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Effect of irrigation and sulphur on growth, yield and water use of summer sesame (*Sesamum indicum* L.) in New Alluvial zone of West Bengal

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ABSTRACT

Field study was undertaken at the University Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India (23.5ºN, 89ºE and 9.75 m above MSL) during two consecutive summer seasons (pre-kharif) to study the effect of irrigation on the basis of soil moisture tension (SMT) and sulphur fertilization on growth, yield, consumptive use (CU) and water use efficiency (WUE) of sesame var. Rama and also to optimize the sulphur application to sesame under New Alluvial zone of West Bengal. The experiment was planned in a split-plot design keeping four levels of irrigation on the basis of SMT [I_0 - without irrigation or control, I_1 - irrigated at 0.35 atm (atmospheric tension), I_2 - irrigated at 0.55 atm and I_3 - irrigated at 0.75 atm) as main plot and four levels of sulphur (S_0 - without sulphur or control, S_1 - 20, S_2 - 40 and S_3 - 80 kg S ha^{-1}] as sub plot treatments, respectively. The experimental results revealed that vegetative growth and yield attributing characteristics of sesame were significantly influenced with irrigation at different SMT and sulphur fertilization. Among different levels of SMT, higher vegetative growth (plant height, number of branches per plant and dry matter production) were observed with irrigation at 0.35 atm. tension but maximum yield components (no. of capsules plant^{-1}, no. of seeds capsule^{-1} and 1000 seed weight), seed yield, oil content and oil yield were exhibited with irrigation applied at 0.55 atm. tension. Higher values of growth characters, yield components and ultimately seed and oil yields of sesame were obtained with 40 kg S ha^{-1}. Maximum oil content was recorded with 60 kg S ha^{-1}, though it did not differ significantly with the former one. CU was maximum (282.50 mm) when irrigation was done maintaining at 0.35 atm. tension and it was decreased with increase in SMT level. WUE was the highest (4.16 kg ha^{-1} mm^{-1} of water use) when irrigation was given at 0.55 atm. tension. For seed yield, the response of per kg of sulphur application was found to be quadratic in nature and maximum response (7.06 kg seeds per kg of S application) at the sulphur level of 20 kg ha^{-1} and decreased with the increase in S level but the optimum level was found at 29.89 kg ha^{-1}. From the study it may be concluded that irrigation at 0.55 atm. tension along with 40 kg level of S ha^{-1} gave the higher economic return than that of other treatments because of the favourable effect of these treatments on the growth and yield attributes and other parameters of sesame in the new alluvial zone of West Bengal.

Keywords: Consumptive use, irrigation, sesame, soil moisture tension, sulphur, water use efficiency.

It is remarkable to note that the Technology Mission on Oilseeds, launched in 1986, envisaged a production boost largely contributed by oilseeds like rapeseed and mustard, groundnut, soybean and sunflower. India became self-sufficient in edible oils by early 90's and thereafter, the gap between demand and production have widened radically. At present, India imports more than 40% of its annual edible oil need amounting to Rs.11,000 crores to the exchequer. Among the oilseeds, sesame (*Sesamum indicum* L.) is the ancient one of India having 50% oil, 25% protein and vitamins, minerals and antioxidants and is grown in 1.74 m ha area with productivity of 421 kg ha^{-1} (OAS, 2009). Production of oilseeds scenario in India has undergone a dramatic change in the last 4-5 decades, being more than doubled achieving self-sufficiency. However, in the last couple of years, oilseed production has virtually declined, somewhat stagnated the productivity level of major oilseeds, mostly dominated in north-eastern part of the country. Sesame occupies a position of prominence in the oilseed scenario in the rainy season in the eastern India and secured second position next to rapeseed mustard, emphasized more as summer crop in the state of West Bengal (Saren *et al.*, 2004). Although the yield performance of *kharif* sesame (June/July - September/October) in general is very low, it has shown a better yield potential when it introduced in summer (February/March – May/June).

In eastern India, the crop is successfully grown in all the seasons and more so in the summer season. But, its productivity is low because it is grown in marginal lands with least external nutrient supply and limited irrigations. However, Garai and Datta (2002) recorded positive response of sesame to application of irrigation in critical growth stages. Similarly, it is reported that the increasing nutrient levels resulted in better biometric parameters, yield attributes and yield (Subrahmaniyan

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et al., 2001 and Nagavani *et al*., 2001) in national as well as in West Bengal (Sarkar and Pal, 2005). Sridevi *et al.* (2005) found that conjunctive use of inorganic fertilizers with organics influenced soil water content and increased seed yield of sesame. However, studies on response of the crop to irrigation regimes under different fertility levels in general and to INM practices in particular are scanty.

