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Research Paper

Response of groundnut (*Arachis hypogaea*) to irrigation schedules, sulphur levels and sources in alluvial zone of West Bengal

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ABSTRACT

A field experiment was conducted from 2010 to 2012 at Gayeshpur, West Bengal to investigate the effect of irrigation schedules, and sources and levels of sulphur on yield and water-use efficiency (WUE) of summer groundnut (*Arachis hypogae*a L.). The experiment was laid out in split-plot design with 3 irrigation schedules (0.5, 0.75 and 1.0 IW/CPE) in main plots and 2 sulphur sources (elemental S and gypsum) along with 4 levels of sulphur (0, 15, 30 and 45 kg/ha) in sub-plots. Pooled results showed that the highest pod (2.03 t/ha) and haulm (3.40 t/ha) yields were observed with 0.75 IW/CPE, whereas maximum WUE of 5.99 kg/ha-mm with 0.5 IW/CPE. The highest pods/plant, 100-kernel weight, shelling out-turn, pod yield, oil yield and sulphur-use efficiency were recorded with 30 kg S/ha, however, maximum oil content (48.7%) with 45 kg S/ha. From the quadratic response curve, the pod yield of 2.09 t/ha was calculated with optimum 35.7 kg S/ha. Sources of sulphur had no significant differences in pod yield, oil yield, nutrient uptake, consumptive use and WUE. Uptake of N, P, K and S was significantly varied with irrigation levels and sulphur doses. Soil residual fertility was not affected by treatments except residual sulphur. The highest gross returns, net returns and benefit: cost ratio were recorded with 0.75 IW/CPE and 30 kg S/ha.

Key words : Consumptive use, Groundnut, Irrigation, IW/CPE ratio, Net returns, Sulphur, Water-use efficiency

India contributes around 19% of world groundnut production, yet the average productivity is relatively low (1.27 t/ha), ranking fifth in the world's productivity (Dash *et al*., 2013). This low productivity is due to rain dependency (85%), monoculture (60%) and cultivation on marginal soils of low fertility (Jat *et al*., 2010). In West Bengal, groundnut presently occupies the area of 65,826 ha with production of 11,3018 tonnes and productivity of 1,717 kg/ha. The cultivation of summer groundnut is gaining popularity in the state due to its higher profitability. There is ample scope for increasing the crop productivity through better management practices including timely sowing, proper plant density, balanced fertilization, optimum irrigation and need based plant protection measures. In irrigation scheduling, the climatological approach based on IW/CPE ratio (IW-irrigation water, CPE-cumulative pan evaporation) has been found most appropriate. This approach integrates all weather parameters that determine water use by the crop and is likely to increase production by at least 15–20% (Dastane, 1972). Optimum scheduling of irrigation leads to increased pod yield and water use efficiency (WUE) of groundnut (Patel *et al.*, 2008).

Among the measures to increase oilseeds production, the application of sulphur nutrient to crops is one of the most important practices. It is recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium and also an integral part of balanced fertilization for oilseed crops. It is essential for protein production, activation of enzymes, root nodulation and synthesis of oil forming substances like glucosinolates (Kumar *et al.*, 2008). Likewise, it plays an important role in chlorophyll and vitamins formation. The deficiency of sulphur nutrient has been reported in Gangetic alluvial soil of West Bengal. The multiple cropping systems, adoption of high-yielding varieties, indiscriminate use of fertilizers and lack of organic manure have intensified the depletion of sulphur from soils (Dash *et al*., 2013). The positive response of sulphur application to groundnut has been reported by earlier authors (Giri *et al*., 2014). Gypsum has been found either superior or equal to other S containing fertilizers in

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groundnut (Ghosh *et al*., 2000). Keeping these aspects in view, the present experiment was undertaken to find out efficient irrigation schedules with optimum requirement and right source of sulphur for summer groundnut in alluvial zone of West Bengal.

