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Effect of sulphur and different irrigation regimes on groundnut

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ABSTRACT

To study the effect of scheduling of irrigation at different physiological growth stages, the most physiologically critical water need stage and different levels of sulphur on yield and water use efficiency (WUE) of groundnut, a field experiment was conducted for two consecutive years during pre-kharif season. The experiment was conducted in a sandy loam soil with 24 treatment combinations (8 irrigation levels and 3 levels of sulphur). The study revealed that levels of irrigation did not significantly influence yield attributing characters but significantly influenced the kernel yield. Levels of sulphur significantly influenced all the yield attributing characters and kernel yield. Irrigation applied at flowering, pegging and pod filling stage (I_8) and sulphur applied @ 15 kg ha^{-1} (S_2) recorded an increase in kernel yield to the tune of 106.52% and 73.11% over control, respectively. The highest consumptive use (CU) (636.90 mm), and WUE (5.61 kg ha^{-1} mm^{-1}) were recorded under same irrigation treatment (I_8) followed by irrigation at pegging and pod filling stage (I_7).

Key words: Groundnut, irrigation, sulphur

Oilseeds and oils have assumed an importance of their own in the economy of the country. The basic per capita requirement of fat and oils per day has been recommended to be 34-38 g (Indian Economy, 2010). However, taking into account invisible fat intake through consumption of other foods, at least 10 g per capita per day of fats and oils is essential (Menon, 1984). In India the availability is below than the standard level and it is around 10 g/day (Indian Economy, 2010). Oilseeds constitute the second major agricultural crop in the country next to food grains in terms of tonnage and value. Of all the oil seed crops in India, groundnut claims largest share in oilseed area (46%), oilseeds production (67%) and in the edible oil production (59%). Groundnut ranks first among the oilseed crops in India contributing 33% of the world's production and 40% of the area.

Sulphur is identified as a key element for increasing the production of oilseeds, of course in combination with NPK (Directorate of oilseed Research, 1984 and 1985).

Water is a prime natural resource and an important input for assured agricultural production. Irrigation accounts for nearly 84% of water requirement (Hashim, 1998). In future non-irrigation requirement will be growing faster, by 2025 the irrigation will account for 73% of the aggregate water requirement. Providing one or two protective irrigations during moisture stress in rainfed conditions in Tamil Nadu (Gnanamurthy *et al.*, 1992 and Subrahmanian *et al.*, 1999) enhances the productivity and sustainability of the groundnut production. On an average, groundnut crop requires about 550-650 mm of water (Chandra Mohan,1970) depending upon the soil types, seasons and groundnut cultivar. Managing soil moisture by applying irrigation water efficiently is the most important factor for stabilizing production in rain fed condition and improving the productivity in irrigated conditions of groundnut cultivation.

MATERIALS AND METHODS

The field experiment was conducted in sandy loam soil of Bidhan Chandra Krishi Viswavidyalaya, 'C' block farm, Kalyani, Nadia, West Bengal at 23^{0}N latitude and 89^{0}E longitude, at an elevation of 9.75 m above mean sea level. The experiment was conducted during *pre-kharif* season for two consecutive years to study the effect of scheduling irrigation at different physiological growth stages, to indentify the most physiologically critical water need stage of groundnut, along with different levels of sulphur on yield, soil moisture depletion pattern, CU and WUE. Crop received average rainfall of about 300 mm throughout the growing period. Maximum and minimum temperature during the period was 41°C and 16°C, respectively. The experiment was laid out in a split plot design, having 8 levels of irrigation in main plots and 3 levels of sulphur in sub-plots. The 8 different levels of irrigation were: I_1 – no irrigation; I_2 – irrigation at flowering stage; I_3 – irrigation at pegging stage; I_4 –irrigation at pod filling stage; I_5 – irrigation at flowering and pegging stage; I_6 – irrigation at flowering and pod filling stage; I_7 – irrigation at pegging and pod filling stage; I_8 – irrigation at flowering, pegging and pod filling stage. Three different levels of sulphur were: S_1 –sulphur @ 0 kg ha^{-1}: S_2 – sulphur @ 15 kg ha^{-1}: S_3 – sulphur @ 30 kg ha^{-1}. Source of sulphur fertilizer was elemental sulphur (85%). Groundnut cultivar used GPPD-5.

