Effect of Nitrogen and Sulfur on the Growth and Yield of Sesame

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Abstract

An experiment was conducted in the field of Sher-e-Bangla Agricultural University farm, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from February to May, 2009 to determine the effect of nitrogen and sulfur on growth and yield of sesame. The experiment consisted of two factors. 4 levels of nitrogen N_0: 0 kg N ha^{-1} (control); N_1: 40 kg N ha^{-1}; N_2: 60 kg N ha^{-1} and N_3: 100 kg N ha^{-1}; and 4 levels of sulfur S_0: 0 kg S ha^{-1} (control); S_1: 20 kg S ha^{-1}; S_2: 40 kg S ha^{-1} and S_3: 60 kg S ha^{-1}. Plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$, seed yield, Stover yield were increased significantly with increasing N level upto 60 kg N ha^{-1} (N_2) . On the other hand, plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and seed yield were increased significantly with increasing S level upto 40 kg S ha^{-1} (S_2) whereas Stover yield was increased upto 60 kg S ha^{-1}. Interaction effects of nitrogen(60 kg P ha^{-1}) and sulphur (40 kg S ha^{-1}) gave the highest number of capsules $plant^{-1}$ (70.40), length of capsule(3.99cm) , diameter of capsule(2.77cm), seeds $capsule^{-1}$(50.63) and thousand seed weight(12.25g). The combined application of 60 kg nitrogen and 40 kg Sulphur may be considered to be optimum for getting higher yield of sesame.

1. Introduction

Sesame (*Sesamum indicum* L.) belongs to the family Pedaliaceae is one of the important oil crops and widely grown in different parts of the world. In Bangladesh it is locally known as til and is the second important edible oil crop (Mondal et al., 1997). It is grown for seed and oil, both for human consumption and has been grown for thousands of years and today its major production areas are the tropics and the subtropics of Asia, Africa, East and Central America. Sesame is a versatile crop having diversified usage and contains 42-45% oil, 20% protein and 14-20% carbohydrate (BARI, 2004). Sesame oil is generally used mostly for edible purpose in confectionaries and for illumination. It is also used for some other purposes, such as in manufacture of margarine, soap, paint, perfumery products and drugs and as dispersing agent for different kinds of insecticide. Sesameolin, a constituent of the oil, is used for its synergistic effect in pyrethrumj, which increases the toxicity of insecticides (Chaubey et al., 2003). The sesame oilcake is a very good cattle feed since it contains protein of high biological value and appreciable quantities of phosphorus and potassium. The cake is also used as manure (Malik et al., 2003). Sesame seed may be eaten fried mixed with sugar or in the form of sweetmeats. The use of the seeds for decoration on the surface of breads and cookies is most familiar to the Americans.

The climate and edaphic conditions of Bangladesh are quite suitable for sesame cultivation. Yield and quality seeds of sesame are very low in Bangladesh. The low yield of sesame in Bangladesh however is not an indication of low yielding potentially of this crop, but of the fact that the low yield may be attributed to a number of reasons viz. unavailability of quality seeds of high yielding varieties, fertilizer management, disease and insect infestation and improper irrigation facilities. Deficiency of soil nutrient is now considered as one of the major constraints to successful upland crop production in Bangladesh (Islam and Noor, 1982). Generally, a large amount of fertilizer is required for the growth and development of vegetable crops (Opena et al., 1988).Nitrogen plays a vital role as a constituent of protein, nucleic acid and chlorophyll. It is also the most difficult element to manage in a fertilization system such that an adequate, but not excessive amount of nitrogen is available during the entire growing season (Anonymous, 1972). An adequate supply of nitrogen is essential for vegetative growth and desirable yield (Yoshizawa et al., 1981). On the other hand excessive application of nitrogen is not only uneconomical, but it can prolong the growing period and delay crop maturity. Excessive nitrogen application causes physiological disorder (Obreza and Vavrina, 1993). Sulfur plays a remarkable role in protein metabolism. It is required for the synthesis of proteins, vitamins and chlorophyl and also S containing amino acids such as cystine, cysteine and methionine which are essential components of proteins (Tisdale et al., 1999). Lack of S causes retardation of terminal growth and root development. S deficiency induces chlorosis in young leaves and decrease seed yield by 45% (BARI, 2004). The objective of this experiment was to study the effect of Nitrogen and Sulphur on the growth and yield of sesame.

