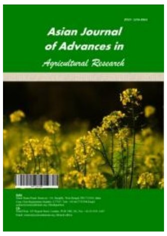

Asian Journal of Advances in Agricultural Research

12(1): 41-47, 2020; Article no.AJAAR.54008
ISSN: 2456-8864

Effect of Zinc and Boron on Growth and Yield of Okra (*Abelmoschus esculentus* L.)

Nusrat Jahan[1], Md. Ashabul Hoque[1], Md. Rasal-Monir[2*], Sumya Fatima[1], Mohammad Nurul Islam[1] and Md. Belal Hossain[3]

[1]*Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.*
[2]*Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.*
[3]*Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAAR/2020/v12i130073
Editor(s):
(1) Dr. Saad Farouk Mohamed Hussiien Gadalla, Professor, Department of Agricultural Botany, Faculty of Agriculture, Mansoura University, Egypt.
Reviewers:
(1) Julian Gonzalez Trinidad, Autonomous University of Zacatecas, Mexico.
(2) Giulia Franzoni, University of Milan, Italy.
Complete Peer review History: http://www.sdiarticle4.com/review-history/54008

Original Research Article

Received 15 November 2019
Accepted 19 January 2020
Published 01 February 2020

ABSTRACT

The study was carried out to find out the effect of zinc (Zn) and boron (B) on growth and yield of okra (BARI Dherosh 1). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The treatments of the experiment were, T_0 (without Zn or B), T_1 (20 kg Zn ha^{-1}), T_2 (30 kg Zn ha^{-1}), T_3 (10 kg B ha^{-1}), T_4 (20 kg B ha^{-1}), T_5 (20 kg Zn ha^{-1} + 10 kg B ha^{-1}), T_6 (20 kg Zn ha^{-1} + 20 kg B ha^{-1}), T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) and T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) were undertaken to evaluate the best results of the study. The highest plant height was found in T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) but the highest number of leaves plant^{-1} was recorded from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}). On the other hand, the maximum leaf area index, SPAD value, mean fruit weight, fruit length, fruit diameter, fruit dry matter (%), number of fruits plant^{-1}, fresh fruit weight plant^{-1} , fruit yield plot^{-1} and fruit yield ha^{-1} were found in T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}), while the control (T_0) showed lowest performance for the respected parameters. It is strongly concluded that 30 kg Zn ha^{-1} with 10 kg B ha^{-1} combination may be helpful for okra cultivation in the field level to increase okra production.

**Corresponding author: Email: monirr718@gmail.com;*

Keywords: Okra; zinc and boron.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is a popular vegetable belongs to the family Malvaceae and locally known as "Dherosh" or "Bhindi" in Bangkasedh. It is also called ladies' fingers in several English speaking countries. Okra is native to West Africa and South Asia [1]. It is an important vegetable crop in Bangladesh that plays an important role to meet the national demand of vegetable of the country more specifically during summer when vegetables are scanty in the market [2]. The young green fruits are generally used as vegetable but sometimes can be dehydrated and canned and marketed. Each 100 g green tender okra fruits contain 1.76 g protein, 8.73 g carbohydrate, 1.1 g fiber, 88 IU Vitamin A, 9.8 mg Vitamin C and 116 mg Ca [3]. Besides, its seed is the good source of protein [4]. Sometimes, dry okra seeds are roasted and used as a substitute for coffee. The fruits also have some medicinal value, the fruit can be used as a plasma replacement or blood volume expander [5] against gastric and inflammatory diseases [6].

The zinc (Zn) and boron (B) in Bangladesh soils was most prevalent which are important in seed formation and seed quality [7]. Furthermore, boron is required for proper development and differentiation of plant tissues. In its absence, abnormal formation and development of fruit occur. Since boron is relatively immobile in plants, the early casualties of boron deficiency occur in the reproductive process of plants, and its inadequacy is often associated with sterility and malformation of reproductive organs [8]. Boron facilitates the transport of carbohydrates through cell membranes. If boron deficiency occurs, the assimilated product accumulates in the leaves and the young growing point lacks sugar. Maximum production of starch and sugar is restricted if crops are inadequately supply with boron [9].