Indeed, in Indo-Gangetic alluvium sesame is being cultivated extensively during summer season in rice-potato based cropping system with a little assurance of irrigation water under residual soil fertility condition. In general this crop is irrigated up to a certain growth periods depending on the availability of limited water source without considering the critical growth stages of the crop. Since, water is a valuable input; levels of irrigation should be confined within the critical growth stages for improving the productivity of the crop. Similarly, maximum emphasis has already been given on N, P and K fertilization of the crop. But sulphur nutrition plays an important role in improving the growth and productivity of the oil seeds.

Realizing the yield potential of summer sesame it is important to standardize the input levels and irrigation which are the most important input in modern agriculture to increase the crop production as well as quality of oil. Irrigation scheduling on the basis of soil moisture tension is one of most important scientific tools now-a-days. But recently some workers visualized the good performance of different oilseed crops including sesame through application of S along with N, P and K fertilizers. Considering the limited water resources and of sulphur fertilization, this has been emphasized on irrigating the crop, particularly on moisture sensitive stages of the crop and to rationalize the dose of sulphur particularly at efficient soil moisture tension.

Keeping with these in view the field experiment was conducted during consecutive two summer seasons the research farm of BCKV, Mohanpur, West Bengal, India to evaluate the performance of sesame at different levels of soil moisture tension (SMT) and sulphur fertilization.

MATERIALS AND METHODS

The field experiment was carried out during two consecutive summer seasons of 2008 and 2009 at the University Research Farm, BCKV, Mohanpur, Nadia (W. B.). The soil was sandyloam in texture and having initial characteristics of the experimental soil was: total nitrogen 0.068% and available P_2O_5 and K_2O was 18.45 and 180.83 kg ha^{-1} and sulphur 8.26 ppm, field capacity 22.86 per cent moisture level and bulk density 1.42 g cc^{-1} (for 0.0-15.0 cm soil layer). The objective of the experiment was emphasized particularly on the effect of irrigation on the basis of SMT along with sulphur fertilization on the growth, yield attributing characteristics and yield, oil content, economic stability of sesame var. '*Rama*' in this sub-zone.

The experiment was planned in a split-plot design keeping four levels of irrigation on the basis of SMT as main plot and four levels of sulphur as sub plot treatments. The irrigation levels comprised: I_0 - without irrigation, I_1 - irrigated at 0.35 atm (atmospheric tension), I_2 - irrigated at 0.55 atm and I_3 - irrigated at 0.75 atm, respectively. The sub-plot treatments were: S_0 - without sulphur, S_1 - 20, S_2 - 40 and S_3 - 80 kg S ha^{-1}, respectively. A common dose of N, P_2O_5 and K_2O was applied to the crop @ 60: 30: 30 kg ha^{-1} at the time of last plough but before sowing. A common depth of 5 cm of water, supplied by a Parshall flume having a throat width of 15 cm was applied in each irrigation. The total rainfall received during the crop growth period of 2008 and 2009 recorded was 224.1 and 215.4 mm and the no. of wet days recorded were 26 and 21, respectively. The soil samples were collected up to 90 cm soil depth during sowing, before and 48 hours after each irrigation and at harvest. The samples were then oven-dried (at 105°C for 48 hours) and moisture content was determined following thermo-gravimetrical or field method. The moisture percentages of the soil samples were determined by using the following formula:

$$\text{Moisture (\%)} = \frac{\text{Wt. of wet sample (g)-Wt. of oven dry sample (g)}}{\text{Wt. of oven dry sample (g)}}$$

Destructive plant samplings were made at 30, 60 and at harvest, respectively to determine the dry matter accumulation (DMA) in plants and at harvest. The entire yield related characteristics were recorded at harvest also.

Initial soil samples were collected before fertilization randomly from eight (8) spots of experimental area with a soil augur up to a depth of 30 cm and mixed up thoroughly. Then these samples were dried in shade and pulverized to pass through 0.2 mm sieve and kept for chemical analysis. The pH, organic carbon, total nitrogen content, available phosphorus and potash were determined by the following method outlined in Jackson (1967). The estimation of sulphur was done by Tabatabai's method. Calibration curve was prepared following the method suggested by Tabatabai (1974). Sulphate sulphur ($SO_4^{=}$) @ 0, 5, 10, 15 and 20 ppm were added in duplicate to the soil (Soil : solution =

1 : 2.5) along with KH_2PO_4. Extracted solution was shaken for one hour and filtered through Whatman No. 1 filter paper. Sulphate sulphur was determined from each sample by $BaCl_2$ gelatin method.

