Annual Research & Review in Biology

20(6): 1-11, 2017; Article no.ARRB.38172
ISSN: 2347-565X, NLM ID: 101632869

Quality Seed of Onion: Effect of Micro and Macronutrients

Md. Monir Hossain[1], Montasir Ahmed[2*], Md. Ehsanul Haq[3], Md. Shefat-Al-Maruf[4], Md. Nur-e-Nabi[3], Sujan Majumder[4] and Md. Abdul Matin[4]

[1]Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.
[2]Plant Pathology Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh.
[3]Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.
[4]Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Authors' contributions

This work was carried out in collaboration between all authors. Author MMH designed and planned the study and carried out the research. Authors MA and MEH helped in designing and performed the statistical analysis. Authors MMH and MSAM carried out the research on field. Authors MMH, MNN, SM and MAM collected the data. Author MA took the lead in writing the manuscript. Authors MNN, MSAM and MEH managed the literature searches. All authors provided critical feedback and helped in shape the research, analysis and manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARRB/2017/38172
Editor(s):
(1) Jin-Zhi Zhang, Key Laboratory of Horticultural Plant Biology (Ministry of Education), College of Horticulture and Forestry Science, Huazhong Agricultural University, China.
(2) George Perry, Dean and Professor of Biology, University of Texas at San Antonio, USA.
Reviewers:
(1) Jayath P. Kirthisinghe, University of Peradeniya, Sri Lanka.
(2) Fabricio Correia de Oliveira, Federal University of Grande Dourados, Brazil.
Complete Peer review History: http://www.sciencedomain.org/review-history/22239

Original Research Article

Received 15th November 2017
Accepted 4th December 2017
Published 11th December 2017

ABSTRACT

An experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka during *Robi* season for determining the effect of micronutrients (Zn, B, and Mn) with different levels of macronutrients (NPKS fertilizers) on the quality of onion (*Allium cepa* L.) seed. The experiment was conducted with four levels of micronutrients viz. M_1= $Zn_0B_0Mn_0$ kg/ha, M_2= $Zn_4B_1Mn_2$ kg/ha, M_3= $Zn_6B_2Mn_3$ kg/ha and M_4= $Zn_8B_3Mn_4$ kg/ha and three doses of macronutrients viz. F_1= $N_{57}P_{21}K_{39}S_9$ kg/ha, F_2= $N_{114}P_{42}K_{78}S_{18}$ kg/ha and F_3 =$N_{171}P_{63}K_{117}S_{27}$ kg/ha. Application of micronutrients and different doses of macronutrients increased plant height and number of leaves per plant at different growth stages, days required to first bolting, days required to first anthesis, the percentage of seed germination and

**Corresponding author: E-mail: ahmed.montasir@ymail.com;*

seed vigor index. The highest percent germination of seeds (88.89%) and seed vigor index (2084.77) were recorded from M_3 ($Zn_6B_2Mn_3$ kg/ha) treatment and the lowest percent germination of seed (84.44%) and seed vigor index (1724.26) were observed in M_1 ($Zn_0B_0Mn_0$ kg/ha) treatment. The F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) treatment produced the highest percent germination of seed (90.67%) and seed vigor index (2258.20) and F_1 ($N_{57}P_{21}K_{39}S_9$ kg/ha) treatment produced lowest (85.25% and 1721.05 respectively). Among the treatment combinations, M_3F_2 ($Zn_6B_2Mn_3$ kg/ha × $N_{114}P_{42}K_{78}S_{18}$ kg/ha) produced the highest germination of seed (94.00%) and seed vigor index (2537.33) and M_1F_1 ($Zn_0B_0Mn_0$ kg/ha × $N_{57}P_{21}K_{39}S_9$ kg/ha) produced the lowest germination of seed (82.67%) and seed vigor index (1488.66).

Keywords: Onion seed; micronutrients; macronutrients; fertilizers; Taherpuri.

1. INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important commercial spice crops of the world belongs to *Amaryllidaceae* family. The center of origin of this crop is western China and the deserts lying east of the Caspian Sea [1]. The major onion producing countries of the world are China, India, USA, Turkey, Japan, Spain, Brazil, Poland and Egypt [2]. Onion production is highest, regard to production and area, among the spice crops grown in Bangladesh [3]. It is grown in almost all the districts of Bangladesh and its cultivation in commercial scale is found in the greater districts of Faridpur, Pabna, Rajshahi, Jessore, Dhaka, Mymensingh, Comilla and Rangpur [3]. However, seeds are produced by a limited number of farmers in particular areas of Faridpur, Natore and Rajshahi districts [4]. Moreover, seeds available in the market are often very poor in quality in respect of germination, varietal purity, seed viability etc. The scarcity of quality seeds of onion in Bangladesh during growing season is due to lower production of onion seed in a limited area. The possible way to increase the quality of onion seed is through manipulating existing method of cultivation such as planting geometry, fertilization, irrigation and other cultural management practices. According to Mondal and Choudhury [5], the price of onion seed is directly proportional to the price of the onion bulb for growing seed crop.

