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Response of sulphur and zinc nutrition on growth, yield attributes and yields of rapeseed (*Brassica napus* L.) under upland soil of Vindhyan region

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Abstract
The field experiment was conducted during *Rabi* season in 2016 at the Agricultural Research Farm of Department of Soil Science and Agricultural Chemistry, Rajiv Gandhi South Campus, Barakachha. The experiment is carried out in Factorial Randomized block design and replicated thrice. The treatments comprising three levels of sulphur (0, 20 kg ha^{-1} and 40 kg ha^{-1}) in combination with zinc at three levels (0, 5 kg ha^{-1} and 10 kg ha^{-1}). The present study result showed that the application of sulphur in combination with zinc in rapeseed significantly affected the growth, yield attributes and yield. Application of 40 kg S ha^{-1} + 10 kg Zn ha^{-1} was found to be best treatments regarding growth, yield attribute and yield of rapeseed. Thus, S nutrition with Zn in application of the rapeseed crop holds immense importance for obtaining better growth and productivity. However, for maximum seed yield/ha (40 Kg S/ha + 10 Kg Zn/ha) hold promise.

Keywords: Growth, Rapeseed, Sulphur, Yield, Zinc

1. Introduction

Mustard is the third largest vegetable oil traded in the world, next to soyabean and palm oil. Yellow sarson (*Brassica napus*) is cultivated in limited areas of eastern Uttar Pradesh. It is a short durationcrop cultivated largely in Assam, Bihar, Orissa and West Bengal in the east mainlyas winter crop. In Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Uttaranchal and western Uttar Pradesh, it is grown as a catch crop during September December. Oilseed rape (*Brescia napus*) is one of the most widely cultivated oil crops in the world. The world production of rapeseed was about 68.86 million tons in 2016 and, as edible vegetable oil only soybean and palm oil production exceeded that of oilseed rape (FAOSTAT, 2016). Rapeseed–mustard crops in India are grown in diverse agro climatic conditions ranging from north-eastern / north western hills to down south under irrigated/rainfed, timely, late sown, saline soils and mixed cropping. The estimated area, production and yield of rapeseed-mustard in the world was 33.65 million hectares (m ha), 68.86 million metric tons (Mmt) and 2500kg/ha respectively, during 2016-17 Globally, India account for 6.50million hectare and 1.07 metric tons/hectare of the total acreage and production (USDA 2016). The basic factors behind this phenomenal low productivity are non-availability of high yielding problem specific varieties, sub-optimal and imbalanced use of fertilizers, lack of irrigation facilities, attack of pests and diseases. In recent years, some promising varieties of rapeseed have been introduced embedded with high genetic yield potentiality. Such varieties are characterized with non-spreading bushy morphological frame work and are known to possess the trait of responsiveness toward fertilizer application. Since fertilizers are most expensive inputs, it is imperative to optimize their use with rational approach with aim to have greater efficiency of applied fertilizers. The major nutrients sulphur plays an important role in Indian mustard, which are insufficient in most of Indian soil.

2. Method and material

A field experiment was carried out during *Rabi* season in 2016 at the Agricultural Research Farm of Department of Soil Science and Agricultural Chemistry, Rajiv Gandhi South Campus, Barakachha, Mirzapur, Uttar Pradesh. Mirzapur falls in a belt of semi-arid to sub-humid climate. The normal period for of onset of the monsoon in this region is third week of June and, it lasts up to end of September or sometimes extends to the first week of October. The average annual rainfall is about 1073 mm and out of which about 90 percent is received by south-west monsoon while annual potential evapo-transpiration is about 1667 mm. The temperature begins to rise from the month of February and reaches its maximum in May month, minimum and maximum temperature ranged between 8.9ºC and 39.85ºC, respectively, whereas minimum and maximum relative humidity ranged between 21.24 and 87.30 percent and field layout in Factorial Randomized Block Design to study the response of sulphur & zinc nutrition on the production potential of rapeseed (*Brassica napus* L.) under rainfed conditions of upland soil of Vindhyan region.