RESULTS AND DISCUSSION

Growth attributing characteristics

Effect of soil moisture

The experimental results revealed that the vegetative growth attributing characteristics (plant height, number of branches per plant, total dry matter production) were increased appreciably with the increasing optimum moisture level effective for growth and development of the crop (Table 1). Taller plants were recorded at 30 DAS (days after sowing) when irrigation was given at 0.35 atm. Tension (SMT). Higher plant height was probably due to receiving first irrigation earlier by the crop than that of other treatments. There was no significant difference in plant height between irrigation at 0.75 atm and control plots, as they did not receive any irrigation by that time. However, at 60 DAS higher plant height was recorded when irrigation was given at 0.35 atm. tension which was statistically *at par* with irrigation at 0.55 atm. tension. Similar trend of plant height of the crop was observed at harvest also. Influence of proper moisture in the field favourably on the growth attributes of the crop noticed by Saren *et al.* (2004 & 2005) and Tripathy and Bastia (2012).

Effect of sulphur

Sulphur also significantly influenced the plant height of sesame (Table 1). At 30 DAS, no significant difference in plant height was observed by the application of different levels of sulphur. At 60 DAS, maximum height was observed at 40 kg S ha^{-1} (S_2), which was statistically at par with the levels of 20 kg S ha^{-1} (S_1), but significantly higher than S_3. Minimum plant height was observed in control plot (S_0), which was significantly lower than that of other treatments. At harvest, higher plant height was recorded with S_2 treatment, which was significantly higher than that of S_0, S_1 and S_3, respectively.

Both SMT and sulphur fertilization had a significant influence on number of branches $plant^{-1}$ at harvest. More number of branches $plant^{-1}$ was recorded with irrigation at 0.35 atm. SMT that was statistically at par with the I_2 treatment and lesser number was obtained from control plot (I_0). Significant improvement in the branches $plant^{-1}$ was observed with that application of sulphur @ 40 kg ha^{-1} over control but reduced significantly when this level of sulphur was increased to 60 kg ha^{-1} (S_3). Perusal of data in table 1 revealed that SMT and sulphur fertilization had a significant influence on the dry matter production of sesame plant. At 30 DAS, although effect of SMT was not significant, but on 60 DAS and at

Table 1: Effect of SMT and sulphur fertilization on vegetative growth attributes of sesame (pooled)

Treatments	Plant height (cm)			Branches plant^{-1} (at harvest)	Dry matter (g m^2)		
	30 DAS	60 DAS	At harvest		30 DAS	60 DAS	At harvest
Levels of soil moisture tension (I)							
I_0	31.50	70.39	87.59	2.41	48.74	319.96	502.37
I_1	32.58	80.85	106.03	4.07	53.50	380.53	605.64
I_2	31.80	78.42	99.02	3.89	50.17	375.87	598.73
I_3	31.52	75.60	96.12	3.36	49.25	351.18	580.94
SEm (±)	**0.37**	**1.25**	**2.17**	**0.069**	**1.42**	**2.47**	**2.96**
LSD (0.05)	**NS**	**4.32**	**7.51**	**0.239**	**NS**	**8.55**	**10.24**
Levels of sulphur (S)							
S_0	31.54	71.10	89.25	3.11	49.94	322.11	522.77
S_1	31.77	77.85	97.18	3.70	50.50	370.32	593.79
S_2	32.17	80.06	104.14	3.87	50.92	382.56	604.54
S_3	31.92	76.25	98.17	3.45	50.29	352.55	566.58
SEm (±)	**0.92**	**1.30**	**1.92**	**0.079**	**1.32**	**2.39**	**3.24**
LSD (0.05)	**NS**	**3.80**	**5.61**	**0.231**	**NS**	**6.98**	**9.46**

