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INFLUENCE OF SULPHUR ON MORPHO-PHYSIOLOGICAL AND YIELD PARAMETERS OF RAPESEED (*Brassica campestris* L.)

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Abstract

Field experiments were conducted at the Central Research Station of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the period from November to February in 2004-05 and 2005-06 to evaluate the effect of different levels of sulphur (0, 20, 40, 60, and 80 kg/ha) on rapeseed variety BARI Sarisha-15. Results showed that the most of the growth parameters and yield attributes were significantly influenced by different doses of sulphur. The growth parameters, yield and yield contributing characters were increased with the increasing levels of sulphur fertilizer up to 60 kg S/ha and with the doses beyond that were found to decrease. All growth parameters like plant height, leaf area, dry matter accumulation, leaf area index, crop growth rate, net assimilation rate, and relative growth rate and all yield components, such as number of siliquae per plant, seeds per siliqua, 1000-seed weight and seed yield per plant were found maximum from the treatment with 60 kg S/ha, which was at par with 80 kg S/ha. The highest seed yield (1990 and 1896 kg/ha) were found when S was used @ 60 kg/ha. The same treatment gave 24.71 % and 24.32 % higher seed yield than the control treatment, which were statistically identical with dose at 80 kg /ha of sulphur in both the years.

Keywords: Rapeseed, sulphur, morpho- physiological parameters, and yield parameters.

Introduction

Mustard/rapeseed is an important oilseed crop of Bangladesh and its oil is mainly used as edible oil. In Bangladesh, *campestris* is mainly cultivated and another species *B. juncea* is also cultivated for edible oil (Kaul and Das, 1986). Edible oil plays a very important role in human nutrition. As a high-energy component of food, edible oils are important for meeting the calorie requirements. Bangladesh has been facing acute shortage of edible oil for the last several decades. Our internal production can meet only about 21% of our consumption. The rest 79 % is met from the import. To meet up the growing demand of oilseed, it is urgent to ensure its higher production. It is almost impossible to increase production by

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increasing area because of crop competitions. Therefore, production per unit area can be increased by adopting improved technology and inputs. Mustard is responsive to sulphur in comparison to other crops. Sulphur is essential for the growth and development of all crops. Oleiferous *Brassica* crops in general have high sulphur requirement owing to higher seed and oil yield (Aulakh *et al.,* 1980; Sing and Shahu, 1986).

Sulphur is the key component of balanced nutrient application for higher yields and superior quality produce. In general, about 97% soils of Bangladesh are deficient in sulphur and this deficiency is becoming acute day by day due to extensive use of sulphur free fertilizers and intensive crop production**.** So to increase total production, increased yield per unit area of land is a must in Bangladesh. This increase can be achieved by using improved varieties and adopting improved management practices in the field level (Mondal and Wahhab, 2001). However, no data are available about the effect of sulphur on the physiological aspects of rapeseed as well as biological and economic yields. Therefore, there is a good scope to work on the morphological and yield aspects of rapeseed, especially with sulphur fertilizer.

Materials and Method

The field experiments were conducted at the Central Research Station of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the period from November 2004 to February 2006.The experimental field was a piece of well drained high land with moderately even topography. The area belongs to Madhupur tract (AEZ,28), clay loam in texture, having low organic matter, moderately slow permeability, and deficient in nitrogen, phosphorus, potassium, and sulphur in comparison with the standard nutrient status. The soil is acidic in nature with p^H ranging from 5.9 to 6.1. The sulphur levels of the experimental site were 8.00 ppm and 9.00ppm, which were quite below the critical level for mustard crop (Table 1).

Table 1. Initial soil properties of the experimental field of Bangladesh agricultural Research Institute, Joydebpur, Gazipur.

Properties	2004-05	2005-06	Critical level
K (µg/ml)	0.16	0.12	0.20
NH_4–N (µg/ml)	0.25	0.45	75.00
P ,,	13.00	12.00	14.00
S ,,	8.00	9.00	14.00

The experiments were laid out in a randomized complete block design (factorial) with three replications having plant distances 30 cm and 5 cm respectively. Plot size was 2.4 m x 3.0 m. Among the different varieties of rapeseed/mustard, a newly developed high yielding variety (BARI Sharisa-15)

was selected for the study. Recommended doses of N, P, K, Zn, and B fertilizers except sulphur, intercultural operations were applied and plant protection measures were done accordingly (Mondal and Wahhab, 2001). Sulphur was applied at the rate of 0, 20,40, 60, and 80 kg/ha in the form of gypsum as basal dose.

Data were collected on growth parameters i.e., plant height, leaf area, dry matter accumulation at different growth stages starting from 18 days after emergence at 10 days interval upto 78 days. Leaf area index, crop growth rate, net assimilation rate, and relative growth rate were calculated. Data were also collected on yield parameters i.e., number of siliquae/plant, siliqua length, seeds/siliqua, 1000-seed weight, seed yield/plant, seed yield per hectare, and stover yield per hectare after harveste. collected data were statistically analyzed and treatment means were compared by least significant difference test (Steel and Torrie, 1960).