The soil of the experimental field was Sandy loam in texture, with soil pH 5.70, low in organic carbon (0.34%), low in available nitrogen (215.25kg ha^{-1}), low in available P_2O_5 (20.74 kg ha^{-1}) and medium in available K_2O (219.38 kg ha^{-1}). Experiment was laid out in Factorial Randomized Bock Design with nine treatment combinations *viz.*0 kg sulphur ha^{-1} + 0 kg $Zinc^{-1}(T_1)$, 0 kg sulphur ha^{-1}+ 5 kg $Zinc^{-1}(T_2)$, 0 kg sulphur ha^{-1}+ 10 kg $Zinc^{-1}(T_3)$, 20 kg sulphur ha^{-1}+ 0 kg $Zinc^{-1}(T_4)$, 20 kg sulphur ha^{-1} + 5 kg $Zinc^{-1}$ (T_5), 20 kg sulphur ha^{-1} +10 kg $Zinc^{-1}(T_6)$, 40 kg sulphur ha^{-1} + 0 kg $Zinc^{-1}(T_7)$, 40 kg sulphur ha^{-1}+ 5 kg $Zinc^{-1}(T_8)$, 40 kg sulphur ha^{-1} + 10 kg $Zinc^{-1}(T_9)$ and replicated thrice. Recommended dose of fertilizer (RDF) for Vindhyan region N, P_2O_5, K_2O (80-40-60 kg ha^{-1}) was used to raise the experimental crop. Full recommended dose of NPK was applied as basal dose (at the time sowing). The sources of fertilizers for NPK were urea (46% N), DAP (18%N, 46 P_2O_5) and muriate of potash (60% K_2O), zinc sulphate (33% Zn and 15% S) and bentonite (80% S) were used as source of sulphur for treatment. Whereas, application of remaining fertilizer are top dressed in two split doses. Rapeseed crop variety 'B9' was raised with seed rate of 5 kg ha^{-1} at spacing of 45 cm × 10 cm weed control was carried out by one mechanical-cum-manual weeding at 4 week stage of the crop. Recommended agronomic practices were followed to raise the crop. The data recorded were analyzed following standard statistical procedure to draw a valid conclusion.

3. Agronomic practices

The details of cultural operations done starting from field preparation to harvesting of the crops are given in Table 1.

Table 1: Schedule of field operation

S. No.	Operation	Date
(A).	Pre-sowing operations	
1.	Land preparation (i) First ploughing (ii) Second ploughing	 16.09.2016 18.09.2016
2.	Layout	19.09.2016
(B).	Sowing operations	
1.	Fertilizer application and seed sowing	20.09.2016
(C).	Intercultural operations	
1.	ISt Thinning	05.10.2016
2.	1stWeeding + 2nd thinning	20.10.2016
3.	Irrigation	05.11.2016
4.	Harvesting	23.12.2016
5.	Threshing	05.01.2017

4. Result and discussion

The data pertaining to effect of sulphur and zinc application on height of plant is presented in table 2. It is evident from the table that height of plant (30 DAS) varied from 27 to 29 cm. At 30 DAS treatment (40 Kg S/ha + 10 Kg Zn/ha) and (20 Kg S/ha + 5 Kg Zn/ha) produced tallest plant of height (29cm). Interaction between sulphur level and Zinc (Table 4.3) for plant height found significant at each levels of treatment combinations. The application of sulphur with zinc (40 Kg S/ha) showed significantly higher plant height (29cm) at 30 DAS than (20 Kg S/ha + 10 Kg Zn/ha) produced plant of height (30 cm). However, the treatment (20 Kg S/ha + 5 Kg Zn/ha), (20 Kg S/ha) and (10Kg Zn/ha) were found statically at par to each other. Moreover, there was no significant difference in control plot with RDF and plot with application of zinc @ 5 Kg Zn/ha showed a lowest plant height of 27 cm at 30 DAS. It is evident from the data; among the sulphur doses with Zn, 40 kg S/ha + 10 Kg Zn/ha was showed highest plant height at 60 DAS and at harvest stage. Almost similar trend was noticed with the plant height recorded at 60 DAS and at harvesting. Sulphur generally tends to increases plant height. It enhances cell division, elongation, and expansion, but the application of sulphur beyond 40 kg/ha did not influence plant height. The highest plant height was recorded by 40 kg sulphur x 10 kg Zn level and was found significantly superior over all the others, interaction levels at 30 DAS and at 60 DAS (Table 3).