MATERIALS AND METHODS

A field experiment was conducted during summer season from 2010 to 2012 at the Regional Research Station of Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal (22.1°N, 89.2°E and 9.75 m above mean sea-level) to investigate the effect of irrigation schedules, and sources and levels of sulphur on yield and water use-efficiency of summer groundnut. The alluvial soil (Inceptisol) of the experimental field was sandy loam in texture with bulk density 1.47 g/cm^3, *p*H 6.7, organic carbon 0.44%, available N 173.3 kg/ha, available P 14.6 kg/ha, available K 157.3 kg/ha and sulfate-S contents (0.15% $CaCl_2$ extractable) 3.7 kg/ha. The moisture content at field capacity was 20.1% and at permanent wilting point 9.8%.

The experiment was laid out in split-plot design replicated thrice. Main plots treatments consisted of 3 irrigation scheduling, viz. IW/CPE ratio of 0.5, 0.75 and 1.0 and sub-plots with 2 sources (elemental S and gypsum) along with 4 levels of sulphur (0, 15, 30 and 45 kg/ha). Recommended doses of N, P_2O_5 and K_2O @ 20: 60: 40 kg/ha were applied uniformly as basal in the form of urea for nitrogen, diammonium phosphate for phosphorus and muriate of potash for potassium. Sulphur content in gypsum material was 18.2% S, where as 85% sulphur in elemental sulphur fertilizer. Entire amount of elemental sulphur and gypsum were applied 21 days prior to sowing as per the treatments to provide time for proper oxidation of the chemicals.

Groundnut 'TAG 24' was sown during third week of February across the experimental period, with a spacing of 30 cm × 10 cm. Plot size was 4 m × 3 m. Inoculation of seeds with suitable *Rhizibium* culture was done prior to sowing. Plant-protection measures were taken as and when required. Other cultural operations were carried out as per recommendations. The crop was harvested during second week of June over all the years. Observations on yield and yield-attributing parameters were recorded at harvest. A pre-sowing irrigation was given for proper germination and establishment of the crop. Remaining irrigations were given as per treatments when cumulative pan evaporation (CPE) reached at respective levels. Irrigation water depth (IW) was maintained 50 mm for each irrigation with the help of parshall flume. Number of irrigations provided was 5, 8 and 10 for 0.5, 0.75 and 1.0 IW/CPE respectively. Irrigation was withdrawn 15 days before harvesting of the crop. The total rainfall during the crop growth period was 38.5 mm in 2010, 46.8 mm in 2011 and 54.7 mm in 2012. The mean minimum temperature of 22.3–32.4°C and the mean maximum temperature of 35.7–42.5°C were recorded during the study period. The total pan evaporation during the crop growth period was 481.6, 410.1 and 462.3 mm in 2010, 2011 and 2012 respectively. Soil moisture studies were done during the entire crop period starting from sowing to final harvest of groundnut. The soil samples for moisture studies were collected before irrigation and 48 hours after irrigation from 0–15, 15–30, 30–45, 45–60 and 60–75 cm soil depth with the help of screw auger from net plot area of each treatment. The moisture content of oven dry soil was measured by thermo-gravimetric method. The moisture percentage of each depth of soil layer was used for calculating consumptive use (CU) of water and the moisture extraction pattern of the crop. The formula described by Dastane (1972) was used to calculate CU of water, where Consumptive use (mm) = Profile soil moisture (mm) + Effective rainfall (mm) + Groundwater contribution (mm). The depth of water table was more than 3.0 m below the surface soil throughout the period of experimentation, hence, the groundwater contribution was considered as nil. The profile soil moisture depletion was worked out using the following formula-

$$d = \sum_{I=1}^{n} \frac{M_1^i - M_2^i}{100} \times ASi \times Di + ER$$

where, d = Moisture deficit in the root zone;