Zinc mainly functions as the metal component of a series of enzymes. The most important enzymes activate by this element are carbonic anhydrase and a number of dehydrogenases. Zinc deficiency is thought to restrict RNA synthesis, which in turn inhibits protein synthesis [8]. Zinc is also involved in auxin production as well as flower and fruit setting. Shoots and buds of zinc deficient plants contain very low auxin, which causes dwarfism and growth reproduction. The net results are stunted plants and prolonged duration of growth. It is also plays an important role in chlorophyll synthesis, cell division, meristematic activity, expansion of cell and formation of cell wall. Zinc application also helps in increasing the uptake of nitrogen and potassium. Zinc is necessary for root cell membrane integrity, and in this function, it prevents excessive potassium uptake by roots and transport of Potassium from roots to leaves [10]. Therefore, boron and zinc play an important role directly and indirectly in improving the yield and quality of okra production. Therefore, the present research was undertaken to evaluate the integrated performance of zinc and boron for growth and yield of okra and therefore determine the optimum doses of Zn and B association on growth and yield of okra.

2. MATERIALS AND METHODS

The experiment was conducted at the department of Agricultural Botany, Sher-e-Bangla Agricultural University in 24º09′N latitude and 90º26′E longitudes. The seeds of okra variety BARI Dherosh was collected from BARI (Bangladesh Agricultural Research Institute), Joydebpur, Gazipur, Bangladesh. The soil was treated with insecticides (cinocarb 3G at 4 kg ha^{-1}) at the time of final land preparation to protect young plants from the attack of soil inhibiting insects such as cutworm and mole cricket. Urea, Triple super phosphate (TSP), Muriate of potash (MoP), $ZnSO_4$ and boric acid were used as source of nitrogen, phosphorous, potassium, Zinc and B respectively. Cow dung (10 t/ha), urea (150 kg/ha), TSP (100 kg/ha), MoP (150 kg/ha) was applied in the soil. The total amount of cow dung, TSP and MP was applied as basal dose at the time of final land preparation. Urea was applied at 15, 30 and 45 days after sowing (DAS). The treatments of the experiment was T_0 (without Zn or B), T_1 (20 kg Zn ha^{-1}), T_2 (30 kg Zn ha^{-1}), T_3 (10 kg B ha^{-1}), T_4 (20 kg B ha^{-1}), T_5 (20 kg Zn ha^{-1} + 10 kg B ha^{-1}), T_6 (20 kg Zn ha^{-1} + 20 kg B ha^{-1}), T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) and T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) that were undertaken to evaluate the role of Zn and/or B on growth and yield

2.1 Design and Layout of the Experiment

The single factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The total area was divided into three equal blocks. Each block was divided into 9 plots where 9 treatments were allotted at randomly. There were 27 unit plots totally in the experiment. The size of the each plot was 3.0 m × 1.5 m. The distance maintained between two blocks and two plots were 0.5 and 0.5 m, respectively. The spacing was at 60 × 50 cm.

2.2 Seeds Sowing

Seeds were treated with Bavistin at 2 ml/L of water before sowing the seeds to control the seed borne diseases. The seeds were sown in rows having a depth of 2-3 cm with maintaining distance from 50 cm and 60 cm from plant to plant and row to row, respectively.

2.3 Intercultural Operation

After raising seedlings, various intercultural operations such as gap filling, weeding, earthling up, irrigation pest and disease control were accomplished for better growth and development of the okra seedlings. Irrigation were given for 7 days starting from germination for their proper establishment. The weeding was done at 15, 30 and 45 days after sowing to keep the plots free from weeds. Cut worms were controlled both mechanically and spraying Darsban 29 EC at 3%. Some discolored and yellowish diseased leaves were also collected from the plant and removed from the field.

2.4 Data Collection

Five plants were randomly selected from the middle rows of each unit plot for avoiding border effect, except yields of plots, which was recorded plot wise. Data were collected in respect of the growth, yield attributes and yields as affected by different treatments of the experiment.

2.5 Statistical Analysis

The data obtained for different parameters were statistically analyzed by using MSTAT-C software to find out the significance of the difference for B and Zn fertilizer on growth and yield of okra. The mean values of all the recorded parameters were evaluated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the means of treatment combinations was estimated by Duncan's Multiple Range Test (DMRT) at 5% level of probability [11].