The data obtained in relation to dry matter accumulation by rapeseed crop influenced by different levels of sulphur and zinc presented in the Table 2. Maximum plant dry weight was recorded under 40 kg S/ha with 10 kg Zn/ha at 60 DAS and. Minimum plant dry weight was recorded under no S and Zn from control plot with 100% RDF. It is evident from the table that dry weight of plant (30 DAS) varied from 6.16 to 7.17g. At 30 DAS, maximum plant dry weight (7.17 g) was obtained from treatment (40 Kg S/ha + 10 Kg Zn/ha) which is 44.7 % higher over control followed by (40 Kg S/ha + 5 Kg Zn/ha) having a value of 6.57 g. Increase in total dry weight at this growth phase was possibly due to increase in photosynthetic rate. While dry weight recorded from treatments (20 Kg S/ha + 5 Kg Zn/ha), (20 Kg S/ha) and (10 Kg Zn/ha) were statistically at par to each other. However, minimum dry weight was recorded from control plot with 100 % RDF. Almost similar trend was noticed with the plant height recorded at 60 DAS and at harvesting. Dry weight per plant was significantly influenced by different level of S and Zn among all treatment combinations at 30 DAS, 60 DAS and at harvest stages. Interaction of sulphur and zinc was also significant and highest value was recorded by the application of 40 kg S ha^{-1} in combination of 10 kg Zn ha^{-1} (Table 4).

A critical perusal of the data presented in Table 5 that a significant increase was found in number of green leaves per plant at 30 and 60 DAS with the application of increasing level of sulphur and zinc. Number of leaves per plant and leaf area index tended to increase with the application up to 40 kg S/ha + 10 kg Zn/ha at 30 and 60 DAS. The highest number of leaves was noted in (40 Kg S/ha + 10 Kg Zn/ha) and minimum number of leaves (42.76) in (control) at 30, 60 DAS and at harvest. Zn @ 5 Kg Zn/ha with increased concentration of S up to 40 Kg S/ha, increase in number of leaves in treatment (0 Kg S/ha + 5 Kg Zn/ha), (20 Kg S/ha + 5 Kg Zn/ha) and (40 Kg S/ha + 5 Kg Zn/ha) thereby. Moreover, increasing rate of application of S with Zn gave increased number of leaves. However, the treatment (0 Kg S/ha + 5 Kg Zn/ha), (0 Kg S/ha + 10 Kg Zn/ha) and (20 Kg S/ha + 0 Kg Zn/ha) and (20 Kg S/ha + 5 Kg Zn/ha) were found statically at par to each other. Almost similar and increasing trend was noticed with the number of leaves recorded at 60 DAS and similar increasing trend at harvesting as compared to 30 DAS.

It is evident from the data presented in the table (5 and 6) increasing rate of sulphur and zinc tend to increase LAI (leaf area index) with maximum value (2.04) obtained in treatment (40 Kg S/ha + 10 Kg Zn/ha) and minimum (1.40) with treatment (0 kg S/ha + 0 kg Zn/ha) with 100% RDF.

Data on number of branches per plant of rapeseed is given in the Table 7. At 30 DAS application of 40 kg S/ha and 10 kg Zn/hashowed significantly highest (8.08) and was at par at 60 DAS and at harvest stage of crop. Lowest numbers of primary branches/plant (6.64) was recorded under (0 kg S/ha + 0 kg Zn/ha) with 100% RDF. It was statistically at par in (0 kg S/ha + 10 kg Zn/ha),(20 kg S/ha + 0 kg Zn/ha) and (20 kg S/ha + 5 kg Zn/ha). Similar findings were recorded by Singh *et al*, (2007). Interaction effect of the treatments does not reach up to level of significance.