harvest significant influence of SMT had been speculated. At 60 DAS, maximum dry matter (380.53 gm^2) obtained with irrigation at 0.35 atm. tension (I_1), which was statistically *at par* with that of 0.55 atm. tension (I_2). But it was significantly superior than that of 0.75 atm. tension (I_3) and no irrigation or control (I_0) treatment. Similar trend was recorded at harvest also. Similar to other growth attributing characteristics sulphur also significantly influenced the dry matter production of sesame. At 30 DAS, there was no significant difference in dry matter production on the different levels of sulphur application. Maximum dry matter accumulation of 382.56 g m^2 and 604.54 g m^2 were obtained both at 60 DAS and harvest respectively, with 40 kg S ha^{-1} over control, *i.e.* 0 kg S ha^{-1} (Table 1). Further increase in levels of S to 60 kg S ha^{-1} decreased dry matter accumulation significantly throughout the growing period of the crop. The effect of 40 kg S ha^{-1} on plant height and number of branches were reflected on dry matter production. This was agreed with the findings of Rahul and Paliwal (1987). However, maintenance of proper moisture at field level along with balance sulphur fertilization favourably effective for the growth and development also observed by different workers on this crop (Ghosh *et al.*, 1997 and Saren *et al.*, 2004 & 2005).

Yield components of sesame

Effect of moisture level

The data presented in the table 2 revealed that application of irrigation in general increased appreciably the yield attributing characteristics and seed yield of sesame over untreated control. Among the different irrigation levels I_2 recorded maximum number of capsules plant^{-1}, which was statistically *at par* with the irrigation applied at 0.75 atm. SMT, but significantly higher than no irrigation. Percent increment in number of capsules per plant with irrigation at 0.55, 0.75 and 0.35 atm. SMT were 69.76, 56.49 and 15.79%, respectively over control or no irrigation. Likewise capsules plant^{-1}, number of seeds capsules^{-1} was significantly influenced by the levels of SMT and with increase in SMT it was increased appreciably, but at higher SMT (0.35 atm.) level it recorded reduced number. I_2 level of SMT (0.55 atm.) recorded the more number (71.71) and it was significantly greater than other three levels of SMT, but I_3 and I_1 levels were found statistically *at par*. The increase in number of seeds capsule^{-1} due I_2, I_3 and I_1 were 45.99, 28.91 and 17.63%, respectively. As expected, I_0 level of SMT produced the least number of seeds capsules^{-1} (49.12). Similar to other yield attributing characters the higher test weight of 3.027 g was obtained in I_2 *i.e.* when irrigation was maintained at 0.55 atm. SMT in the field and it was *at par* with that of I_3. Test weight increases by 60, 33.8 and 24.7% when the crop was irrigated at 0.35, 0.55 and 0.75 atm. tensions, respectively over without irrigation, was conformity with the findings of Ghosh *et al.* (1997) and Saren *et al.* (2004 & 2005).

Effect of sulphur

The yield attributing characteristics of sesame were also found to be significant with the sulphur fertilization (Table 2). More number of capsules plant^{-1} was recorded from the plot which received 40 kg S ha^{-1} (S_2) which was *at par* with 20 kg S ha^{-1} (S_1), but significantly higher over 0 kg S ha^{-1} (S_0) and 60 kg S ha^{-1} (S_3). Application of 40 kg S ha^{-1} increased the number of capsules plant^{-1} by 64.99% over control. This increasing yield attributing characteristics favourably influenced with sulphur fertilization was confirmation with the findings of Balamuragan and Venkatesan (1983), Ghosh *et al.* (1997) and Saren *et al.* (2005). In case of number of seeds capsule^{-1} 40 kg S ha^{-1} recorded the higher value, which was significant over other and it provides 29.30% greater advantage over control. Again 20 kg S ha^{-1} obtained comparatively higher number of seeds capsule^{-1} over 0 kg S ha^{-1} and it becomes at par with that of 60 kg S ha^{-1}. Similarly sulphur fertilization had a significant influence over the test weight and maximum test weight of 2.599 g was obtained with the application of 40 kg S ha^{-1} which was significantly higher over the other levels other sulphur. Again 20 kg S ha^{-1} produced higher test weight (2.594 g) over control, which was statistically at par with 60 kg S ha^{-1}. The similar trend was also noticed by Ghosh *et al.* (1997), Tiwari *et al.* (2000), Nagavani *et al.* (2001) and Saren *et al.* (2005).