2. Materials and Methods

An experiment was conducted in the field of Sher-e-Bangla Agricultural University farm, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from February to May, 2009. The characteristics of initial surface soil (0-15) were: pH 6.47, textural class silty clay loam, organic arbon 0.98%, total N 0.078%, Phosphorous 20.14 ppm and Sulfur 10.87 ppm. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The size of the plot was 2.5 m × 2.0 m. The experiment consisted of 2 factors viz. 4 levels of Nitrogen N_0: 0 kg N ha^{-1} (control); N_1: 40 kg N ha^{-1}; N_2: 60 kg N ha^{-1} and N_3: 100 kg N ha^{-1}; and 4 levels of sulfur S_0: 0 kg S ha^{-1} (control); S_1: 20 kg S ha^{-1}; S_2: 40 kg S ha^{-1} and S_3: 60 kg S ha^{-1}. BARI Til-3 variety of sesame was used as a test crop in this experiment. Recommended doses of P, K, Zn and B (150 kg N ha^{-1} from TSP, 50 kg K ha^{-1} from MP, 5 kg Zn ha^{-1} from ZnO and 1 kg B $ha^{-1}$from Boric acid, respectively) were applied. Sesame seeds were sown on the 17th February 2009. Intercultural operations were applied when necessary. The crop was hervested on 30th May, 2009. The harvested crop of each individual plots were recorded plot wise the yields were expressed in t ha^{-1}. Data collections were done on Plant height (cm), Number of branches $plant^{-1}$, Number of leaves $plant^{-1}$, Days to 1st flowering, Number of capsule $plant^{-1}$, Length of capsule(cm) , Diameter of capsule(MM), Seeds $capsule^{-1}$, Thousand seed weight (g), Seed yield $hectare^{-1}$, Stover yield $hectare^{-1}$. The data were analyzed statistically to find out the treatment difference and the mean differences were compared by DMRT (Gomez and Gomez 1984).

3. Results and Discussion

3.1. Plant height

The tallest plant was observed from N_2 (60 kg N ha^{-1}), while the shortest plant was recorded from N_0 (control) (Table 1 & 2). Fayed et al. (2000) and Pathak et al. (2002) also reported similar findings. Plant height of sesame varied significantly due to sulfur application. The tallest plant was recorded from S_3 (60 kg S ha^{-1}) which was statistically identical with S_2 (40 kg S ha^{-1}) and the shortest plant was obtained from S_0 (control). The tallest plant was observed from N_2S_3 (60 kg N ha^{-1} and 60 kg S ha^{-1}) and the shortest plant was recorded from N_0S_0 (control).

3.2. Number of branches $plant^{-1}$

The maximum number of branches $plant^{-1}$ was recorded from N_2 (60 kg N ha^{-1}) which was followed by N_3 (100 kg N ha^{-1}), again the minimum number was found from N_0 (control). The maximum number of branches $plant^{-1}$ was recorded from S_3 (60 kg S ha^{-1}) which was followed by S_2 (40 kg S ha^{-1}), while the minimum number was observed from S_0 (control). Mitra and Pal (1999) also reported similar findings.

Interaction effects of nitrogen and sulfur were only statistically significant in terms of number of branches $plant^{-1}$. The maximum number of branches $plant^{-1}$ was found from N_2S_3 (60 kg N ha^{-1} and 60 kg S ha^{-1}), whereas the minimum number was recorded from N_0S_0 (control)

3.3. Number of leaves $plant^{-1}$

Significant differences were recorded for nitrogen on number of leaves $plant^{-1}$ of sesame. The maximum number of leaves $plant^{-1}$ was obtained from N_2 (60 kg N ha^{-1}) which was followed by N_3 (100 kg N ha^{-1}) and the minimum number was recorded from N_0 (control). Pathak et al. (2002) also reported similar findings.