Number of branches per plant significantly varied among the S and Zn fertilization treatments. Data on number of branches per plant of rapeseed is given in the Table 7. At 60 DAS application of 40 kg S/ha and 10 kg Zn/ha showed significantly highest (7.88) branches/plant and which was at par with 60 DAS. Lowest numbers of branches/plant (6.48) was recorded under (0 kg S/ha + 0 kg Zn/ha) and (20 kg S/ha + 0 kg Zn/ha). It was statistically at par in (0 kg S/ha + 10 kg Zn/ha), (20 kg S/ha + 10 kg Zn/ha), (40 kg S/ha + 0 kg Zn/ha) and (40 kg S/ha + 5 kg Zn/ha). Rana and Rana (2003) observed an increase in the number of branches per plant in mustard with the application of 60 kg/ha S. Similar findings were also reported by Nepalia (2005). Interaction effect of the treatments does not reach up to level of significance.

Data pertaining to number of siliquae as affected by different rates of sulphur and zinc remain in the Table 8. Maximum number of siliquae per plant (5.84) was observed at 40 kg /ha of sulphur with 10 kg /ha of zinc and the lowest number (5.24) was recorded fromthe control treatment (0 kg S/ha + 0 kg Zn/ha) (60DAS). The siliqua per plant of mustard significantly increased up to 50 kg/ha which was reported by Kumar *et al*., 2002.In general, the number of siliquae/plant increased significantly with increasing levels of sulphur up to 40 kg/ha with zinc up to 10 kg/ha.

The application of sulphur @ 40 kg/ha with varying zinc (0, 5 and 10 kg/ha) rates in treatment increases number of siliquae12.24%, 14.37% and 15.63% higher over the control respectively. While at lower dose sulphur @ 20 kg/ha with varying zinc (0, 5 and 10 kg/ha) concentration in treatment increases number of siliquae 10.92%, 12.56% and 14.72% higher over the control, respectively. Sulphur @ 0 kg/ha with varying zinc (5 and 10 kg/ha) in treatment increases number of siliquae7.99% and 13.32% higher over the control respectively. Moreover, treatment (0 kg S/ha + 10 kg Zn/ha),(20 kg S/ha + 5 kg Zn/ha) and (40 kg S/ha + 0 kg Zn/ha) were found statistically at par to each other. The number of siliquae of mustard crop was significantly influenced due to different treatments of sulphur in combination with zinc. These results are in conformity with those of Rana *et al.* (2005), Chauhan *et al.* (1996) and Piri and Sharma (2006). Furthermore, it is evident form data that at same rate of sulphur with different concentration of zinc there was increased number of siliquae and it was continuously increase with increasing sulphur. Thus, at lower rate of sulphur application there was less number of siliquae and higher the number of siliquae at higher rate.

Data pertaining to length of the siliquae/plant as affected by application of different combination of sulphur and zinc have been presented in the Table (9). In general, the length of siliquae/plant increased with increasing levels of sulphur up to 40 kg/ha applied in combination with zinc up to 10 kg/ha but does not reach upto the level of significance. Data indicate that highest length of siliquae/plant was recorded with treatment (40 kg S/ha + 10 kg Zn/ha). Corroborative results are also studied by Singh *et al*, (2007). It is apparent from the data (Table 9) that sulphur and zinc application brought about significant effect on number of seeds per siliquae on rapeseed. Treatment (40 kg S/ha + 10 kg Zn/ha) produced the highest number of seeds per siliqua (18.58) and minimum (16.45) with control (0 kg S/ha + 0 kg Zn/ha).

