was accounted in the equation when the precipitation was occurred within 48 hr of irrigation.

RESULTS AND DISCUSSION

Yield-attributing characters

Yield-attributing characters of groundnut showed a favourable response to frequent irrigation, as indicated by increased IW:CPE. However, the significant increase was noticed at 1.2 IW:CPE except number of matured pods which, however, was the maximum (13.08) at 1.4 IW:CPE, weight of 100 pods showed significantly higher value of 82.87 g at 1.2 IW:CPE, but did not show any appreciable difference at IW:CPE of 1.4 and 1.0. Similar trend was also observed with 100-kernel weight, producing significantly the highest kernel weight of 50.1 g at 1.2 IW:CPE (Table 1).

Shelling percentage

Maximum shelling percentage of 60.36 was noticed at 1.2 IW:CPE and it was significantly superior to that of all other ratios. Stress regime of 0.2 and 0.4 IW:CPE reduced the shelling percentage of groundnut to a lowest value of 40–41.8% (Table 1).

Pod yield

Pod yield followed more or less similar trend to that of other characters of groundnut. It increased significantly with increasing IW:CPE from 0.2 to 1.2 IW:CPE, with a pod yield of 8.54 and 21.91 q/ha, respectively, though the maximum yield of 22.41 q/ha was recorded with the highest IW : CPE of 1.4. The loss in yield under stress regime of 0.2 and 0.4 IW : CPE was between 61 and 54% and under moderate regime of 0.6 and 0.8, the loss was 36 to 43% against 1.2 IW : CPE moisture regime (Table 1). The results are in confirmity with those of Gulati and Lenka (1999).

Moisture utilization

Moisture utilization increased from a minimum of 9.47 cm at stress regime of 0.2 IW:CPE to a maximum of 40.36 cm at the

Table 1. Effect of irrigation schedule on yield and yield-attributing characters of groundnut (pooled data of 3 years)

Irrigation schedule (IW:CPE)	Pod yield (q/ha)	Matured pods/ plant	100-pod weight (g)	100-kernel weight (g)	Shelling percentage
0.2	8.54	7.63	69.70	27.92	40.08
0.4	10.16	8.51	71.84	30.02	41.79
0.6	12.55	9.72	72.72	33.91	46.52
0.8	14.05	10.19	75.84	37.87	49.77
1.0	18.96	11.47	77.92	41.35	53.23
1.2	21.91	12.82	82.87	50.08	60.36
1.4	22.41	13.08	82.63	49.78	60.26
CD (P=0.05)	1.79	1.00	3.52	4.18	4.63

Table 2. Effect of irrigation schedule on moisture utilization or extraction pattern in groundnut (mean data of 3 years)

Irrigation schedule (IW:CPE)	Soil depth (cm)				
	0–15	15–30	30–45	45–60	0–60
0.2	4.30	3.51	1.46	0.47	9.47
	(45.4)	(37.1)	(15.5)	(5.0)	(100)
0.4	5.51	3.70	1.84	0.51	11.56
	(47.7)	(32.0)	(15.9)	(4.4)	(100)
0.6	7.38	5.20	2.36	0.70	15.64
	(47.2)	(33.2)	(15.1)	(4.5)	(100)
0.8	10.26	7.20	3.36	1.00	21.82
	(47.0)	(33.0)	(15.4)	(4.6)	(100)
1.0	12.12	8.61	3.94	1.11	25.78
	(47.0)	(33.4)	(15.3)	(4.3)	(100)
1.2	16.54	12.22	5.57	1.62	35.95
	(46.0)	(34.0)	(15.5)	(4.5)	(100)
1.4	18.12	14.13	6.50	1.61	40.36
	(44.9)	(35.0)	(16.1)	(4.0)	(100)

Figures in parentheses denote moisture extraction in per cent wettest regime of 1.4 IW:CPE. Gulati (1995) found that root growth as expressed by lateral spread and branches/plant and root volume increased with inreased moisture regime, resulting in more utilization. Crop extracted maximum moisture (49.9–47.2%) from surface (0–15 cm) layer which decreased with increase in depth and minimum extraction (4.5–5.0%) was found from the deepest soil depth (45–60 cm) irrespective of moisture regime (Table 2). More amount of soil moisture utilized by the crop from surface (0–15 cm) layer might be due to more root concentration in this layer.