Number of leaves $plant^{-1}$ of sesame varied significantly due to the application of sulfur (Table 1 & 2).The maximum number of leaves $plant^{-1}$ was observed from S_3 (60 kg S ha^{-1}) which was followed by S_2 (40 kg S ha^{-1}), again the minimum number was obtained from S_0 (control). Significant variation was recorded for the interaction effect of nitrogen and sulfur in terms of number of leaves $plant^{-1}$. The maximum number of leaves $plant^{-1}$ was found from N_2S_3 (60 kg N ha^{-1} and 60 kg S ha^{-1}), whereas the minimum number was recorded from N_0S_0.

3.4. Days to 1st flowering:

Days for 1st flowering of sesame showed statistically significant variation for nitrogen (Figure 1). The lowest days for 1st flowering (50.83) was obtained from N_2 (60 kg N ha^{-1}) which was followed by 51.75 obtained from N_1 (40 kg N ha^{-1}) and N_3 (100 kg N ha^{-1}) but the highest days (53.67) was observed from N_0 (control).

Different sulfur doses caused a significant variation in the days for 1st flowering of sesame (Figure 1). The lowest days for 1st flowering (50.25) was found from S_2 (40 kg S ha^{-1}) which was followed by 51.83 found from S_3 (60 kg S ha^{-1}), while the highest (53.92) from S_0. Interaction effect of nitrogen and sulfur showed statistically significant difference in terms of days for 1st flowering (Figure 2). The lowest days for 1st flowering (49.00) was recorded from N_2S_2 (60 kg N ha^{-1} and 40 kg S ha^{-1}) and the highest days (55.67) was observed from N_0S_0 (control).

Table 1. Single effect of nitrogen and sulfur on growth and yield parameters

Treatment (s)	Plant height (cm)	Number of branches plant^{-1}	Number of leaves plant^{-1}	Number of capsule plan^{t-1}	Length of capsule (cm)	Diameter of capsule (cm)	Seeds capsule^{-1}	Test weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
Nitrogen										
N_0	72.09^{d}	9.06^{c}	43.52^{c}	48.88^{c}	2.30^{c}	1.31^{d}	38.02^{c}	9.06^{c}	0.91^{d}	2.52^{c}
N_1	91.50^{c}	10.70^{b}	46.34^{b}	58.22^{b}	3.48^{b}	1.77^{c}	45.75^{b}	10.70^{b}	1.05^{c}	2.96^{b}
N_2	112.20^{a}	11.47^{a}	47.58^{a}	64.29^{a}	3.62^{a}	2.58^{a}	47.79^{a}	11.47^{a}	1.31^{a}	3.05^{ab}
N_3	90.94^{b}	10.85^{b}	45.20^{b}	59.69^{b}	3.44^{b}	2.02^{b}	46.09^{b}	10.85^{b}	1.22^{b}	3.11^{a}
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sulfur										
S_0	80.43^{c}	9.40^{c}	40.21^{c}	50.79^{c}	2.80^{c}	1.66^{c}	39.44^{c}	9.40^{c}	0.98^{c}	2.74^{c}
S_1	93.67^{b}	10.64^{b}	46.03^{b}	58.69^{b}	3.30^{b}	1.97^{b}	45.11^{b}	10.64^{b}	1.14^{b}	2.87^{b}
S_2	98.83^{a}	11.22^{a}	47.76^{a}	62.34^{a}	3.44^{a}	2.09^{a}	47.77^{a}	11.22^{a}	1.21^{a}	2.88^{b}
S_3	93.81$_{b}$	10.82^{b}	48.65^{a}	59.26^{b}	3.31^{b}	1.97^{b}	45.34^{b}	10.82^{b}	1.18^{ab}	3.14^{a}
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

