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Effect of zinc on the growth and yield of sesame

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ABSTRACT

The experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during March to June 2014 to examine effect of Zinc on the growth and yield of sesame. BARI Til-3 variety was used for the study. There have been used three levels of zinc viz. (i) Zn_0 (0 % ZnO), (ii) Zn_1 (2.5 % P) and (iii) Zn_2 (5 % P). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Different levels of zinc showed significant effect on growth, yield, and oil content of sesame. The highest plant height (133.70 cm) and days to first flowering (33.33) and days to maturity (33.33) were recorded from Zn_0 (0 %ZnO), but the highest number of leaves plant^{-1} (38.78), number of primary branches/plant (5.72), number of secondary branches plant^{-1} of sesame (8.17), number of capsule plant^{-1} (26.43), number of seeds capsule^{-1} (70.68), 1000 seed weight (3.52), seed yield (1619.00 kg ha^{-1}), Stover yield (3061.11 kg ha^{-1}), biological yield (4679.67 kg ha^{-1}), harvest index (34.44%) and oil content (44.88%) was recorded from Zn_1 (2.5 %ZnO). Again, the lowest plant height (129.30 cm) and days to first flowering (31.33) was achieved from Zn_1 (2.5 %ZnO) but the lowest number of leaves plant^{-1} (29.44), number of primary branches plant^{-1} (4.44), number of secondary branches plant^{-1} (4.17), days to maturity (86.67), number of capsule plant^{-1} (22.49), number of seeds capsule^{-1} (59.23), 1000 seed weight (2.99), seed yield (1239.00 kg ha^{-1}), Stover yield (2658.57 kg ha^{-1}), biological yield (3897.90 kg ha^{-1}), harvest index (31.67%), oil content (39.80%) was recorded from Zn_0 (0 % ZnO).

INTRODUCTION

In Bangladesh, Sesame *(Sesamum indicum* L.) is commonly known as TIL a second most important edible oil crop. This crop is cultivated in about 80 thousand hectare (ha) of land and produces about 49 thousand metric tons (Abdel, 2008).In our country it occupies 34.8 thousand ha of land and produces 31 thousand metric tons with an average yield of this crop is 889 kg ha^{-1} (BBS, 2011). It is used as oil seed and local preparation of weaning food (Abdel, 2008).

Sesame can be grown both in kharif (summer) and rabi (winter) season. Though kharif season the growth, yield and production is comparatively lower. But it could be possible to increase up to 1200 kg ha^{-1} by improved management practices. Left behind these opportunities, in Bangladesh the productivity of sesame is very low (889 kg/ha) in comparison to global level of production (Anonymous, 1996).

Among the oil crops, sesame has the highest oil content of 46-64% (Raja, 2007). Sesame is also known as “seeds of immortality” due to the presence of antioxidants such as sesamin and sesaminol that prevents the biological system from the effect of free radicals. This seed contains good quality poly-unsaturated fatty acids *viz.,* 47% oleic and 39% linoleic acid. Sesame is quality food, nutritious, edible oil, biomedicine and health care all in one. Sesame is one of the world’s ancient spice and oilseed crop. It contains 42-50% oil, 20% protein 5.3% water, 5.2% minerals, 2.9% fiber and 25% carbohydrate per 100g edible portion (Burden, 2005).

Zinc has a great role for increased yield potential. Among the micronutrients, Zn has gained macro importance to meet soil fertility needs to enhance

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productivity. For an optimum plant growth and seed yield, adequate supply of Zn is essential. Agricultural soils with low zinc (Zn) availability are wide spread worldwide. There are estimates that more than 30% of agricultural soils globally are low in available Zn leading to deficiency in crops cultivated on these soils (Alloway 2008). Zinc is an essential micronutrient and plays a key role as a structural constituent or regulatory cofactor of a wide range of different enzymes and proteins in many important biochemical pathways like carbohydrate metabolism, photosynthesis, conversion of sugars to starch, protein metabolism, auxin (growth regulator) metabolism, pollen formation, integrity of biological membranes and resistance to infection by certain pathogens (Alloway 2008).