The recommended dose of fertilizer was 20:40:40 kg ha^{-1} N, P_2O_5 and K_2O, respectively. Source of fertilizers were urea, DAP and MOP for N, P_2O_5 and K_2O, respectively. The statistical analysis

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was done using methods described by Gomez and Gomez (1984).

Water use efficiency (WUE) was computed using the following standard formulae:

$$\text{WUE (kg ha}^{-1}\text{ cm}^{-1}) = \frac{\text{Yield (kg ha}^{-1})}{\text{ET or CU value (mm)}}$$

ET = Evapotranspiration

CU = Consumptive Use

The weather data was recorded from the laboratory of AICRP on Agro-Meteorology, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, W.B., India.

RESULTS AND DISCUSSION

The data was analysized on the basis of the mean data of two years.

Levels of irrigation:

All the yield attributing characters were not significantly influenced by the levels of irrigation except number of pods plant^{-1}. Highest values of yield attributing characters (number of pods plant^{-1}, number of kernels pod^{-1}, 100 kernel weight (g)) were recorded under irrigation applied at flowering, pegging and pod filling stage (I_8) followed by irrigation at pegging and pod filling stage (I_7) and they were at per incase of number of pods plant^{-1}. Lowest values of yield attributing characters were recorded under no irrigation treatment (I_1) (Table-1). This is in conformity with the results of Patra *et al.* (1998) and Ali (2001).

The kernel yield (q ha^{-1}) was significantly influenced by the levels of irrigation. Highest kernel yield (35.75 q ha^{-}1) was recorded under irrigation applied at flowering, pegging and pod filling stage (I_8) followed by irrigation at pegging and pod filling stage (I_7) and they were at per (Table - 1). Lowest kernel yield (17.31 q ha^{-}1) was recorded under no irrigation treatment (I_1). Irrigation applied at flowering, pegging and pod filling stage (I_8) and irrigation applied at pegging and pod filling stage (I_7) recorded an increase in kernel yield to the tune of 106.52% and 87.55% over control, respectively. This might be due to application of 3 irrigations at important physiologically critical growth stages helps to better utilization of moisture resulting in an increase of yield attributing characters and ultimately yield. Similar results were observed by Jana *et al.* (1989). Harman *et. al.* (1990) also found the similar observations.

Levels of sulphur

All the yield attributing characters were significantly influenced by the levels of sulphur. Highest values of yield attributing characters (number of pods plant^{-1}, number of kernels pod^{-1}, 100 kernel weight (g)) were recorded when sulphur applied @ 15 kg ha^{-1} (S_2) followed by sulphur applied @ 30 kg ha^{-1} (S_3). Lowest values of yield attributing characters were recorded when sulphur applied @ 0 kg ha^{-1} (S_1) (Table-1). Chaplot *et. al.* (1991) observed the same results.

The kernel yield (q ha^{-1}) was significantly influenced by the levels of sulphur. Highest kernel yield (31.11 q ha^{-}1) was recorded when sulphur applied @ 15 kg ha^{-1} (S_2) followed by sulphur applied @ 30 kg ha^{-1} (S_3) (Table - 1). Lowest kernel yield (17.97 q ha^{-}1) was recorded when sulphur applied @ 0 kg ha^{-1} (S_1). Sulphur applied @ 15 kg ha^{-1} (S_2) and sulphur applied @ 30 kg ha^{-1} (S_3) recorded an increase in kernel yield to the tune of 73.11% and 42.95% over control, respectively (Table - 1). This might be due to increased photosynthate and their subsequent translocation to storage organ resulted in better fill up of production. This is in conformity with the results of Shamsuddin *et al.* (1991) and Suriyapan *et al.* (1985). Similar findings were also observed by Tandon (1984).

Interaction Effect

Interactions of levels of irrigation with levels of sulphur were not significant in all the yield attributing characters except the number of kernels pod^{-1} and also kernel yield. Groundnut recorded significant improvement in number of kernels pod^{-1} upto application of sulphur @ 30 kg ha^{-1} (S_3) and irrigation at flowering, pegging and pod filling stage (I_8) (Table - 3). Significant higher number of kernels pod^{-1} was obtained with the combine application of irrigation at flowering, pegging and pod filling stage (I_8) and sulphur @ 30 kg ha^{-1} (S_3) when compare with other combinations. This is because of increase availability of sulphur which is mobile in nature in the plant system with adequate supply of water helps to produce higher number of kernels pod^{-1} (Vaghasia *et al.*, 2007).

