

Effect of irrigation and fertilizer on yield, water-use efficiency and nutrient uptake of summer groundnut (*Arachis hypogaea*)

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ABSTRACT

An experiment conducted was during summer 1993 and 1994 at Kharagpur, to study the influence of fertilizer and water on yield, water-use efficiency and nutrient uptake in 'J 11' groundnut (*Arachis hypogaea* L.). Significant increase in pod yield was recorded at IW : CPE ratio 0.60, with an average yield of 1,903 kg/ha. Among the fertilizer treatments, the crop responded significantly at fertilizer level of 30 kg N, 60 kg P₂O₅ and 30 kg K₂O/ha and increase in yield was 30% higher than lower level. Water-use efficiency was also increased at IW : CPE ratio of 0.60 and nutrient level of 30 kg N, 60 kg P₂O₅ and 30 kg K₂O/ha. Uptake of NPK was higher up to 0.8 IW : CPE ratio and fertilizer level of 30 kg N, 60 kg P₂O₅ and 30 kg K₂O/ha.

Key words : Summer groundnut, Irrigation, Fertilizer, Yield, Water-use efficiency, Nutrient uptake

Though groundnut is traditionally a rainy-season crop, it has potential to grow during summer in high rainfall region of eastern India replacing summer rice. However, the yield potential of this crop grown during summer can be realized to a greater extent by adopting suitable water-management practices (Desai and Raman, 1993). Besides, nutrient availability is important for crop development and has relation with moisture levels present in the

soil (Pahalwan, 1986). Further, crops perform better when nutrients are supplied in an integrated manner combining with inorganic and organic sources than inorganic alone (Prasad, 1994). Since information available on nutrient and water management of groundnut when grown during summer is scanty particularly in acid lateritic region of eastern India, the study was conducted to investigate the effect of water and nutrient management in summer

groundnut.

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Farm of Agricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur, during summer season of 1993 and 1994. The average annual rainfall of this region was 1,300–1,500 mm, most of which was received during May–October due to south-west monsoon. The mean minimum and maximum temperature ranged from 9 to 27°C and 27 to 41°C respectively. The soil was acid lateritic (Haplustalf), sandy clay loam in texture with pH 5.6, CEC 8.4 meq/100 g, organic carbon 0.40%, available nitrogen 180.91 kg/ha, available phosphorus 12.98 kg/ha and available potassium 220.2 kg/ha. The treatment consisted of 3 levels of irrigation following

IW : CPE ratio 0.45, 0.6 and 0.75, and 6 fertilizer treatments supplied nutrients through inorganic alone and in combination with FYM (Table 1). In combined organic and inorganic fertilizer treatments 5 kg total N was supplied through FYM and remaining through inorganic sources. Decomposed FYM was applied to the soil 10 days before sowing of the groundnut crop, while the entire dose of inorganic fertilizers N, P₂O₅ and K₂O was applied as basal dose in all the cases. For irrigation schedule, a uniform depth of water (6 cm) was applied in all treatments which was measured by Parshall flume. The details of number and depth of irrigation water are given in Table 2. The experiment was laid out following split-plot design, keeping irrigation in main-plots and the fertilizers in subplot. 'J 11' groundnut was grown as test crop. N, P and K contents in the crop were

Table 1. Yield (kg/ha) of groundnut as influenced by different levels of irrigation and fertilizers

Treatment	1993		1994	
	Pod yield	Haulm yield	Pod yield	Haulm yield
<i>Irrigation</i>				
0.4 IW : CPE	1,433	2,292	1,427	2,077
0.6 IW : CPE	1,840	2,654	1,966	2,595
0.8 IW : CPE	1,966	3,059	2,108	3,002
CD (P=0.05)	181	246	180	234
<i>Fertilizer</i>				
N ₁₀ P ₄₀ K ₁₀ (I)	1,448	2,457	1,531	2,403
N ₁₀ P ₂₀ K ₁₀ (I+O)	1,503	2,349	1,611	2,309
N ₂₀ P ₄₀ K ₂₀ (I)	1,788	2,705	1,878	2,621
N ₂₀ P ₄₀ K ₂₀ (I+O)	1,843	2,5097	1,979	2,525
N ₃₀ P ₆₀ K ₃₀ (I)	1,894	3,030	1,979	2,849
N ₃₀ P ₆₀ K ₃₀ (I+O)	2,000	2,871	2,064	2,638
CD (P = 0.05)	138	230	170	242

I, Inorganic source; O, organic source

Table 2. Water requirement and water-use efficiency of groundnut as influenced by irrigation levels