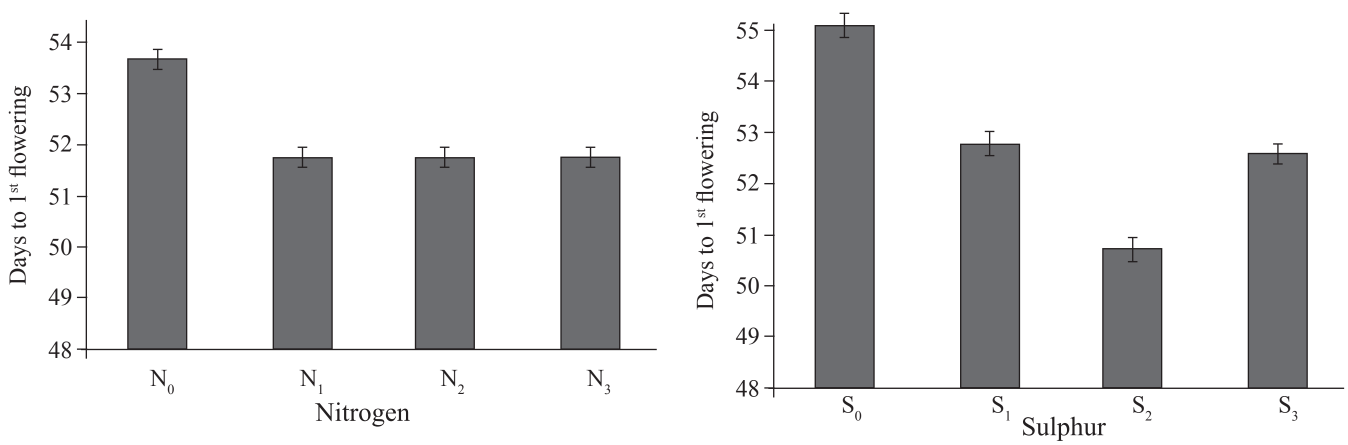

Figure 1: Single effect of nitrogen and sulfur on days to 1st flowering

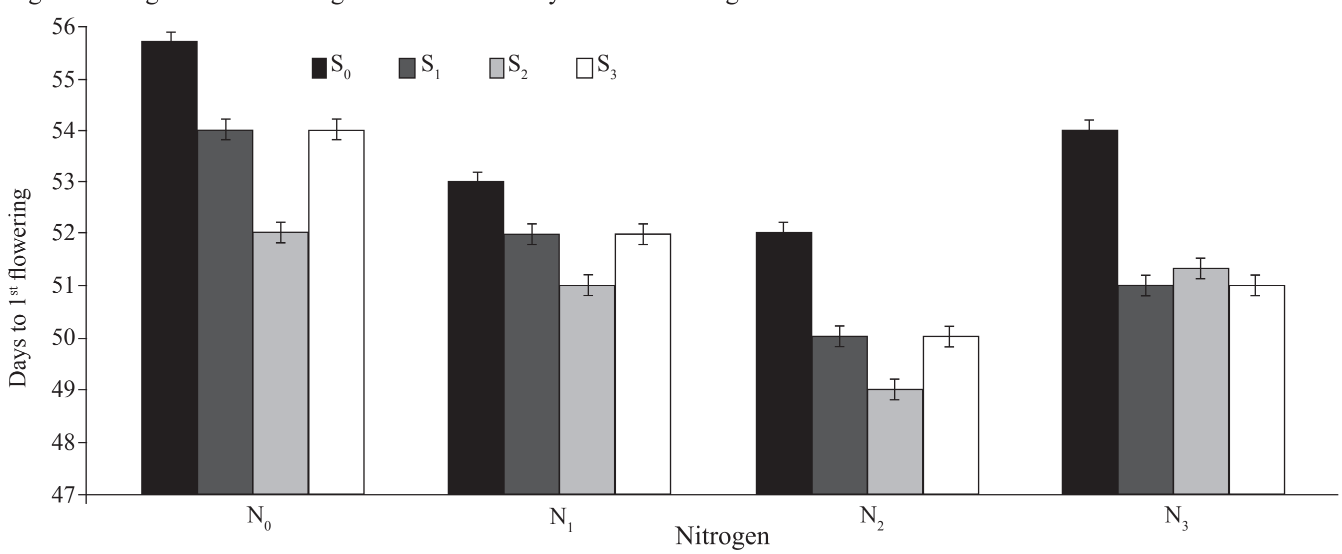

Figure 2: Interaction effect of nitrogen and sulfur on days to 1st flowering

Table 2: Interaction effect of nitrogen and sulfur on growth and yield parameters