Soil moisture depletion pattern (%), Consumptive Use and Water-use efficiency:

Moisture depletion pattern of groundnut crop was influenced by irrigation levels. The data presented in the (Table 2) show that an increase in depth of soil, gradually decreased the soil moisture depletion pattern from second layer at all the levels of irrigation till the last depth of observation recorded. More amount of soil moisture utilization by the crop from surface (0-15 cm) layer might be due to more root concentration in this layer. Soil moisture depletion was maximum under irrigation applied at flowering, pegging and pod filling stage (I_8). The lowest depletion of soil moisture at different depths was found in under no irrigation treatment (I_1).

The lowest CU (360.33 mm), and WUE (4.80 kg ha^{-1} mm^{-1}) (Table-2) were recorded under no irrigation treatment (I_1) and the highest CU (636.90 mm), and WUE (5.61 kg ha^{-1} mm^{-1}) were recorded under irrigation applied at flowering, pegging and pod filling stage (I_8) followed by irrigation at pegging and pod filling stage (I_7). Similar results were observed by Chavan *et al.* (1999) and Reddy and Reddy (1993). Tayel *et al.* (1993) also followed the same results.

Thus, it could be concluded that irrigation applied at flowering, pegging and pod filling stage (I_8) along with sulphur applied @ 15 kg ha^{-1} (S_2) gave the best result with maximum crop water-use efficiency.

Table 1: Effect of levels of irrigation and levels of sulphur on yield attributing characters and kernel yield (q ha $^{-1}$) of groundnut (mean of two years)

Irrigation Treatments	No. of pods plant^{-1}	No. of kernels pod^{-1}	100 kernels weight (g)	Kernel Yield (q ha $^{-1}$)	% yield increase
I_1	16.61	1.47	34.18	17.31	
I_2	18.22	1.47	35.58	19.44	12.32
I_3	20.22	1.50	35.60	21.84	26.14
I_4	17.78	1.47	35.55	19.08	10.20
I_5	24.44	1.53	36.23	27.50	58.87
I_6	23.22	1.53	36.22	25.99	50.16
I_7	28.90	1.53	36.31	32.46	87.55
I_8	28.97	1.68	36.40	35.75	106.52
SEm (±)	2.61	NS	NS	3.42	
LSD (0.05)	6.54			8.58	
Sulphur Treatments					
S_1	18.37	1.44	32.97	17.97	
S_2	25.52	1.59	38.24	31.11	73.11
S_3	23.00	1.54	36.07	25.69	42.95
SEm (±)	1.08	0.02	0.79	1.36	
LSD (0.05)	2.54	0.05	1.85	3.19	

Table 2: Effect of levels of irrigation on Soil profile moisture depletion (%), CU (mm) and WUE (kg ha^{-1}mm^{-1}) of groundnut (mean of two years)

Irrigation Treatments	Soil profile moisture depletion (%) Depth of soil (cm)				CU (mm)	WUE (kg ha $^{-1}$ mm^{-1})
	0 - 15	15- 30	30 - 45	45 - 60		
I_1	47.84	49.01	47.95	42.05	360.33	4.80
I_2	47.46	53.60	55.90	43.81	388.66	5.00
I_3	55.05	60.72	58.13	49.95	432.45	5.05
I_4	53.47	58.13	45.85	43.46	386.39	4.94
I_5	75.03	76.46	68.82	60.79	540.75	5.09
I_6	77.29	74.13	68.73	47.84	513.22	5.06
I_7	69.26	80.75	76.98	84.23	604.24	5.37
I_8	86.86	75.20	87.00	81.41	636.90	5.61

Table 3: Interaction effect of levels of irrigation and levels of sulphur on number of kernels pod^{-1} of groundnut

Irrigation Treatments	Sulphur Treatments			
	S_1	S_2	S_3	Mean
I_1	1.40	1.50	1.50	1.47
I_2	1.40	1.50	1.50	1.47
I_3	1.50	1.50	1.50	1.50
I_4	1.30	1.60	1.50	1.47
I_5	1.40	1.60	1.60	1.53
I_6	1.40	1.70	1.50	1.53
I_7	1.50	1.60	1.50	1.53
I_8	1.65	1.70	1.70	1.68
Mean	1.44	1.59	1.54	

	IxS	SxI
SEm (±)	0.06	0.08
LSD (0.05)	0.13	0.19

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