Data pertaining to the number of seeds per siliquae @ 40 kg S/ha with different level of zinc (0, 5 and 10 kg /ha) in treatment increases number of seeds per siliquae 12.90%, 13.82% and 14.28% higher over the control respectively. While, sulphur @ 20 kg/ha with varying levels of zinc (0, 5 and 10 kg/ha) concentration in treatment increases number of seeds per siliquae5.26%, 10.49% and 10.50% higher over the control respectively. Sulphur @ 0 kg/ha with varying zinc (5 and 10 kg/ha) in treatment increases number of seeds per siliquae3.57% and 4.14% higher over the control respectively. Moreover, treatment (0 kg S/ha + 10 kg Zn/ha),(20 kg S/ha + 0 kg Zn/ha),(20 kg S/ha + 5 kg Zn/ha) and(20 kg S/ha + 10 kg Zn/ha) were found statistically at par to each other. Further, increasing rates of sulphur with zinc significantly increases the number of seeds per siliquae. These results are in conformity with those of Rana *et al.* (2005), Piri and Sharma (2006).

A critical perusal of the data presented in table 9 revealed that the seed yield of rapeseed was ranging from 10.55 g/plant to 15.57 g/plant and it has increased significantly with the application of sulphur with zinc at different levels. The maximum seed yield (15.57 g) was recorded in the treatment (40 kg S/ha + 10 kg Zn/ha) which was 39.42% higher than treatment (0 kg S/ha + 0 kg Zn/ha) and 6.53 % and higher than (40 kg S/ha + 5 kg Zn/ha). While treatment (0 kg S/ha + 0 kg Zn/ha) gave minimum seed yield of 10.55 g. The application of sulphur @ 40 kg/ha with varying zinc (0, 5 and 10 kg/ha) rates in treatment increases seed yield per plant30.22% and 35.19% higher over the control, respectively. While at lower dose sulphur @ 20 kg/ha with varying zinc (0, 5 and 10 kg/ha) concentration in treatment increases seed yield per plant16.51%, 20.70% and 22.23% higher over the control, respectively. Moreover, treatment (0 kg S/ha + 0 kg Zn/ha), (0 kg S/ha + 5 kg Zn/ha) and (0 kg S/ha + 10 kg Zn/ha) were found statistically at par to each other. It is clear from the data shown in the table 9 and highest test weight was obtained due to application of 40 kg with 10 kg zinc per hectare. It remained at par results of treatment combination of sulphur with zinc applied at 40 kg S/ha + 10 kg Zn/ha but was significantly superior over other treatment and control. These results are in conformity with those of Rana *et al.* (2005), Piri and Sharma (2006).

Sulphur with zinc significantly increased 1000-seed weight. Among all treatments, the highest 1000- seed weight (3.27) were shown by (40 kg S/ha + 10 kg Zn/ha), which was at par with (40 kg S/ha + 5 kg Zn/ha) and were 10.14 % higher than that of control. While control plot showed lowest 1000-seed weight (3.15) among all the treatment. The improved nutritional environment as a result of increased S and Zn supply might have favorably influenced the carbohydrate metabolism. This favorable effect led to increased translocation of photosynthates towards seeds resulting in formation of bold seeds.

The data on yield of rapeseed apparent from the Table 9 and increasing S + Zn doses brought about significant increase in seed yield (q/ha). The application of (40 kg S/ha + 10 kg Zn/ha) showed at par with treatment (40 kg S/ha + 0 kg Zn/ha) and (40 kg S/ha + 5 kg Zn/ha) and significantly highest seed yield of rapeseed.

A critical perusal of the data presented in table revealed that the grain yield of rapeseed was ranging from 15.38qha^{-1} to

18.77 qha^{-1} and it was increased significantly with the increasing levels of sulphur with zinc in the experimental plot. The maximum seed (18.77 qha^{-1}) was recorded in the treatment (40 kg S/ha + 10 kg Zn/ha) which was 20.73 % higher than treatment (control) and was statistically (40 kg S/ha + 5 kg Zn/ha) and (40 kg S/ha + 0 kg Zn/ha). The application of sulphur @ 40 kg/ha with varying zinc (0, 5 and 10 kg/ha) rates in treatment increases seed yield 19.33% and 19.89% higher over the control respectively. While at lower dose sulphur @ 20 kg/ha with varying zinc (0, 5 and 10 kg/ha) concentration in treatment increases seed yield 7.26%, 8.72% and 10.35% higher over the control respectively. Moreover, treatment(0 kg S/ha + 5 kg Zn/ha)and(0 kg S/ha + 10 kg Zn/ha) were found statistically at par to each other. These results are in conformity with those of Piri and Sharma (2006).