The amount of trace elements in soil is sometimes so small and barely detectable, but without them plants fail to thrive. Zinc (Zn) is one of the essential trace elements, known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory cofactor of a large number of enzymes (Gupta *et al*. 2006)**.** Zn deficiency causes leaf discoloration called chlorosis, which causes the tissue between the veins to turn yellow while the veins remain green. The extent of variation in seed phytic acid and Zn observed when sesame plants are grown in nutrient cultures with widely varying levels of P and Zn (Havlin, 2005). Kalita (1994) indicated Zn application raise yield components. Bagci (2007) noted that Zn increase oil seed yield. Murthy (2008) stated that application of Zn can be implemented for higher yield and quality.The increase in plant protein is related with increasing soil-Zn concentrations. Murthy (2003) reported Zn deficiency results lower oil content.

As zinc is involved in many physiological functions and its adequate supply may reduce crop yields, affect plant by stunting its growth and inferior quality of harvested products. This research is intends for a measure of effect of zinc on the growth and yield of sesame plant.

Proper combination of ideal variety, balanced nutrition, proper environment and appropriate cultural practices can give higher productivity of a crop. Keeping all the above this fact into deliberation, a field trial in sesame has been conducted consecutively to study the response of different levels of Zn on the growth and yield parameter of sesame.

MATERIALS AND METHODS

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during March to June 2014 to examine effect of Zinc on the growth and yield of Sesame.

The soil of the experimental site belongs to Tejgaon Series under the Agro-Ecological Zone, Madhupur Tract (AEZ -28), which falls into deep red brown terrace soils. Soil samples were collected from the experimental plots to a depth of 0-15 cm from the surface before initiation of the experiment and analyzed in the laboratory.

BARI Til-3 variety of sesame which was developed in 2001 by Bangladesh Agricultural Research Institute (BARI), Gazipur was used as experiment crop. The seeds were collected from BARI, Gazipur. The life cycle of this variety ranges from 90- 100 days. Maximum seed yield is 1.2 to 1.5 t ha^{-1}.

Design and layout of experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Fertilizer treatments consisted of three levels of Zn viz. (i) Zn_0 (0 % ZnO), (ii) Zn_1 (2.5 % ZnO) and (iii) Zn_2 (5 % ZnO) respectively. Fertilizer treatments were randomly distributed in each block. Each block consisted of 9 plots and individual plot was 2m × 1m. The row-to-row and seed to seed distance were 30 and 5 cm respectively. The adjacent block and neighboring plots were separated by 1.0 m and 0.5 m, respectively.

Land preparation to threshing

Different type of organic and chemical fertilizers have used for the experiment as per requirement of the crop variety eg. Cowdung (5 t ha^{-1}), Urea (100 kg ha^{-1}), TSP (35 kg ha^{-1}), MP (50 kg ha^{-1}), ZnO (As per treatment).One third (1/3) of whole amount of Urea and full amount of MP, TSP and Zinc oxide were applied at the time of final land preparation. The remaining Urea was top dressed in two equal installments at 25 days after sowing (DAS) and 45 DAS respectively. Seeds were sown continuously @ 7 kg ha^{-1} by hand as uniform as possible in the 30 cm apart lines. Weeding and thinning were done at 25 DAS and 45 DAS respectively. Irrigation was applied three times at 21 DAS, 35 DAS and 50 DAS respectively. Malathion 50 EC @ 2ml /L water was sprayed to control aphids (*Lipaphis erysimi*) at the time of capsule initiation. The crop was harvested plot wise when 90% capsules were matured at 95 DAS. Then the plants were sun dried by spreading the bundles on the threshing floor and then seeds were separated from the stover by beating the bundles with bamboo sticks. At harvest, seed yield was recorded plot wise and expressed on hectare basis.

Collection of experimental data

Ten (10) plants from each plot were selected randomly for data collection and marked with sample card. The sample plants were uprooted prior to harvest and dried properly in the sun. The seed yield and stover yield per plot were recorded after cleaning and drying those properly in the sun. Harvest index is the ratio of economic yield to biological yield. It was calculated using the following formula:

$$Harvest\ index\ (\%) = \frac{Seed\ yield}{Biological\ yield} \times 100$$

Here, Biological yield = Seed yield + Stover yield

Oil content of seed

One gram sesame seed was taken in a morter. The seeds were completely ground with pastle. Thirty mili liter Filch reagent (Chloroform: methanol = 2: 1) was added to it. After through mixing, the melt was filtered through Whatman No. 42 filter paper and the filtrate taken in a beaker. The filtrate was allowed to stand for about six hours for air drying and then dried in an oven for about half an hour to determine total oil. Proper care was taken so that chloroform and methanol mixture completely had dried out. Oil content was calculated by the following formula:

$$\text{Oil content (\%)} = \frac{Weight\ of\ extract\ (g)}{Sample\ weight\ (g)} \times 100$$