Results and Discussion

Effect of sulphur on morphological parameters

Sulphur application induced significant increase in the physiological parameters and seed yield (Tables 2, 3, 4, and 5). The S_3 (60 kg S/ha) treatment produced the tallest plant (104.5 cm and 102.8 cm) in both years, while it was statistically at par with S_4 treatment (80 kg /ha) in first year and significantly different from other treatments in second year (Table 2). Sulphur generally tends to increase plant height. It enhances cell division, elongation, and expansion, but the application of sulphur beyond 60 kg/ha did not influence plant height. This result agrees well with those of Nepalia (2005); Singh and Meena (2004) on mustard.

Table 2. Effect of sulphur fertilization on physiological parameters of rapeseed var. BARI Sarisha-15.

Treatment	Plant height (78 DAE)		Leaf number per plant (58 DAE)		Leaf area index (LAI) (58 DAE)		Dry matter per plant (68 DAE)	
	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year
S_0	97.6	95.5	17.1	17.6	1.56	1.66	9.43	10.25
S_1	99.4	97.7	17.4	17.8	1.59	1.69	9.83	10.91
S_2	102.7	100.1	19.0	19.5	1.85	1.90	10.92	12.35
S_3	104.5	102.8	20.6	21.3	2.13	2.21	12.65	14.69
S_4	103.1	99.9	19.3 b	19.7	2.01	1.98	11.36	12.92
CV (%)	2.18	2.02	7.63	9.85	7.56	9.83	3.96	5.2
LSD (.05)	1.48	1.33	0.95	1.26	0.12	0.12	0.29	0.261

S_0 = 0 kg/ha, S_1 = 20 kg/ha, S_2 = 40 kg/ha, S_3 = 60 kg/ha , S_4 = 80 kg/ha

Table 3. Effect of sulphur fertilization on physiological parameters and seed yield of rapeseed var. BARI Sarisha-15.

Treatment	Crop growth rate (CGR) ($g/m^2/day$)		Net assimilation rate (NAR) ($g/m^2/day$)	
	Ist year (48-58 DAE)	2^{nd} year (48-58 DAE)	Ist year (38-48 DAE)	2^{nd} year (38-48 DAE)
S_0	18.60	18.91	13.60	16.59
S_1	18.92	19.81	13.83	16.71
S_2	20.09	20.12	14.29	16.73
S_3	20.34	22.24	15.40	17.40
S_4	17.64	20.51	14.61	16.55
CV (%)	6.09	8.59	6.21	3.99
LSD (.05)	1.54	1.17	0.59	0.45

S_0 = 0 kg/ha, S_1 = 20 kg/ha, S_2 = 40 kg/ha, S_3 = 60 kg/ha , S_4 = 80 kg/ha

Number of leaves per plant and leaf area index tended to increase with the application of sulphur up to 60 kg /ha (S_3) at 58 DAE. Further increase in sulphur rate tended to depress number of leaves per plant possibly due to sulphur becoming unavailable to plants or might have created the toxic effect on mustard. This result is agreement with of those of Mohan and Sharma (1992). Nasreen *et al*., 2003 reported that number of leaves of sunflower plant tended to increase with the application of sulphur up to 60 kg/ha and then declined. Sulphur at S_3 (60 kg/ha) also enhanced LAI over other treatments. The positive effect of sulphur on LAI has also been reported in opium poppy (Intodia and Sahu, 2005); in rice (Ali *et al.*, 2004); in summar green (Kumawat *et al.*, 2005). Besides, the treatment S_3 (60 kg S/ha) showed 25.4% and 30.2% more dry weight per plant over those of the control at 68 DAE in both the years (Table 2). Increase in total drymatter production at this growth phase was possibly due to increase in photosynthetic rate. The result confirms the findings of Singh and Singh (1984). Similar result was observed by Ali *et al.* (1995) in mustard. Dry matter production in mustard at Sulphur @ 60 kg/ha was also reported by Singh and Meena (2004). The highest crop growth rate CGR (20.34 and 22.24) were obtained with the treatment S_3 (60 S kg/ha) at 48-58 DAE, which was followed by S_2 (40 kg/ha) in both the years (Table 3). Net assimilation rate (NAR) varied significantly among the treatments. Among the sulphur treatments, the S_3 (60 kg/ha) treatment showed the highest NAR (15.40 and 17.40) at 38-48 DAE in both the years (Table 3). The gradual decrease of NAR with plant's age was also observed in jute (Begum, 1998). Maity *et al.* (2003) observed an increase of NAR in groundnut and sunflower with the sulphur treatments up to 30 kg /ha.

Effects of sulphur on yield contributing parameters

Number of branches per plant significantly varied among the S fertilization treatments. Maximum number of branches per plant (5.9 and 5.9) was observed from the treatment S_2 (40 kg S/ha) in first year and treatment S_3 (60 kg/ha) treatment in second year (Table 4). 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). Maximum number of siliquae per plant (96.7 and 95.9) was observed at 60 kg /ha of sulphur (S_3) and the lowest number (60.5 and 59.7) was recorded from the control treatment in both the years (Table 4). The siliqua per plant of mustard significantly increased up to 50 kg/ha which was reported by Kumar *et al*., 2002.