$\sum_{i=1}^{n}$ = Summation of 'n' number of layers of the root zone; M_1^i = Soil moisture in the ith layer of profile on the day just before the next irrigation; M_2^i = Soil moisture in the ith layer of profile 48 hours after irrigation; ASi = Bulk density of ith layer (g/cc); Di = Depth of the ith layer (cm); ER = Effective rainfall (mm)

The water-use efficiency (WUE) was calculated based on the pod yield of the crop per unit of water used in CU. The oil content of the kernels was determined by Soxhelt ether extraction method. At harvest, the available N, P, K and S in soil and plant were estimated by standard methods. Nutrient uptake was estimated by multiplying the drymatter accumulation at maturity in kernels, pods and haulm of groundnut by their respective percentage. Total uptake was calculated by adding uptake of kernels, pods and haulm. From the pooled data, economics was worked out on the basis of prevailing market price of the produce and inputs used in the experiment. The data were statistically analyzed by standard tools for interpretation of the results.

RESULTS AND DISCUSSION

Yield attributes and yield

Yield and yield attributes of groundnut were significantly influenced by the irrigation schedules, except the number of kernels/pod (Table 1). Pooled data showed that irrigation scheduled at 0.75 IW/CPE registered significantly higher pod and kernel yields than 0.5 IW/CPE, however, this treatment was on a par with 1.0 IW/CPE. The highest pod yield (2.03 t/ha) and kernel yield (1.53 t/ha) obtained with 0.75 IW/CPE was due to maximum number of pods per plant, greater weight of 100-kernels and higher shelling out-tern, whereas the lowest values were observed with 0.5 IW/CPE. Increase in pod and kernel yields of groundnut by levels of irrigation was reported by Patel *et al*. (2008). This might be due to maintaining optimum moisture condition in the root zone soil which influences the nodulation and availability of different nutrients. The results are also congruous with the findings of Rathod and Trivedi (2011), which indicated the harmful effects of both higher and lower irrigation frequencies in groundnut. Haulm yield due to different irrigation schedules also followed the similar trend as that of pod yield (Table 1). Mean haulm yield varied from 3.23 to 3.40 t/ha, where the highest under irrigation at 0.75 IW/CPE, followed by 1.0 IW/CPE.

The highest number of pods/plant, 100-kernels weight and shelling out-tern were observed with application of sulphur @ 30 kg/ha (Table 1). Similarly, application of 30 kg S/ha resulted higher pod yield of 8.21% over 15 kg S/ha and 14.49 % over no sulphur treatment. However, this treatment was at par with application of 45 kg S/ha. The increase in pod yield was mainly ascribed to improvement in yield attributes with sulphur application in addition to its multiple roles in metabolism as an essential constituent of amino acids and also improvement in vegetative structure, production of reproductive structures and assimilates, thereby maintaining balanced source-sink. These results were in close conformity with findings of Jat *et al*. (2011). But the reductions in pod yield with higher dose of 45 kg S/ha might be due to some antagonistic effect of sulphur interfering with availability of some beneficial cations and anions essential for different metabolic processes (Nayak *et al*., 2004). Similarly, sulphur levels significantly influenced the kernel and haulm yields (Table 1). The maximum kernel yield (1.57 t/ha) and haulm yield (3.42 t/ha) were recorded at 30 kg S/ha, closely on a par with application of 45 kg S/ha. However, yield attributes and yields of pod, haulm and kernel were not significantly influenced by sources of sulphur irrespective of the years.

The interaction effect between irrigation schedules and sulphur doses for the three years was statistically analyzed (Table 2). It had been observed that the yield response to

Table 1. Yield attributes and pod yield of groundnut as influenced by irrigation schedules, sources and levels of sulphur (pooled mean of 3 years)