Treatment	Plant height (cm)	No. of branches plant^{-1}	No. of leaves plant^{-1}	No. of capsule plant^{-1}	Length of capsule (cm)	Diameter of capsule (cm)	Seeds capsule^{-1}	Test weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
N_0S_0	63.68^{j}	8.41^{g}	39.35^{h}	46.80^{j}	2.11^{g}	1.10^{j}	32.47^{j}	8.41^{g}	0.77^{g}	2.32^{g}
N_0S_1	74.22^{i}	9.18^{f}	46.06^{c-e}	50.04^{h-j}	2.37^{f}	1.37^{i}	38.24^{i}	9.18^{f}	0.95^{ef}	2.50^{fg}
N_0S_2	75.72^{hi}	9.52^{ef}	45.73^{de}	50.08^{h-j}	2.40^{f}	1.41^{hi}	41.62^{fg}	9.52^{ef}	0.98^{ef}	2.59^{ef}
N_0S_3	74.75^{i}	9.11^{f}	47.04^{b-d}	48.62^{ij}	2.34^{f}	1.38^{hi}	39.76^{hi}	9.11^{f}	0.94^{ef}	2.66^{ef}
N_1S_0	80.19^{gh}	9.47^{ef}	40.50^{gh}	50.31^{hi}	3.09^{d}	1.51^{gh}	40.43^{gh}	9.47^{ef}	0.90^{f}	2.75^{de}
N_1S_1	93.16^{f}	10.62^{d}	47.29^{b-d}	57.26^{f}	3.56^{c}	1.82^{f}	46.03^{de}	10.62^{d}	1.07^{de}	3.01^{c}
N^1S^2	98.72^{e}	11.60^{b}	49.13^{a-c}	65.13^{bc}	3.71^{b}	1.93^{ef}	49.77^{ab}	11.60^{b}	1.11^{d}	2.98^{c}
N_1S_3	93.93^{f}	11.11^{c}	48.99^{a-c}	60.19^{ef}	3.57^{c}	1.82^{f}	46.79^{de}	11.11^{c}	1.14^{cd}	3.10^{c}
N_2S_0	103.12^{c}	9.92^{e}	38.61^{h}	53.56^{g}	3.03^{de}	2.39^{bc}	42.78^{f}	9.92^{e}	1.27^{ab}	3.00^{c}
N_2S_1	115.41^{a}	11.72^{b}	47.62^{b-d}	65.90^{bc}	3.72^{b}	2.64^{a}	48.69^{bc}	11.72^{b}	1.29^{ab}	3.00^{c}
N_2S_2	110.70^{b}	11.97^{ab}	49.68^{ab}	70.40^{a}	3.99^{a}	2.77^{a}	50.63^{a}	12.25^{a}	1.40^{a}	2.91^{cd}
N_2S_3	119.58^{a}	12.25^{a}	50.57^{a}	67.29^{b}	3.75^{b}	2.51^{b}	49.07^{a-c}	11.97^{ab}	1.29^{ab}	3.30^{b}
N_3S_0	74.70^{g}	9.78^{e}	42.36^{fg}	52.47^{gh}	2.95^{e}	1.63^{g}	42.07^{fg}	9.78^{e}	0.96^{ef}	2.91^{cd}
N_3S_1	91.88^{de}	11.04^{cd}	43.56^{ef}	61.58^{de}	3.55^{c}	2.04^{de}	47.48^{cd}	11.04^{cd}	1.24^{bc}	2.97^{c}
N_3S_2	101.29^{c}	11.50^{bc}	46.58^{cd}	63.74^{cd}	3.69^{b}	2.27^{c}	49.07^{a-c}	11.50^{bc}	1.35^{ab}	3.05^{c}
N_3S_3	95.88^{d}	11.09^{cd}	48.29^{a-d}	60.96^{de}	3.56^{c}	2.14^{d}	45.75^{e}	11.09^{cd}	1.34^{ab}	3.51^{a}
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.05	0.05