Yield of sesame

Effect of moisture level

It was clear from pooled analyzed data that application of irrigation increased the seed yield over unirrigated control. Maximum seed yield was recorded when the crop was irrigated at 0.55 atm. SMT. Actually this treatment produced higher yield attributing characteristics that contributed higher yield and this level was significantly superior to the other levels of SMT. Irrigation at 0.75 atm. tension and at 0.35 atm. did not differ significantly between them in respect to their seed yield. The positive effect of irrigation at 0.55 atm. tension on seed yield of sesame was probably due to the synergistic improvement of the yield components as it received three irrigations and the time of irrigations were coincided with early branching, flowering and capsules development stages of the crop. Irrigation at 0.35 atm. (I_1), 0.55 atm. (I_2) and 0.75 atm. (I_3) tensions give the increment in seed yield by 22.19, 44.77 and 29.23%, respectively over control or no irrigation (I_0). The results are close conformity with the earlier findings reported by Prakasha and Timmegowda (1992) and Parihar *et al.* (1999).

Effect of sulphur

Significant and progressive increase in seed yield of sesame with successive increment in sulphur levels up to 40 kg S ha^{-1} was recorded (Table 2). A further increase to 60 kg S ha^{-1} significantly decreased over 40 kg S ha^{-1}, assumed the detrimental effect of higher doses of S on different yield components might be the cause of yield reduction in sesame. The beneficial effects S on yield characteristics up to 40 kg S ha^{-1} contributed to greater seed yield. The present increment in seed yield with the application of S @ 20 kg S ha^{-1}, 40 kg S ha^{-1} and 60 kg S ha^{-1} were to the tune of 13.67, 22.80 and 13.69%, respectively over control or 0 kg S ha^{-1}. The result corroborated with the findings of Tandon (1984), Mondal *et al.* (1993), Ghosh *et al.* (1997), Subramaniyam *et al.* (1999) and Tiwari *et al.* (2000).

Quality of the produce

Oil content as affected by irrigation

The results showed that the amount of oil content an increase significantly with the application of irrigation and sulphur than that of control (Table 2). The maximum oil content of 44.23% was recorded with the treatment I_2 (irrigation at 0.55 atm. tension) and S_3 (application of S @ 60 kg S ha^{-1}) than that of other treatments of SMT and sulphur, which might be due to greater response of irrigation and sulphur towards the growth and yield of sesame. Favourable effect of irrigation as well as sulphur fertilization on oil content and yields have been visualized by many workers in the country including in West Bengal (Dutta *et al.*, 2000; Nagavani *et al.*, 2001 and Saren *et al.*, 2005).

Response to sulphur

The input-output relationship between levels of sulphur and seed yield of sesame was quadratic in nature (Fig. 1). The equation is as follows –

$$Y = - 0.1353\, X^2 + 10.084\, X + 847.50$$

where, 'Y' is the seed yield (kg ha^{-1}) of sesame due to an application of 'X' unit of S kg ha^{-1}, where one unit of S is 20 kg ha^{-1}. The optimum sulphur level for sesame was 29.89 kg ha^{-1}, taking ₹ 14.00 as the selling price of one kg of sesame and ₹ 28.00 for one kg of sulphur fertilizer.

Economics of sulphur and irrigation based on SMT

Benefit: Cost ratio (BC ratio) decreased with increase in the levels of sulphur application (Table 3). At 20 kg ha^{-1}, it recorded maximum value (2.53) and further increase in sulphur level it was decreased (at 40 kg ha^{-1} it decreased to 1.42 and at 60 kg ha^{-1}, the ratio was negative *i.e.* – 0.03).

Table 2: Effect of SMT and sulphur on yield components, seed yield and oil content of sesame (pooled)

Treatments	Yield components			Seed yield	Oil content
	Capsules plant^{-1}	Seeds capsule^{-1}	Test weight (g)	(kg ha^{-1})	(%)
Levels of soil moisture tension (I)					
I_0	46.79	49.12	2.263	774.01	30.18
I_1	54.18	57.78	2.491	945.75	40.52
I_2	79.43	71.71	3.027	1120.50	44.23
I_3	73.22	63.32	2.823	1000.25	43.05
SEm (±)	**1.90**	**2.13**	**0.110**	**17.73**	**0.46**
LSD (0.05)	**6.57**	**7.37**	**0.381**	**60.10**	**1.59**
Levels of sulphur (S)					
S_0	47.62	53.02	2.484	847.50	38.34
S_1	76.20	60.61	2.594	988.75	40.67
S_2	78.57	68.53	2.959	1040.75	43.04
S_3	51.23	59.80	2.567	963.50	43.93
SEm (±)	**1.92**	**2.09**	**0.103**	**16.52**	**0.39**
LSD (0.05)	**5.61**	**6.10**	**0.301**	**48.24**	**1.14**
Interaction effect					
I x S					
SEm (±)	**3.84**	**4.12**	**0.181**	**22.44**	**0.57**
LSD (0.05)	**11.21**	**12.03**	**NS**	**65.52**	**1.66**
S x I					
Sem (±)	**5.421**	**5.22**	**0.124**	**23.41**	**0.63**
LSD (0.05)	**5.83**	**15.24**	**NS**	**68.36**	**1.84**