It is evident from the data given in the (table 9) and sulphur application enhanced straw yield significantly over 40 kg/ha. The highest straw yield was obtained at 20 kg sulphur per hectare followed by 40 kg sulphur/ha. These results are in conformity with those of Rana *et al*, (2005) and Piri and Sharma (2006). 40kgS and 10 kg Zinc ha^{-1}observed that significant increase in the mustard crop physiological parameters and seed yield. Interaction effects between sulphur and Zn was not reach upto level of significance.

Table 2: Effect of sulphur and zinc application on plant height (cm) and plant dry weight (g) of rapeseed crop

Treatments	Plant height (cm)			Plant dry weight (g)		
Sulphur Level	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
0 kg S/ha	28.48	84.00	112.21	6.16	15.59	27.50
20 kg S/ha	27.35	86.11	114.82	6.20	16.09	27.51
40 kg S/ha	29.33	89.88	115.80	7.17	17.40	29.27
SEm (±)	0.07	0.27	0.22	0.13	0.12	0.20
CD (P=0.05)	0.23	0.83	0.68	0.39	0.38	0.60
Zinc Level						
0 kg Zn/ha	27.86	84.97	113.48	5.98	15.73	27.70
5 kg Zn/ha	27.28	86.82	114.28	6.57	16.12	28.06
10 kg Zn/ha	30.02	88.20	115.05	6.98	17.23	28.52
SEm (±)	0.07	0.27	0.22	0.13	0.12	0.20
CD (P=0.05)	0.23	0.83	0.68	0.39	0.38	0.60
S×Z	S	S	NS	NS	S	NS

Table 3: Interaction effect of sulphur and zinc level on plant height (30-60 DAS) of rapeseed crop

Sulphur levels x Zinc level	Plant height 30 DAS(cm)				Plant height 60 DAS (cm)			
	0 Kg	5 Kg	10 Kg	Mean	0 Kg	5 Kg	10 Kg	Mean
0 Kg S ha^{-1}	22.2	21.86	23.86	22.64	83.46	84.06	84.06	84.22
20 Kg S ha^{-1}	24.33	24.26	24.8	24.46	85.13	86.46	86.46	86.11
40 Kg S ha^{-1}	27.06	28.26	28.33	27.88	87	89.93	89.93	89.88
Mean	24.53	24.8	25.66		85.2	86.82	86.82	
SEm (±)				0.28				0.45
CD (p=0.05)				0.64				1.03

Table 4: Interaction effect of sulphur levels and zinc on plant dry weight of rapeseed crop

Sulphur levels x zinc level	Dry weight $Plant^{-1}$(g) 60 DAS			
	0 Kg	5 Kg	10 Kg	Mean
0 Kg S ha^{-1}	14.58	15.71	16.49	15.59
20 Kg S ha^{-1}	16.02	16.03	16.22	16.09
40 Kg S ha^{-1}	16.59	16.64	18.97	17.40
Mean	15.73	16.12	17.23	
SEm (±)				0.21
CD (p=0.05)				0.48

Table 5: Effect of sulphur and zinc application on number of leaves per plants and leaf area index of rapeseed crop

Treatments	Number of leaves $plant^{-1}$			Leaf area index
Sulphur Level	30 DAS	60 DAS	At harvest	60 (DAS)
0 kg S/ha	42.76	63.53	62.75	1.40
20 kg S/ha	44.86	64.48	64.29	1.59
40 kg S/ha	46.86	65.57	66.32	2.04
SEm(±)	0.29	0.31	0.12	0.03
CD	0.86	0.95	0.36	0.10
Zinc Level				
0 kg Zn/ha	43.87	64.26	63.93	1.62
5 kg Zn/ha	44.86	64.51	63.98	1.67
1 0 kg Zn/ha	45.75	64.82	65.44	1.75
SEm (±)	0.29	0.31	0.12	0.03
CD (P=0.05)	0.86	0.95	0.36	0.10
S×Z	NS	NS	S	S