Treatment	Mature pods/ plant	Kernels/ pod	100-kernel weight (g)	Shelling out-turn (%)	Pod yield (t/ha)	Haulm yield (t/ha)	Kernel yield (t/ha)	Oil content (%)	Oil yield (t/ha)	Consumptive use (mm)	WUE (kg/ha-mm)	Sulphur-efficiency use (kg/kg)
Irrigation schedule (IW/CPE)												
0.5	16.0	2.07	34.5	74.5	1.79	3.23	1.33	47.3	0.63	298.4	5.99	-
0.75	23.9	2.11	39.1	75.7	2.03	3.40	1.53	48.0	0.73	374.2	5.42	-
1.0	20.6	2.08	36.7	75.1	1.98	3.36	1.49	47.5	0.71	390.7	5.06	-
SEm±	0.46	0.02	0.84	0.11	0.03	0.05	0.02	0.33	0.03	-	-	-
CD (P=0.05)	1.62	NS	2.68	0.44	0.08	0.12	0.06	NS	0.08	-	-	-
Sulphur source												
Elemental S	19.7	2.17	36.6	75.2	1.93	3.32	1.45	47.7	0.69	355.4	5.43	-
Gypsum	20.6	2.15	36.9	75.0	1.94	3.34	1.46	47.5	0.69	353.5	5.49	-
SEm±	0.40	0.03	0.81	0.14	0.03	0.02	0.02	0.45	0.01	-	-	-
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-	-
Sulphur level (kg/ha)												
0	17.6	2.05	33.4	74.4	1.77	3.21	1.31	46.2	0.60	359.2	4.92	-
15	19.4	2.07	36.7	74.6	1.90	3.30	1.41	47.1	0.66	355.1	5.35	8.66
30	21.9	2.11	38.9	75.9	2.07	3.42	1.57	48.5	0.76	353.1	5.86	10.0
45	21.9	2.12	38.0	75.5	2.00	3.39	1.51	48.7	0.74	350.4	5.70	5.11
SEm±	0.32	0.03	0.73	0.16	0.03	0.04	0.04	0.51	0.02	-	-	-
CD (P=0.05)	0.95	NS	2.18	0.48	0.09	0.10	0.10	1.24	0.05	-	-	-

IW, Irrigation water; CPE, cumulative pan evaporation; NS, non-significant sulphur application showed an increasing trend from 0 to 30 kg/ha followed by a declining yield with 45 kg S/ha irrespective of irrigation levels. Similarly the pod yield was increased with irrigation level up to 0.75 IW/CPE, thereafter yield reduced at highest IW/CPE under each level of sulphur. Hence, the interaction effect showed significantly higher pod yield (2.18 t/ha) with application of irrigation at 0.75 IW/CPE along with 30 kg S/ha. Response curve of groundnut to graded doses of sulphur showed a quadratic equation (R^2 = 0.923), where the highest agronomic pod yield of 2.09 t/ha was calculated with the optimum dose of 35.7 kg S/ha (Fig. 1).

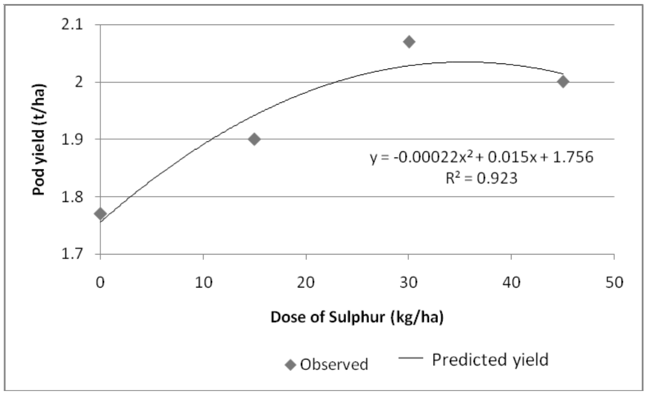


Fig. 1. Response curve between groundnut pod yield and doses of sulphur.