Statistical Analysis

The collected data were statistically analyzed by using the ANOVA technique. The test of significance of all parameters was done. The Duncan`s Multiple Range Test (DMRT) with Least Significant Difference value was determined with appropriate levels of significance and the means were tabulated. The mean comparison was carried out by DMRT technique at 5% level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of zinc on plant growth characters

Plant height of sesame showed statistically significant variation after harvesting at 95 DAS. Different levels of zinc showed significant variation for plant height of sesame. The highest plant height of sesame (133.70 cm) was recorded from Zn_0 (0 % ZnO) where the lowest plant height of sesame (129.30 cm) was recorded from Zn_1 (2.5 % ZnO). Again, Zn_2 (5 % ZnO) gave medium plant height (132.70 cm) compared to highest and lowest plant height among the treatments. The result obtained from the findings of Shehu (2014) was not similar with the present study. They observed that plant height was not significantly influenced by Zn.

Number of leavesof sesame showed statistically significant variation at 60 DAS. Different levels of zinc showed significant variation for number of leaves/plant of sesame. It was found from the results, the highest number of leaves $plant^{-1}$ of sesame (38.78) was recorded from Zn_1 (2.5 %ZnO). The lowest number of leaves $plant^{-1}$ of sesame (29.44 respectively) was recorded from Zn_0 (0 %ZnO) which was statistically same (29.67) with Zn_2 (5 % ZnO). The result obtained from the findings of Shehu (2014) was not similar with the present study. They observed that number of leaves was not significantly influenced by Zn.

Number of primary branchesof Sesame showed statistically significant variation at 30 DAS. Different levels of zinc showed significant variation for number of primary branches plant^{-1}nt of sesame. The highest number of primary branches plant^{-1}of sesame (5.72) was recorded from Zn_1 (2.5 %ZnO) where the lowest number of primary branches plant^{-1}of sesame (4.44) was recorded from Zn_0 (0 %ZnO). The results obtained from Zn_2 (5 %ZnO) gave intermediate results compared to other treatments. The result obtained from the findings of Shehu (2014) was not similar with the present study. They observed that number of branches was not significantly influenced by Zn.

Number of secondary branchesof Sesame showed statistically significant variation at 60 DAS. Different levels of zinc showed significant variation for number of secondary branches plant^{-1}nt of sesame. The highest number of secondary branches plant^{-1} of sesame (8.17) was recorded from Zn_1 (2.5 % ZnO) where the lowest number of secondary branches plant^{-1}of sesame (4.17) was recorded from Zn_0 (0 %ZnO). The results obtained from Zn_2 (5 % ZnO) gave intermediate result compared to other treatments.

Effect of zinc on yield contributing characters

Different levels of zinc showed significant variation for days to first flowering of sesame at 30 DAS (Table 1). Results showed that the highest days to first flowering of sesame (33.33) was recorded from Zn_0 (0 %ZnO) where the second lowest days to first flowering of sesame (31.78) was recorded from Zn_2 (5 %ZnO). The results obtained from Zn_1 (2.5 %ZnO) also showed promising effect on days to first flowering.

Table 1
Effect of zinc on flowering and maturation of sesame.

Treatments	Flowering and maturity of sesame ((BARI TIL-3)	
	Days to first flowering	Days to maturity
Zn_0	33.33 a	86.67 b
Zn_1	31.33 c	88.33 a
Zn_2	31.78 b	88.56 a
$LSD_{0.05}$	0.38	0.27

In a column, same letter indicate non-significant difference and different letter indicate significant difference between them.

Different levels of zinc showed significant variation for days to maturity of sesame 95 DAS. It was observed that the highest days to maturity of sesame (88.56) was recorded from Zn_2 (5 %ZnO) which was statistically same (88.33) with Zn_1 (2.5 %ZnO).Whereas the lowest days to maturity of sesame (86.67) were recorded from Zn_0 (0 % ZnO).

Different levels of zinc showed significant variation for number of capsule plant^{-1} of sesame 95 DAS. Results showed that the highest number of capsule plant^{-1} of sesame (26.43) was recorded from Zn_1 (2.5 % ZnO). The lowest number of capsule plant^{-1} of sesame (22.49) was recorded from Zn_0 (0 %ZnO). The results obtained from Zn_2 (5 % ZnO) gave intermediate result compared to other treatments.