3. RESULTS AND DISCUSSION

The results obtained from the study have been presented, discussed and compared through different tables and graphs and possible interpretations have been given under the following headings.

3.1 Plant Height (cm)

Significant influence was recorded on plant height of okra at different growth stages as influenced by boron (B) and zinc (Zn) application (Fig. 1). The highest plant height was found from the treatment T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) at all growth stages. At 30 DAS, the highest plant height (33.15 cm) was observed from treatment T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) which was statistically identical with T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) on the other hand, the lowest plant height (28.79 cm) was observed from T_0 (control). Similar trend was also observed at 60 and 90 DAS. At 60 DAS, the highest plant height (95.22 cm) was observed from treatment T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) which was statistically identical with T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) whereas the lowest plant height (58.82 cm) was observed from T_0 (control) treatment. Again, at 90 DAS, the highest plant height (33.15 cm) was observed from treatment T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) which was statistically identical with T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) whereas the lowest plant height (83.45 cm) was observed from T_0 (control) treatment. As a result the highest plant height (53.15, 95.22 and 118.30 cm at 30, 60 and 90 DAS, respectively) was recorded from T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) whereas the lowest plant height (28.9, 58.82 and 83.45 cm at 30, 60 and 90 DAS, respectively) was observed from the treatment T_0 (control).

3.2 Number of Leaves Plant^{-1}

Significant influence was recorded on number of leaves plant^{-1} of okra at different growth stages as influenced by boron (B) and zinc (Zn) application (Fig. 2). The highest number of leaves plant^{-1} was found from the treatment T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) at all growth stages. On the other hand, the lowest number of leaves plant^{-1} was observed from T_0 (control) treatment. From the experiment, a progressive results of number of leaves was observed with increasing the days after sowing.

3.3 Leaf Area Index at 60 DAS

Significant variation was found for leaf area index at 60 DAS as influenced by different Zn and B application (Fig. 3). Results indicated that the highest leaf area index at 60 DAS (298.60) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) followed by T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) whereas the lowest leaf area index at 60 DAS (187.80) was found from T_0 (control).

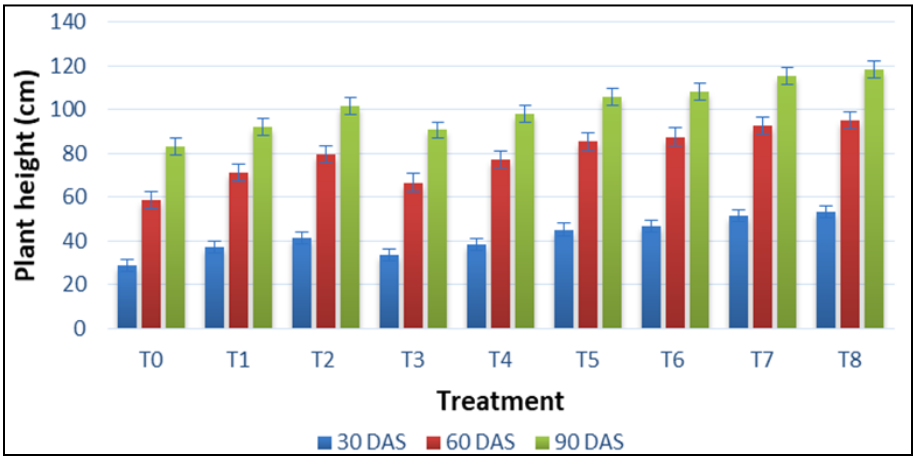

Fig. 1. Plant height of okra as influenced by different levels of Zn and B application