Oil contents and sulphur-use efficiency

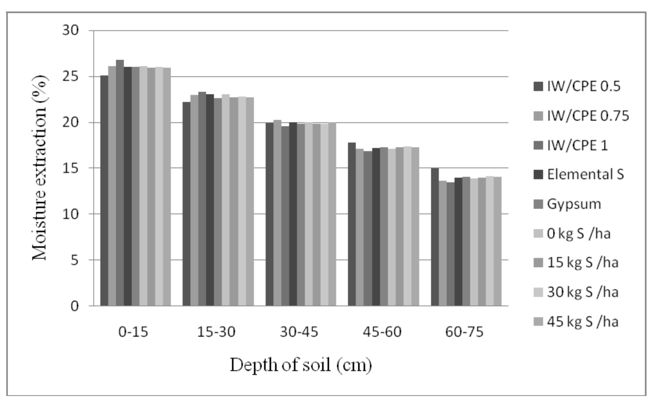
Irrigation schedules had no significant effect on oil content (%) of groundnut (Table 1). Due to higher kernel yield as well oil content, the maximum oil yield of 0.73 t/ha was obtained with 0.75 IW/CPE, which was statistically at par with that of 1.0 IW/CPE. The lowest oil yield of 0.63 t/ha was recorded in 0.5 IW/CPE. However, sulphur levels significantly influenced oil content and oil yield of groundnut. The oil content of the kernel showed an increasing trend with increase in sulphur doses from 15 to 45 kg/ha. The mean oil content was highest (48.7%) with 45 kg S/ha and the increase was 5.59% over the control (no sulphur). The increase in oil content with application of sulphur fertilizer might be attributed to greater hydrolysis of glucosinolates (Kumar *et al*., 2008). The maximum oil yield of 0.76 t/ha was obtained with 30 kg S/ha due to higher kernel yield, closely followed by 45 kg S/ha. However, the oil content and oil yield due to two sources of sulphur was statistically at par in all the 3 years.

The mean sulphur-use efficiency (SUE) varied from 5.11 to 10.0 kg of pod/kg of sulphur applied (Table 1). Among the levels of sulphur, the highest response was achieved with 30 kg S/ha, followed by 15 kg S/ha and the lowest response with 45 kg S/ha. The diminishing yield response to applied sulphur at highest level was due to the higher sulphur concentration at rhizosphere soil solution by higher dose of sulphur might have reduced the SUE due to its antagonistic effect.

Soil moisture extraction pattern, consumptive use and water-use efficiency

The percentage of soil moisture extracted (Fig. 2) from the surface layers (0–15 and 15–30 cm depth) was higher (50.05%) at 1.0 IW/CPE compared to 0.75 IW/CPE, (49.06%) and 0.5 IW/CPE (47.27%). However, the soil moisture extracted from 30–45 cm soil depth was found maximum (20.24%) with 0.75 IW/CPE and that of (32.79%) from the deeper layers (45–60 and 60–75 cm) with 0.5 IW/CPE. This could be due to enhancement of moisture availability in the surface layer with frequent irrigations. Lack of sufficient moisture in the surface layers at 0.5 IW/CPE might have forced the plants for vertical movement to meet water requirement from deeper layers. The maximum configuration of groundnut roots in the top 30 cm soil profile explained the higher moisture extraction pattern by the crop. In case of the sources of sulphur, the higher percentage of soil moisture (69.04%) was extracted from surface layer (0–45 cm) with elemental sulphur, whereas moisture extraction (31.41%) was increased from deeper layer (45–75 cm) with gypsum. This might be due to improvement of physical properties of soil by gypsum as an amendment. However, the more soil moisture extraction (69.13%) was observed from 0–45 cm soil layer under control (no sulphur application) and that of (31.52%) from deeper layer (45–75 cm) with 30 kg S/ha.