Evapotranspiration and water-use efficiency

Lowest evapotranspiration (ET) of the crop (16.2 cm) was recorded at 0.2 and maximum (52.49 cm) at 1.4 IW:CPE, whereas 46.95 cm of ET was recorded at 1.2 IW : CPE corresponding to the second highest pod yield which corroborates with the seasonal ET value determined by lysimeter (Shekh *et al.*, 1995). The crop

Table 3. Effect of irrigation schedule on water requirement (WR), crop water-use efficiency (CWUE), field water-use efficiency (FWUE), ET:Pan E and number of irrigation in groundnut (mean data of 3 years)

Irrigation schedule (IW:CPE)	WR (cm)	CWUE (kg/ha/cm)	FWUE (kg/ha/cm)	Number of irrigation	ET:Pan E
0.2	20.38	52.59	42.31	3.0	0.27
0.4	28.34	51.73	36.70	4.3	0.33
0.6	40.21	49.10	31.57	6.3	0.46
0.8	45.57	47.88	31.07	7.3	0.49
1.0	58.08	46.98	32.90	9.3	0.60
1.2	65.39	46.69	33.81	10.7	0.78
1.4	76.08	42.77	29.87	12.3	0.87

Table 4. Effect of irrigation schedule on components of field water balance in groundnut (mean data of 3 years)

Irrigation schedule (IW:CPE)	Components of field water balance (cm)					
	Precipitation	Irrigation	Run-off	Percolation	Change in soil water storage	Evapotranspiration
0.2	6.16	18.0	2.60	6.53	−1.17	16.20
0.4	6.16	26.0	2.75	10.99	−1.21	19.63
0.6	6.16	38.0	2.82	17.09	−1.29	25.54
0.8	6.16	44.0	2.98	19.14	−1.31	29.35
1.0	6.16	56.0	3.14	20.03	−1.38	40.37
1.2	6.16	64.0	3.25	21.39	−1.43	46.95
1.4	6.16	74.0	3.34	25.80	−1.47	52.49

water-use efficiency (CMUE) was the maximum (52.59 kg/ha with 0.2 IW:CPE compared with 42.77 kg/ha/cm at 1.4 IW:CPE (Table 3). The results confirm those of Parihar *et al.* (1999) in summer groundnut.

Water requirement and ET : Pan E

Water requirement (WR) and ET:Pan E increased with increase in IW:CPE from 0.2 to 1.4 IW:CPE (Table 3). The WR of 65.39 cm and ET:Pan E of 0.78 were recorded at 1.2 IW:CPE corresponding the second highest pod yield which was at par with the highest pod yield recorded at 1.4 IW:CPE. Similar results were obtained by Shekh *et al.* (1995) and Ghadekar *et al.* (1996).

Water balance components

The components of field water balance (Table 4) including change in soil water storage though showed negative values, more or less increased with the increase in IW:CPE from 0.2 to 1.4. For the optimum pod yield at 1.2 IW:CPE, the values of irrigation requirement, run-off, percolation and change in soil-water storage were found to be 64.0, 3.25, 21.39 and –1.43 cm respectively. The percolation loss was nearly 6 times more than the surface run-off, which might be due to the fact that soil remained wet for longer duration than the surface run-off. The findings are close confirmity with those of Taha and Gulati (2000) in case of summer groundnut.

It can be concluded that significantly higher pod yield and highest shelling percentage of winter groundnut can be achieved by applying 10 to 11 number of irrigations with crop water-use efficiency of 46.69 kg/ha/cm.

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