The highest BC ratio (0.94) was recorded when the crop received irrigation at 0.55 atm. tension and this was close to the crop which was irrigated at 0.75 atm. tension (Table 3). But the negative benefit : cost ratio was recorded when the crop received irrigation at 0.35 atm tension (- 0.03), was probably due to their higher irrigation cost accomplished with comparatively less yield in this treatment. This is in conformation with De *et al.* (2013) who reported that more profitability had gone in favour of the crop was due to increase in available soil moisture in the field.

Consumptive use (cu) and water use efficiency (WUE)

In the present study, scheduling of irrigation at 0.35 atm. tension recorded the CU value (282.50 mm) and it decreased with the increase of number of irrigation *i.e.* increase in tensiometric level from 0.35 atm to 0.75 atm. tension (Table 4). The minimum CU value (207.10 mm) was recorded with control. Similar increase in the moisture use with increasing the moisture level observed in the sesame by many workers (Ibrahim *et al.*, 1987; Parihar *et al.*, 1999 and Dutta *et al.*, 2000).

The WUE value (4.16 kg $ha^{-1}mm^{-1}$ of water use) was obtained from the irrigation at 0.55 atm. tension followed by irrigation at 0.75 atm tension. Minimum WUE value (3.35 kg $ha^{-1}mm^{-1}$ of water use) was recorded with irrigation at 0.35 atm. tension (Table 4).

From the present study it may be concluded that irrigation at 0.55 atm. tension along with application of 40 kg S ha^{-1} gave the higher economic return than that of other treatments because of the favourable effect of this treatment on the growth and yield attributes of sesame in this new alluvial zone of West Bengal.

From the present study it may be concluded that irrigation at 0.55 atm. tension along with application of 40 kg S ha^{-1} gave the highest economic return than that of other treatments practiced in the experiment as because of the favourable effect of these treatments on the growth and yield attributes of sesame in this new alluvial zone of West Bengal.

Table 3: Economics of sulphur fertilization to sesame during summer (mean of 2 years)

Levels of sulphur (kg ha^{-1})	Seed yield (kg ha^{-1})	Additional income over control (RS.)	Cost of fertilizer (RS.)	Net profit (RS.)	Benefit : cost ratio
Effect of sulphur levels on the economics (S)					
0	847.50	—	—	—	—
20	988.75	1977.50	560.00	1417.50	2.53
40	1040.75	2705.50	1120.00	1585.50	1.42
60	963.50	1624.00	1680.00	-56.00	-0.03
Effect of irrigation level on the economics (I)					
0	774.01	—	—	—	—
20	945.75	2404.50	3328.00	923.50	-0.28
40	1120.50	4851.00	2496.00	2355.00	0.94
60	1000.25	3167.50	1664.00	1503.50	0.90

Table 4: Consumptive use (CU) and water use efficiency (WUE) of sesame under different levels of soil moisture tension (mean of 2 years)

Levels of soil moisture tension (I)	Consumptive use (mm)	Water use efficiency (kg $ha^{-1}mm^{-1}$)
I_0 (Control or without irrigation)	207.10	3.74
I_1 (Irrigation at 0.35 atm. tension)	282.50	3.35
I_2 (Irrigation at 0.55 atm. tension)	269.20	4.16
I_3 (Irrigation at 0.75 atm. tension)	255.80	3.91

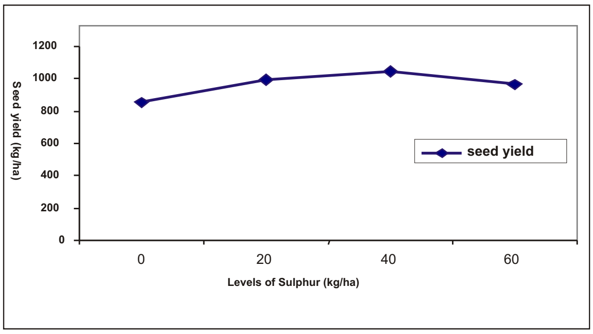

Fig.1: Response of sesame to sulphur application

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