Treatment	1993						1994					
	Number of irrigations	Irrigation water (cm)	Effective rainfall (cm)	Profile water contribution (cm)	Water requirement (cm)	Water-use efficiency (kg/ha-cm)	Number of irrigations	Irrigation water (cm)	Effective rainfall (cm)	Profile-water contribution (cm)	Water requirement (cm)	Water-use efficiency (kg/ha-cm)
<i>Irrigation</i>												
0.4 IW : CPE	3	18.00	23.91	0.49	42.40	33.80	4	24.00	16.74	0.99	41.73	34.20
0.6 IW : CPE	4	24.00	23.91	0.53	48.44	37.99	5	30.00	16.74	0.69	47.43	41.45
0.8 IW : CPE	5	30.00	23.91	0.54	54.45	36.11	7	42.00	16.74	0.47	59.21	35.60
<i>Fertilizer</i>												
N ₁₀ P ₄₀ K ₁₀ (I)		24.00	23.91	0.40	48.31	29.97		32.00	16.74	0.59	49.33	31.04
N ₁₀ P ₂₀ K ₁₀ (I+O)		24.00	23.91	0.31	48.22	31.17		32.00	16.74	0.51	49.47	32.27
N ₂₀ P ₄₀ K ₂₀ (I)		24.00	23.91	0.58	48.49	36.87		32.00	16.74	0.73	49.47	37.96
N ₂₀ P ₄₀ K ₂₀ (I+O)		24.00	23.91	0.52	48.43	38.96		32.00	16.74	0.65	49.68	39.83
N ₃₀ P ₆₀ K ₃₀ (I)		24.00	23.91	0.70	48.61	38.96		32.00	16.74	0.94	49.68	39.83
N ₃₀ P ₆₀ K ₃₀ (I+O)		24.00	23.91	0.64	48.55	41.19		32.00	16.74	0.88	49.62	61.60

I, Inorganic source; O, organic source

determined by standard methods, and the nutrient uptake was calculated.

RESULTS AND DISCUSSION

Yield performance

The pod yield of groundnut was significantly increased when IW : CPE ratio was maintained at 0.6 as compared to 0.4. Further increase in irrigation water to 0.8 IW : CPE ratio did not show significant improvement in yield (Table 1). Haulm yield was increased with irrigation level up to 0.8 IW : CPE ratio. Low yield at 0.4 IW : CPE ratio can be attributed to the reasons that the crop suffered due to moisture stress at 0.4 IW : CPE ratio where depletion of available soil moisture was recorded up to 78.6%.

In both the years, there was an increase in pod and haulm yields with the increase in level of fertilizer from $N_{10} P_{20} K_{10}$ to $N_{20} P_{40} K_{20}$ and $N_{30} P_{60} K_{30}$. The extent of increase

in yield was 30%. Yadkari *et al.* (1992) also reported that high level of fertilizer inputs brought about positive response in terms of pod yield of groundnut. However, sources of fertilizer applied through inorganic alone or in combination with organic did not bring significant variation in pod and haulm yields. The interaction effects of irrigation and fertilizer treatments were not significant.

Water requirement and water-use efficiency

Though water requirement increased with an increase in level of irrigation, maximum water-use efficiency was recorded at 0.6 IW : CPE ratio (Table 2). Our results confirm the findings of Parihar and Tripathi (1989).

There was a marginal variation in water requirement due to application of different doses and sources of fertilizer. However,

Table 3. Nutrient uptake (kg/ha) of groundnut as influenced by different levels of irrigation fertilizers

Treatment	1993			1994		
	N	P	K	N	P	K
<i>Irrigation</i>						
0.4 IW : CPE	83.51	5.86	21.83	80.75	5.97	20.65
0.6 IW : CPE	112.66	8.56	29.46	115.23	9.10	30.07
0.8 IW : CPE	123.43	10.14	33.78	126.85	10.81	34.78
LSD (P = 0.05)	7.93	0.63	2.11	5.30	0.37	1.41
<i>Fertilizer</i>						
$N_{10} P_{40} K_{10}$ (I)	87.32	5.82	22.78	88.75	6.21	22.89
$N_{10} P_{20} K_{10}$ (I+O)	87.12	6.35	20.74	90.25	6.88	21.45
$N_{20} P_{40} K_{20}$ (I)	108.10	8.01	29.45	109.63	8.51	29.83
$N_{20} P_{40} K_{20}$ (I+O)	109.81	8.65	27.99	111.69	9.23	28.53
$N_{30} P_{60} K_{30}$ (I)	121.73	9.75	36.15	121.15	10.14	34.89
$N_{30} P_{60} K_{30}$ (I+O)	125.10	10.51	34.02	122.98	10.79	33.40
LSD (P = 0.05)	6.71	0.51	1.86	7.36	0.60	1.95

I, Inorganic source; O, organic source

there was a progressive increase in water-use-efficiency with increased level of fertilizer application and it was recorded to be higher with the use of organic and inorganic sources of fertilizer during both the years.

Nutrient uptake

Total uptake of N, P and K nutrients increased significantly with an increase in irrigation level from 0.4 to 0.6 and 0.8 IW : CPE ratio (Table 3). Increase in supply of irrigation provided adequate soil moisture in soil which plays an important role in the mechanism of nutrient uptake involving diffusion, mass flow and interception (Tisdale *et al.*, 1985).

Increase in doses of fertilizer was also responsible for significant increase in uptake of N, P and K nutrients. However, difference in uptake between source of fertilizer was marginal except for P uptake, which was significantly more under combined organic and inorganic sources than only organic source.

Thus summer groundnut yield may be augmented by providing irrigation water at 0.6 IW : CPE ratio and fertilizer level at N_{30} , P_{60} , K_{30} for acid lateritic soil under hot, humid climate of eastern India.

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