The consumptive use (CU) of water increased with increase in IW/CPE ratio (Table 1). The highest mean CU of water (390.7 mm) was noted under 1.0 IW/CPE, where irrigation frequency was maximum. This might be due to conductive effect of wet rhizosphere on maintainance of



IW, irrigation water; CPE, cumulative pan evaporation

Fig. 2. Moisture extraction pattern (%) at different soil depths under various irrigation schedules, sources and levels of sulphur.

wet surface for longer period and consequently had led to higher losses through evaporation. Moreover, creation of higher vapour pressure gradient between canopy air and atmospheric air might also be responsible for greater evapotranspiration from frequently irrigated plots. However, the CU of water decreased with sulphur application. It was highest under control and the lowest with 45 kg S/ha. CU of water was almost similar between 2 sources of sulphur.

The water-use efficiency (WUE) increased with increase in irrigation interval (Table 1). The mean WUE was the highest (5.99 kg/ha-mm) with irrigation at 0.5 IW/CPE, followed by 0.75 IW/CPE. The lowest WUE (5.06 kg/ha-mm) was obtained with 1.0 IW/CPE. The highest WUE recorded in 0.5 IW/CPE was not because of higher yield but due to lower application of water. However, relatively higher WUE obtained with 0.75 IW/CPE over 1.0 IW/CPE was attributed to favourable effect of optimum water supply and thereby improvement in yield contributing characters and ultimately higher pod yield than 1.0 IW/CPE. The results lent support from the findings of Suryawanshi *et al*. (2008). On the other hand, application of 30 kg S/ha realized highest WUE (5.86 kg/ha-mm). However, WUE was almost similar with both the sources of sulphur.

Nutrient uptake and soil fertility

The total uptake of nutrients (N, P, K and S) by plant (kernel+pod +haulm) was significantly influenced by irrigation levels and sulphur sources (Table 3). The maximum uptake of 116.1 kg N, 12.3 kg P, 36.3 kg K and 9.3 kg S/ha was recorded with 0.75 IW/CPE and the lowest uptake

Table 2. Interaction effect of irrigation schedules and levels of sulphur on pod yield (t/ha) of groundnut (pooled mean of 3 years)

Irrigation schedule (I) (IW/CPE)	Sulphur level (S) (kg/ha)				
	0	15	30	45	Mean
0.5	1.69	1.73	1.94	1.82	1.79
0.75	1.81	1.98	2.18	2.15	2.03
1.0	1.81	1.99	2.09	2.03	1.98
Mean	1.77	1.90	2.07	2.00	
	I	S	I×S	S×I	
SEm±	0.03	0.03	0.05	0.05	
CD (P=0.05)	0.08	0.09	0.12	0.13	

IW, Irrigation water; CPE, cumulative pan evaporation

Table 3. Nutrient uptake by groundnut and soil fertility as influenced by irrigation schedules, sources and levels of sulphur (mean of 3 years)

Treatment	Total nutrient uptake (kg/ha)				Available nutrient status in soil (kg/ha)			
	N	P	K	S	N	P	K	S
Irrigation schedule (IW/CPE)								
0.5	98.8	7.6	28.7	6.5	189.2	15.6	163.7	4.8
0.75	116.1	12.3	36.3	9.3	178.5	14.7	158.1	4.5
1.0	112.7	11.7	34.6	8.8	183.6	15.1	160.4	4.7
SEm±	2.45	0.24	0.76	0.19	3.63	0.34	2.12	0.10
CD (P=0.05)	7.64	0.75	2.37	0.58	NS	NS	NS	NS
Sulphur source								
Elemental S	107.8	11.3	32.3	8.1	187.5	15.4	162.9	4.6
Gypsum	110.6	10.8	34.1	8.3	180.2	14.9	158.6	4.7
SEm±	2.17	0.21	0.66	0.16	3.06	0.30	1.65	0.07
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Sulphur level (kg/ha)								
0	100.1	9.2	29.1	4.8	187.2	15.5	162.0	3.9
15	106.7	10.3	32.2	8.1	185.7	15.2	161.6	4.5
30	115.4	11.6	35.8	10.1	180.3	14.8	159.1	4.9
45	114.6	11.2	35.7	10.4	182.1	15.0	160.2	5.2
SEm±	1.93	0.17	0.54	0.13	2.37	0.24	1.01	0.05
CD (P=0.05)	5.98	0.53	1.70	0.41	NS	NS	NS	0.15