Table 6: Interaction effect of sulphur and zinc application on number of leaves at harvest and leaf area index of rapeseed crop

Sulphur levels x Zinc level	No. of leaves at harvest				Leaf area index (60 days)			
	0 Kg	5 Kg	10 Kg	Mean	0 Kg	5 Kg	10 Kg	Mean
0 Kg S ha^{-1}	62.03	61.74	64.48	62.75	1.47	1.29	1.43	1.40
20 Kg S ha^{-1}	64.05	64.31	64.50	64.29	1.55	1.59	1.65	1.59
40 Kg S ha^{-1}	65.71	65.90	67.35	66.32	1.84	2.13	2.16	2.04
Mean	63.93	63.98	65.44		1.62	1.67	1.75	
SEm (±)				0.20				0.06
CD (p=0.05)				0.45				0.13

Table 7: Effect of sulphur and zinc application on number of primary and secondary branches $plant^{-1}$

Treatments	Number of branches $plant^{-1}$	Number of branches $plant^{-1}$
Sulphur Level	**(30 DAS)**	**(60DAS)**
0 kg S/ha	6.64	6.48
20 kg S/ha	7.40	7.24
40 kg S/ha	8.08	7.88
SEm (±)	0.09	0.20
CD	0.29	0.62
Zinc Level		
0 kg Zn/ha	7.08	6.84
5 kg Zn/ha	7.40	7.24
10kg Zn/ha	7.64	7.53
SEm (±)	0.09	0.20
CD (P=0.05)	0.29	0.62
S×Z	NS	NS

Table 8: Effect of sulphur and zinc application on number of siliquae $plant^{-1}$of rapeseed crop

Treatments	Number of siliquae $plant^{-1}$	Number of siliquae $plant^{-1}$
Sulphur Level	(60 DAS)	At harvest
0 kg S/ha	5.24	236.72
20 kg S/ha	5.44	248.88
40 kg S/ha	5.84	272.26
SEm±	0.03	2.35
CD	0.11	7.05
Zinc Level		
0 kg Zn/ha	5.36	249.66
5 kg Zn/ha	5.42	248.58
10 kg Zn/ha	5.74	259.62
SEm (±)	0.03	2.35
CD	0.11	7.05
S×Z	NS	NS

Table 9: Effect of sulphur and zinc application on rapeseed number of seed $siliquae^{-1}$, test weight and seed yield per plot

Treatments	Length of siliqua/plant	Number of Seed $siliquae^{-1}$	Seed yield $plant^{-1}$(g)	Seed yield/hectare (q)	Stover yield (kg ha^{-1})	Test weight (g)
Sulphur Level						
0 kg S/ha	6.50	16.45	10.55	15.38	35.81	3.15
20 kg S/ha	6.59	17.68	12.64	16.52	37.84	3.16
40 kg S/ha	7.77	18.58	15.57	18.77	39.84	3.27
SEm (±)	1.74	0.07	0.05	0.05	0.09	0.04
CD	NS	0.21	0.16	0.16	0.28	0.14
Zinc Level						
0 kg Zn/ha	6.90	17.35	12.32	16.68	37.49	3.13
5 kg Zn/ha	6.95	17.56	12.82	16.86	37.63	3.25
10kgZn/ha	7.01	17.81	13.63	17.13	38.36	3.20
SEm (±)	1.74	0.07	0.05	0.05	0.09	0.04
CD (P=0.05)	NS	0.21	0.16	0.16	0.28	0.14
S×Z		S	S	NS	NS	NS

5. Conclusions

It is concluded that the sulphur (40 Kg S/ha) and zinc @ 10 Kg Zn/ha fertilization in the rapeseed significantly improved growth parameter *viz* plant height, Plant dry weight (g), Number of leaves $plant^{-1}$, Leaf area index, Number of branches $plant^{-1}$ and yield attribute *viz.* number of siliquae $plant^{-1}$, Test weight (g), Number of seed $siliquae^{-1}$and yield the crop response and yield and straw.

6. References

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