3.5. Number of capsule plant^{-1}

Significant variation was recorded for nitrogen on the number of capsule plant^{-1} of sesame (Table 1 & 2). The number of capsule plant^{-1} increased significantly with increasing N level upto N2, but decreased significantly with further increase of N level. The maximum number of capsule plant^{-1} was 64.29, while the minimum number (48.88) was found from N_0. Number of capsule plant^{-1} of sesame varied significantly for the application of sulfur. The number of capsule plant^{-1}increased significantly with increasing S level upto 40 kg S ha^{-1} but decreased significantly with further increase in S level. The maximum number was 62.34 (S_2) and the minimum number (50.79) was obtained from S_0 (control). Number of capsule plant^{-1} showed significant difference for the interaction between nitrogen and sulfur. The maximum number of capsule plant^{-1} (70.40) was found from N_2S_2 (60 kg N ha^{-1} and 40 kg S ha^{-1}) and the minimum number (46.80) was obtained from N_0S_0 (control).

3.6. Length of capsule

Statistically significant variation was recorded for nitrogen on length of capsule of sesame (Table 1 & 2). The longest length of capsule (3.62 cm) was recorded from N_2 (60 kg N ha^{-1}), whereas the shortest length (2.30 cm) was observed from N_0 (control). However, it was reduced significantly at the highest dose of N. Mitra and Pal (1999) also reported similar findings earlier. Different sulfur doses resulted in a significant variation for length of capsule of sesame. The longest length of capsule (3.44 cm) was found from S_2 (40 kg S ha^{-1}) and the shortest length (2.80 cm) was attained from S_0 (control). However, it was decreased significantly at the highest dose of S. Interaction effect of nitrogen and sulfur varied significantly in terms of length of capsule. The highest length of capsule (3.99 cm) was observed from N_2S_2 (60 kg N ha^{-1} and 40 kg S ha^{-1}), while the shortest length (2.11 cm) was recorded from N_0S_0 (control).

3.7. Diameter of capsule

Diameter of capsule of sesame showed statistically significant variation for nitrogen. The longest diameter of capsule (2.58 mm) was observed from N_2 (60 kg N ha^{-1}) and the shortest diameter (1.31 mm) was recorded from N_0 (control). Statistically significant variation was recorded for different sulfur in terms of diameter of capsule of sesame. The longest diameter of capsule (2.09 mm) was found from S_2 (40 kg S ha^{-1}) and the shortest diameter (1.66 mm) was obtained from S_0 (control). Diameter of capsule showed a statistically significant variation for the interaction effect of nitrogen and sulfur. The highest diameter of capsule (2.77 mm) was obtained from N_2S_2 (60 kg N ha^{-1} and 40 kg S ha^{-1}), while the shortest diameter (1.10 mm) was recorded from N_0S_0 (control).

3.8. Number of seeds capsule^{-1}

Statistically significant variation was recorded for nitrogen on number of seeds capsule^{-1} of sesame (Table 1 & 2). The maximum number of seeds capsule^{-1} (47.79) was obtained from N_2 (60 kg N ha^{-1}), whereas the minimum number (38.02 cm) was found from N_0 (control). However, the highest dose of N reduced the number of seeds capsule^{-1}significantly. Pathak et al. (2002) also reported similar findings. Different sulfur doses caused a significant variation for number of seeds capsule^{-1} of sesame. The maximum number of seeds capsule^{-1} of sesame (47.77) was found from S_2 (40 kg S ha^{-1}) and the minimum number (39.44) was recorded from S_0 (control). But increase of S from S_2 to S_3, reduced the number of seeds capsule^{-1} significantly. Interaction effect of nitrogen and sulfur showed a statistically significant difference in terms of number of seeds capsule^{-1} of sesame. The maximum number of seeds capsule^{-1} of sesame (50.63) was recorded from N_2S_2 (60 kg N ha^{-1} and 40 kg S ha^{-1}), whereas the minimum number (32.47) was recorded from N_0S_0 (control).