IW, Irrigation water; CPE, cumulative pan evaporation; NS, non-significant

Table 4. Economics of groundnut grown under different irrigation schedules, sources and levels of sulphur (mean of 3 years)

Treatment	Cost of cultivation ($\times 10^3$₹/ha)	Gross returns ($\times 10^3$₹/ha)	Net returns ($\times 10^3$₹/ha)	Benefit: cost ratio
Irrigation schedule (IW/CPE)				
0.5	31.8	71.6	39.8	2.25
0.75	34.1	81.2	47.1	2.38
1.0	35.6	79.2	43.6	2.22
Sulphur source				
Elemental S	34.0	77.2	43.2	2.27
Gypsum	33.7	77.6	43.9	2.29
Sulphur level (kg/ha)				
0	32.6	70.8	38.2	2.17
15	33.4	76.0	42.6	2.27
30	34.3	82.8	48.5	2.41
45	35.1	80.0	44.9	2.27

IW, Irrigation water; CPE, cumulative pan evaporation; Irrigation cost-₹750/ha/irrigation, Gypsum cost-₹10/kg; Elemental sulphur cost-₹55/kg; Groundnut price-₹40/kg

with 0.5 IW/CPE. This might be due to increase in supply of irrigation provided adequate moisture in the soil, which played an important role in nutrient uptake involving diffusion, mass flow and interception. However, the 2 sources of sulphur did not show any significant difference in terms of nutrients uptake. On the other hand, the significantly higher uptake of nutrients (115.4 kg N, 11.6 kg P, 35.8 kg K and 10.4 kg S/ha) was obtained with application of 30 kg S/ha, which was at par with 45 kg S/ha. The lowest uptake was noticed at no sulphur application treatment in all the years. The increase in uptake of nutrients with sulphur application could be assigned to increase in concentration of N, P, K and S in kernel, pod and haulm of groundnut. The balanced nutrition by application of sulphur in addition to N, P and K fertilizers might have enhanced the synergistic effect on uptake of major plant nutrients (Ahmad *et al*., 2007).

The available nutrients in soil (N, P, K and S) after harvest were not affected significantly due to various irrigation levels and sulphur sources (Table 3). The maximum residual soil fertility status of available N, P, and K was recorded in lower irrigation level (0.5 IW/CPE) and no sulphur treatment. However, the residual sulphur availability in soil was significantly influenced by sulphur doses. Sulphur applied @ 45 kg/ha showed significantly higher residual sulphur (5.2 kg/ha) over other treatments. Application of sulphur might have enhanced the nutrient availability and showed more response towards the applied sulphur in the deficient soil. The lowest residual sulphur of 3.9 kg/ha was recorded with no sulphur application (control). This might be due to increase in the level of sulphur doses also assured the availability of this nutrient to the crop plants in adequate amount and remained in soil in substantial quantity after fulfilling the crop requirement that ultimately improved the available sulphur status in soil with its application. These results were in conformity with the findings of Giri *et al*. (2014) which indicated the effect of irrigation levels and sulphur doses on residual N, P and K fertility were not significant.

Economics

The highest gross returns, net returns and benefit: cost ratio were observed with irrigation scheduled at 0.75 IW/CPE (Table 4). But, the benefit: cost ratio was lowest with 1.0 IW/CPE due to higher cost for more number of irrigations. Among the sulphur levels, the highest gross returns, net returns and benefit: cost ratio were found with application of 30 kg S/ha, whereas the lowest values were obtained for no sulphur application. However, the economic benefits were almost similar in both the sources of sulphur.

It was concluded from the study that irrigation scheduling at 0.75 IW/CPE along with application of 30 S kg/ha either as gypsum or elemental sulphur was found beneficial to improve pod yield, SUE, WUE and economic returns of summer groundnut in alluvial zone of West Bengal.

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