The S fertilization at 80 kg/ha produced the highest number of seeds per siliqua (18.6), which was also at par with S_3 (60kg S/ha) and S_2 (40 kg S/ha) in this respect. Increased number of seeds per siliqua in mustard was reported by Rana and Rana (2003). Similar results were also reported by Singh *et al*. (2002). The S_3 (60 kg S/ha) showed the highest seed yield per plant (18.91 g and 18.73 g). The S_3 showed 40.19% and 40.79 % higher seed yield than the control in both the years (Table 5). Sulphur application significantly increased 1000-seed weight over S_0 level. Among S treatments, the highest 1000- seed weight (3.35 g and 3.37g) were shown by S_3 (60 kg S/ha), which was at par with S_4 (80 kg S/ha) and were 7.16 % and 5.64 % higher than that of control in both the years (Table 5). The improved nutritional environment as a result of increased S supply might have favourably influenced the carbohydrate metabolism. This favourable effect led to increased translocation of photosynthates towards seeds resulting in formation of bold seeds. Rathore and Manohar (1989) also reported similar results.

The seed yield/ha significantly increased with increasing level of S up to 60 kg /ha and thereafter declined in both the years. Among S treatments, the highest seed yield/ha (1990 kg/ha and 1826 kg/ha) were shown by S_3(60 kg S/ha) in both the years, which was at par with S_4(80 kg S/ha and S_2 40 kg S/ha) and 24.32 % 21.46 % higher than that of control (Table 5). Among S treatments, the highest stover yield (4666 kg and 4281 kg /ha) was shown at S_3 (60 kg/ha) in the both the years, which was 26.83 % and 27.98 % higher than that of control. (Table 5).

Yield capacity of mustard is the function of the number of plants per unit area, number of seeds/siliqua, seed yield/plant, and 1000-seed weight. The highest seed yield with the application of sulphur might be due to increased formation of reproductive structure for sink strength and increased production of assimilates to fill the economically important sink. Application of sulphur through gypsum significantly increased the seed yield in mustard as reported by Dubey *et al*. (1993).

From the results of the experiments, it can be concluded that application of sulphur fertilizer to rapeseed var. BARI Sarisha-15, the stimulated growth of plants which had significant effects on plant height, leaf area index, crop growth rate, and net assimilation rate. Most of the growth parameters, yield, and yield contributing characters were increased with the increasing levels of sulphur fertilizer up to 60 kg S/ha and with the doses beyond that were found to decrease the parameters .So, it may be concluded that 60 kg S/ha may be used for increasing physiological parameters and seed yield of the rapeseed variety BARI Sarisha- 15.

Table 4. Effect of sulphur fertilization on yield parameters of rapeseed var. ARI Sarisha- 15.

Treatment	Number of branches per plant (At harvest)		Number of siliqua per plant		Siliqua length (cm)		Number of seeds/ siliqua	
	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year
S_0	3.7	3.6	60.5	59.7	4.1	4.1	17.1	16.9
S_1	4.1	4.1	68.2	66.4	4.4	4.3	17.4	17.1
S_2	**5.9**	5.1	85.9	85.1	4.7	4.6	**18.7**	**18.4**
S_3	5.5	**5.9**	**96.7**	**95.9**	**5.5**	**5.3**	**18.6**	**18.2**
S_4	5.2	5.4	90.7	90.0	4.9	4.8	**18.4**	**18.6**
CV (%)	7.54	5.83	4.69	3.23	6.29	7.4	5.2	4.5
LSD (.05)	0.25	0.19	2.52	1.71	0.18	0.25	0.83	0.55

S_0 = 0 kg/ha, S_1 = 20 kg/ha, S_2 = 40 kg/ha, S_3 = 60 kg/ha , S_4 = 80 kg/ha

Table 5. Effect of sulphur fertilization on yield parameters and seed yield of rapeseed var. BARI sarisha-15.

Treatment	Seed yield per plant (g)		1000-seed wt (g)		Seed yield/ hectare (kg)		Stover yield (kg)	
	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year	Ist year	2nd year
S_0	11.31	11.09	3.11	3.18	1506	1434	3414	3083
S_1	12.11	12.02	3.19	3.25	1624	1464	3658	3457
S_2	14.49	14.34	3.26	3.31	**1867**	1686	4294	4025
S_3	**18.91**	**18.73**	**3.35**	**3.37**	**1990**	**1826**	**4666**	**4281**
S_4	17.61	17.43	**3.34**	**3.34**	**1940**	**1806**	4390	4141
CV (%)	6.29	7.36	3.1	5.28	4.6	4.52	3.73	4.31
LSD (.05)	0.62	0.72	0.08	0.12	54.83	49.55	101.71	109.13

S_0 = 0 kg/ha, S_1 = 20 kg/ha, S_2 = 40 kg/ha, S_3 = 60 kg/ha , S_4 = 80 kg/ha

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