3.9. Test weight

Statistically significant variation was recorded for nitrogen for weight of 1000 seeds of sesame. The highest weight of 1000 seeds (11.47 g) was observed from N_2 (60 kg N ha^{-1}) and the lowest weight (9.06 g) was found from N_0 (control). Weight of 1000 seeds of sesame varied significantly for sulfur (Table 3). The highest weight of 1000 seeds (11.22 g) was recorded from S_2 (40 kg S ha^{-1}) and the lowest weight (9.40 g) was obtained from S_0 (control). Significant difference was recorded for the interaction effect of nitrogen and sulfur in terms of weight of 1000 seeds of sesame. The highest weight of 1000 seeds of sesame (12.25 g) was recorded from N_2S_2 (60 kg N ha^{-1} and 40 kg S ha^{-1}) and the lowest weight (8.41 g) was recorded from N_0S_0 (control).

3.10. Seed yield hectare^{-1}

Seed yield hectare^{-1} of sesame showed statistically significant differences for nitrogen (Table 1 & 2). The highest seed yield increased significantly with increasing N doses upto N_2 (60 kg N ha^{-1}). The highest yield obtained from this treatment was 1.31 t ha^{-1} the lowest seed yield (0.91 t ha^{-1}) was observed from N_0 (control). An adequate supply of nitrogen is essential for vegetative growth and desirable yield (Yoshizawa et al., 1981). Abdel et al. (2003) recorded highest seed (6.20 ard/fed) were obtained at 80 kg N fed^{-1}. Sulfur had a significant effect on seed yield ha^{-1} of sesame. The seed yield increased significantly with increasing S doses upto 40 kg ha^{-1}. The highest seed yield was 1.21 t ha^{-1} obtained from S_2, while the lowest seed yield (0.98 t ha^{-1}) was obtained from S_0 (control). Amudha et al. (2005) reported highest yield with the application of 45 kg S ha^{-1}. Interaction effect of nitrogen and sulfur showed statistically significant difference for seed yield hectare^{-1}. The highest seed yield of sesame (1.40 t ha^{-1}) was recorded from N_2S_2 (60 kg N ha^{-1} and 40 kg S ha^{-1}), whereas and the lowest yield (0.77 t ha^{-1}) was recorded from N_0S_0 (control).

3.11. Stover yield ha^{-1}

Significant variation was recorded for stover yield hectare of^{-1} sesame for the application of nitrogen. Stover yield increased significantly with increasing N doses upto N_2 (100 kg N ha^{-1}). The highest stover yield obtained from this treatment was 3.11 t ha^{-1} the lowest yield (2.52 t ha^{-1}) was observed from N_0 (control). An adequate supply of nitrogen is essential for vegetative growth and (Yoshizawa et al., 1981). Sulfur had a significant effect on stover yield ha^{-1} of sesame. The stover yield increased significantly with increasing S doses upto 60 kg ha^{-1}. The highest stover yield was 3.14 t ha^{-1} obtained from S_3, while the lowest yield (2.74 t ha^{-1}) was obtained from S_0 (control). Interaction effect of nitrogen and sulfur showed statistically significant difference for stover yield hectare^{-1}. The highest stover yield of sesame (3.51 t ha^{-1}) was recorded from N_3S_3 (100 kg N ha^{-1} and 60 kg S ha^{-1}), whereas and the lowest (2.32 t ha^{-1}) was recorded from N_0S_0 (control).

4. Conclusion

Different combination of Nitrogen and Sulphur fertilizer exhibited significant variation in respect of growth and yield of sesame plant. The combination of N_2S_2 treatment combination i.e. 60 kg N ha^{-1} and 40 kg S ha^{-1} is optimum for the best growth and yield sesame. In case of some parameters highest values were observed at the highest doses of fertilizers which were statistically similar with the results found at the treatment combination of 60 kg N ha^{-1} and 40 kg S ha^{-1}. It may be concluded that it's wise and economic to use the optimum dose of N and S for maximum yield of sesame.

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