Different levels of zinc showed significant variation for number of seeds capsule^{-1} of sesame at 5 DAS. Results showed that the highest number of seeds capsule^{-1} of sesame (70.68) was recorded from Zn_1 (2.5 %ZnO) where the lowest number of seeds capsule^{-1} of sesame (59.23) was recorded from Zn_0 (0 %ZnO). The results obtained from Zn_2 (5 % ZnO) gave intermediate result compared to other treatments.

Different levels of zinc showed significant variation for 1000 seed weight (g) of sesame. Results indicated that the highest 1000 seed weight of sesame (3.52) was recorded from Zn_1 (2.5 % ZnO) where the lowest 1000 seed wt of sesame (2.99) was recorded from Zn_0 (0 % ZnO). The results obtained from Zn_2 (5 %ZnO) gave intermediate result compared to other treatments.

Effect of zinc on yield

Significantly different results were found with different levels of zinc application for seed yield (kg ha^{-1}) of sesame harvesting time (Table 2). Results pointed out that the highest seed yield of sesame (1619.00 kg ha^{-1}) was recorded from Zn_1 (2.5 % ZnO) where the lowest seed yield of sesame (1239.00 kg ha^{-1}) was recorded from Zn_0 (0 % ZnO). The yield achieved from Zn_2 (5 %ZnO) was medium measured up to highest and lowest results but significantly different from other treatments. Field results revealed that average response of oilseed crops to Zn was 110–360 kg ha^{-1}. This signifies the necessity of Zn application for obtaining higher crop yield in Zn-deficient areas (Suresh, 2013).

Different levels of zinc showed significant variation for Stover yield (kg ha^{-1}) of sesame at harvesting time. The highest Stover yield of sesame (3061.11 kg ha^{-1}) was recorded from Zn_1(2.5 % ZnO). Again, the lowest Stover yield of sesame (2658.57 kg ha^{-1}) was recorded from Zn_0 (0 %ZnO). The result obtained from Zn_2 (5 %ZnO) showed intermediate result compared to highest and lowest Stover yield but significantly different among the treatments.

Different levels of zinc showed significant variation for biological yield (kg ha^{-1}) of sesame at harvesting time. Results indicated that the highest biological yield of sesame (4679.67 kg ha^{-1}) was recorded from Zn_1 (2.5 %ZnO) where the lowest biological yield of sesame (3897.90 kg ha^{-1}) was recorded from Zn_0 (0 %ZnO). Application rate of zinc at 5 % ZnO gave intermediate result in case of biological yield compared to highest and lowest results.

Different levels of zinc showed significant variation for harvest index (%) of sesame. It was observed that he highest harvest index of sesame (34.44 %) was recorded from Zn_1 (2.5 % ZnO) where the lowest harvest index (31.67 %) was recorded from Zn_0 (0 % ZnO). The treatment effect of Zn_2 (5 % ZnO) provided medium harvest index (32.71%) compared to others.

Table 2
Effect of zinc on yield parameters of sesame**.**

Treatments	Yield parameters of sesame (BARI TIL-3)			
	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Zn_0	1239.00 c	2658.57 c	3897.90 c	31.67 c
Zn_1	1619.00 a	3061.11 a	4679.67 a	34.44 a
Zn_2	1448.00 b	2958.23 b	4406.01 b	32.71 b
LSD $_{(0.05)}$	2.89	2.66	2.7	0.28

In a column, same letter indicate non-significant difference and different indicate significant difference between them.

Effect of zinc on oil content (%):

Different levels of zinc showed significant variation for oil content (%) of sesame (Table 3). The highest oil content of sesame (44.88%) was recorded from Zn_1 (2.5 % ZnO). The lowest oil content of sesame (39.80%) was recorded from Zn_0 (0 % ZnO) where as the intermediate result (42.33%) was obtained from Zn_2 (5 % ZnO).

Table 3
Effect of zinc on oil content of sesame.

Treatment	Oil content (%)
Zn0	39.80 c
Zn1	44.88 a
Zn2	42.33 b
LSD (0.05)	0.73

In a column, same letter indicate non-significant difference and different indicate significant difference between them.

CONCLUSION

Zinc showed significant effect on growth, yield and oil content of sesame on this study. Optimum use of zinc can give ideal growth and yield of sesame. Less application of the nutrient can cause yield loss. However, further study may be needed in different Agro Ecological Zones (AEZ) of Bangladesh with different varieties to recommend a package of technology for use at grower's level.

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