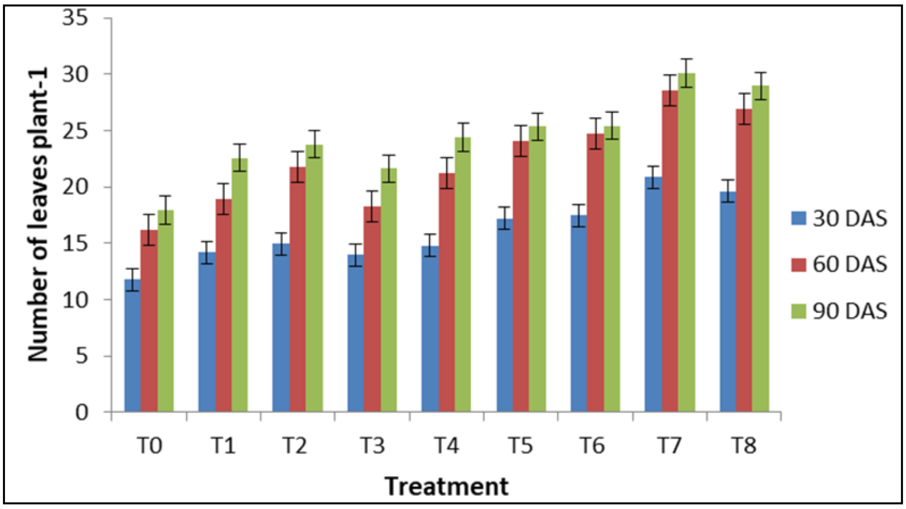

Fig. 2. Number of leaves plant^{-1} of okra as influenced by different levels of Zn and B application

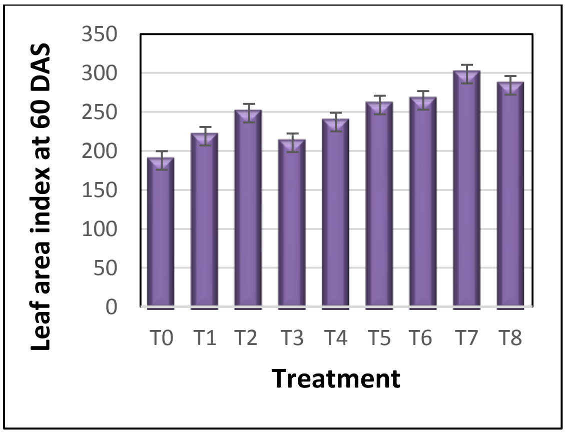

Fig. 3. Leaf area index of okra as influenced by different levels of Zn and B application

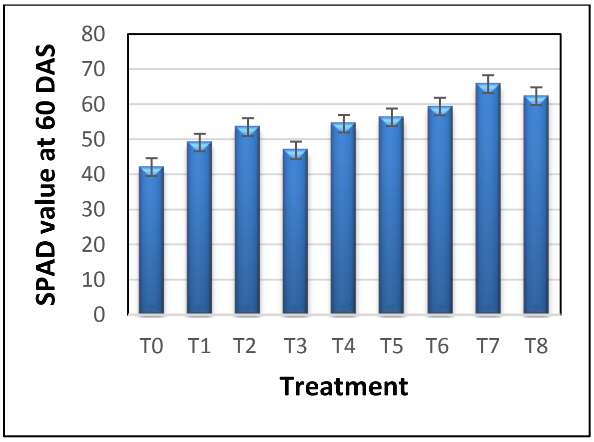

Fig. 4. SPAD value of okra as influenced by different levels of Zn and B application

3.4 SPAD Value at 60 DAS

Significant variation was found for SPAD value at 60 DAS as influenced by different Zn and B application (Fig. 3). Results showed that the highest SPAD value at 60 DAS (65.73) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was statistically similar with T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) whereas the lowest SPAD value at 60 DAS (42.05) was found from T_0 (control).

3.5 Single Fruit Weight (g)

Significant variation was found for single fruit weight as influenced by different Zn and B application (Fig. 5). Results indicated that the highest single fruit weight (14.14 g) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was statistically similar with T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) whereas the lowest single fruit weight (11.90 g) was found from T_0 (control) which was statistically similar with T_3 (10 kg B ha^{-1}).

3.6 Fruit Length (cm)

Significant variation was recorded for fruit length as influenced by different Zn and B application (Table 1). Results indicated that the highest fruit length (15.12 cm) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was statistically identical with T_6 (20 kg Zn ha^{-1} + 20 kg B ha^{-1}) and T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) and statistically similar with T_5 (20 kg Zn ha^{-1} + 10 kg B ha^{-1}) whereas the lowest fruit length (9.20 cm) was found from T_0 (control) which was significantly different from other treatments.

3.7 Fruit Diameter (cm)

Significant variation was found for fruit diameter as influenced by different Zn and B application (Table 1). Results indicated that the highest fruit diameter (1.96 cm) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was significantly different from other treatments followed by T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) the lowest fruit diameter (1.48 cm) was found from T_0 (control) which was significantly different from other treatments.

3.8 Fruit Dry Matter (%)

Significant variation was found for % fruit dry matter as influenced by different Zn and B application (Table 1). Results indicated that the highest % fruit dry matter (9.26) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was statistically similar with T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) whereas the lowest % fruit dry matter (6.85) was found from T_0 (control) which was significantly different from other treatments.

3.9 Number of Fruits Plant^{-1}

Significant variation was found for number of fruits plant^{-1} as influenced by different Zn and B application (Table 1). Results indicated that the highest number of fruits plant^{-1} (36.12) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was statistically identical with T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) the lowest number of fruits plant^{-1} (11.48) was found from T_0 (control) which was statistically similar with T_3 (10 kg B ha^{-1}).

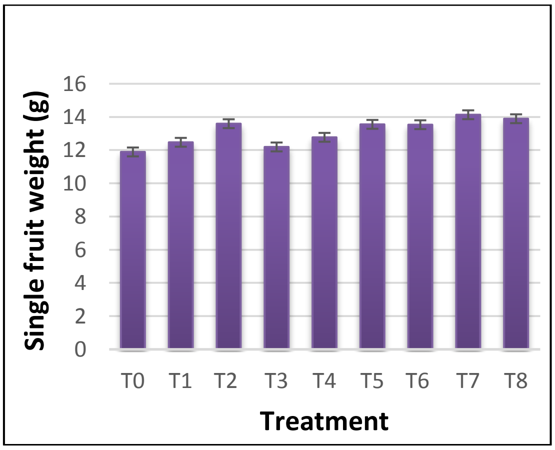

Fig. 5. Single fruit weight of okra as influenced by different levels of Zn and B application

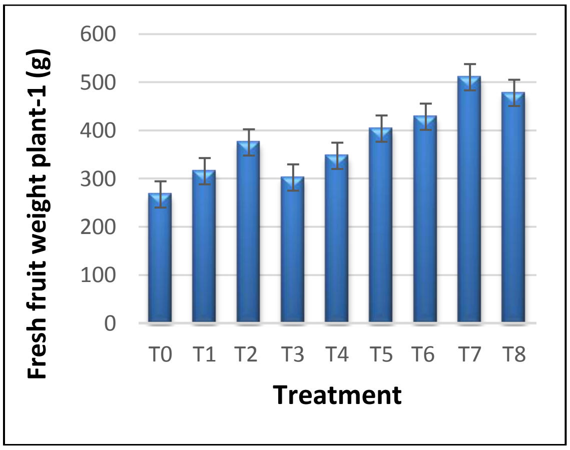

Fig. 6. Fresh fruit weight plant^{-1} of okra as influenced by different levels of Zn and B application

Table 1. Yield contributing parameters of okra as influenced by different levels of Zn and B application

Treatments	Fruit length (cm)	Fruit diameter (cm)	% fruit dry matter	Number of fruits plant^{-1}
T_0	9.20 e	1.48 f	6.85 g	22.48 f
T_1	11.72 cd	1.60 de	7.44 ef	25.30 de
T_2	12.60 bc	1.64 d	8.12 cd	27.60 cd
T_3	10.90 d	1.55 e	7.14 fg	24.80 ef
T_4	12.16 cd	1.60 de	7.72 de	27.20 d
T_5	13.88 ab	1.70 c	8.48 bc	29.80 bc
T_6	14.78 a	1.75 c	8.67 bc	31.66 b
T_7	15.12 a	1.96 a	9.26 a	36.12 a
T_8	14.90 a	1.88 b	8.92 ab	34.40 a
$LSD_{0.05}$	1.494	0.054	0.550	2.393
CV (%)	6.74	8.36	7.24	8.80

In a column, means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% levels of probability

Table 2. Yield parameters of okra as influenced by different levels of Zn and B application

Treatments	Fruit yield plot^{-1} (kg)	Fruit yield ha^{-1} (t)
T_0	4.00 g	8.89 h
T_1	4.69 ef	10.42 fg
T_2	5.63 cd	12.50 de
T_3	4.50 fg	10.00 gh
T_4	5.25 de	11.67 ef
T_5	6.00 bc	13.33 cd
T_6	6.38 b	14.17 c
T_7	7.75 a	17.22 a
T_8	7.12 a	15.83 b
$LSD_{0.05}$	0.6815	1.272
CV(%)	7.91	6.80

In a column, means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% levels of probability

3.10 Fresh Fruit Weight Plant^{-1} (g)

Significant variation was found for fresh fruit weight plant^{-1} as influenced by different Zn and B application (Fig. 6). Results indicated that the highest fresh fruit weight plant^{-1} (510.70 g) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was significantly different from other treatments followed by T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) the lowest fresh fruit weight plant^{-1} (267.50 g) was found from T_0 (control) which was significantly different from other treatments.

3.11 Fruit Yield Plot^{-1} (kg)

Significant variation was found for fruit yield plot^{-1} as influenced by different Zn and B application (Table 2). Results indicated that the highest fruit yield plot^{-1} (7.75 kg) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was statistically identical with T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) the lowest fruit yield plot^{-1} (4.00 kg) was found from T_0 (control) and statistically similar with T_3 (10 kg B ha^{-1}).

3.12 Fruit Yield ha^{-1} (t)

Significant variation was found for fruit yield ha^{-1} as influenced by different Zn and B application (Table 2). Results indicated that the highest fruit yield ha^{-1} (17.22 t ha^{-1}) was found from T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1}) which was significantly different from other treatments followed by T_8 (30 kg Zn ha^{-1} + 20 kg B ha^{-1}) the lowest fruit yield ha^{-1} (8.89 t ha^{-1}) was found from T_0 (control) which was significantly different from other treatments.

4. CONCLUSION

From the above results, it can be concluded that the treatment T_7 (30 kg Zn ha^{-1} + 10 kg B ha^{-1})

gave the best performance on different growth, development and yield of okra and this treatment showed highest yield (17.22 t ha^{-1}). So, this treatment can be considered as best among the whole treatments studied under the present study. It is also recommended for further study in the different agro-ecological zone.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Prakash M, Narayanan GS, Kumar BS. Flyash seed pelleting enhances growth and yield in Bhendi *[Abelmoschus esculentus* (L.) Moench]. Agric. Sci. Digest. 2014;34(1):49-51.
2. Ahmad KU. Phul-phal O Shak-Shabji (in Bangla) Fifth edition. Mrs. Momtaj kamal. Mirpur, Dhaka, Bangladesh. 1995;353.
3. Ishaque M. Nutritive value of fruits and vegetables. A bulletin of horticultural development board. Horticultural Development Board, Dhaka. 1976;5-15.
4. Adelakun OE, Oyelade OJ, Ade-Omowaye BIO, Adeyemi IA, Van-de-Venter M. Chemical composition and the antioxidative properties of Nigerian Okra seed (*Abelmoschus esculentus* Moench) flour. Food Chem. Toxicol. 2009;47(6): 1123-1126.
5. Savello PA, Mortin FW, Hill JM. Nutritional composition of okra seed meal. Agril. Food Chem. 1980;28:1163-1166.
6. Lengsfeld C, Titgemeyer F, Faller G, Hensel A. Glycosylated compounds from okra inhibit adhesion of Helicobacter pylori to human gastric mucosa. J. Agric. Food Chem. 2004;52(6):1495-1503.
7. Begum RABIA, Jahiruddin M, Kader MA, Haque MA, Hoque ABMA. Effects of zinc and boron application on onion and their residual effects on Mungbean. Progress. Agric. 2015;26(2):90-96.
8. Katyal JC, Randhawa NS. Micronutrients. FAO Fertilizer and Plant Nutrition Bulletin. 1983;3-76.
9. Kalloo R. Tomato. Allied Publishers Private Limited, New Delhi, India. 1985;204-211.
10. Welch RM, Webb MJ, Lonegaran JF. Zinc in membrane function and its role in phosphorus toxicity. In: Proc. 9th Int. Plant Nutrition Coll. Commonwealth Agricultural Bureau, A Scarify (ed) nham Royal, England. 1982;710-715.
11. Gomez KA, Gomez AA. Statistical procedure for agricultural research. Second Edn. Intl. Rice Res. Inst., John Wiley and Sons. New York. 1984;1-340.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/54008