Many scientists believe that some secondary elements such as zinc, boron, and manganese can play a vital role in increasing the yield and quality of onion seed [6]. Zinc is essential for the plant enzymes formation; besides, Zn activates many enzymatic reactions [7]. Additionally, Zn has an impact on the pollination through pollen tube formation [8,9]. Zinc has an influence on basic plant life processes, such as nitrogen metabolism and uptake of nitrogen and protein quality; photosynthesis and chlorophyll synthesis, carbon anhydrase activity; resistance to abiotic and biotic stresses and protection against oxidative damage [10,11,12]. Boron is crucial for cell division, nitrogen and carbohydrate metabolism, salt absorption and water relation in the plant, translocation of sugars, starches, nitrogen and phosphorus and synthesis of amino acids and proteins [13]. Research shows that boron had significant effects on germination percentage and quality of onion seed [14,15]. Manganese (Mn) is important for nitrogen metabolism and photosynthesis [16]. Maturity delayed because of the Mn deficiency [17]. Seed with 0.1% $MnSO_4$ solution increased germination by 36% and field emergence by 27% over untreated control [18]. Nitrogen (N) application helps to uptake of nutrient elements from soil [19]. Phosphorus (P) is an essential factor for nucleic acid and phospholipids formation, enzyme activation and production of ADP and ATP [20]. Potassium (K) helps to increase the nitrogen uptake [6,21]. Sulphur fertilizer increases the pungency of onion [22]. At last, there is a possibility to have positive effects of micronutrients and macronutrients on seed quality of onion. Considering the above circumstances, the present experiment was designed for determining the appropriate micronutrients and macronutrients doses and to investigate the combined effect of micronutrients and macronutrients for quality seed production of onion cv. Taherpuri.

2. MATERIALS AND METHODS

The experiment was carried out during *robi* season (October to March) of 2013-2014, at Sher-e-Bangla Agricultural University, Dhaka. The site was located in the agro-ecological zone named Madhupur Tract (AEZ NO. 28) of Bangladesh. The experiment conducted at area falls under the sub-tropical climate that is characterized by less rainfall associated with moderately low temperature during the *robi* season (October to March). The land was above flood level and sufficient sunshine was available during the experimental period.

The experiment had two factors. Factor-A: four levels of micronutrients viz. M_1 = Zn (0 kg/ha) + B (0 kg/ha) + Mn (0 kg/ha) = $Zn_0B_0Mn_0$ kg/ha, M_2 = Zn (4 kg/ha) + B (1 kg/ha) + Mn (2 kg/ha) = $Zn_4B_1Mn_2$ kg/ha, M_3 = Zn (6 kg/ha) + B(2 kg/ha) + Mn (3 kg/ha) = $Zn_6B_2Mn_3$ kg/ha, M_4 = Zn (8 kg/ha) + B (3 kg/ha) + Mn (4 kg/ha) = $Zn_8B_3Mn_4$ kg/ha and Factor-B: three levels of NPKS fertilizer viz. F_1 = N (57 kg/ha) + P (21 kg/ha) + K (39 kg/ha) + S (9 kg/ha) = $N_{57}P_{21}K_{39}S_9$ kg/ha, F_2 = N (114 kg/ha) + P (42 kg/ha) + K (78 kg/ha) + S (18 kg/ha) = $N_{114}P_{42}K_{78}S_{18}$ kg/ha, F_3 = N (171 kg/ha) + P (63 kg/ha) + K (117 kg/ha) + S (27 kg/ha) = $N_{171}P_{63}K_{117}S_{27}$ kg/ha. Zinc sulphate ($ZnSO_4.H_2O$), boric acid (H_3BO_3), manganese sulphate ($MnSO_4.H_2O$), urea [$CO(NH_2)_2$], TSP [$Ca_3(H_2PO_4)_2$], MoP (KCl) and gypsum ($CaSO_4.2H_2O$) were used as the sources of zinc, boron, manganese, nitrogen, phosphorus, potassium and sulphur respectively. The recommended doses of NPKS fertilizer for onion's seed production are 250 kg Urea, 200 kg TSP, 150 kg MP and 100 kg Gypsum [23].

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The whole experimental unit was divided into three blocks, each of which representing a replication. Each block was divided into 12 unit plots. In total 36 treatment combinations were allocated in each of the three blocks. The size of each unit plot was 1.5 m×1 m. The space between blocks and unit plot were maintained 50 cm and 50 cm respectively for proper management. The land was prepared by three successive ploughings and cross-ploughings. Each plowing was followed by laddering to have a desirable fine tilth. All necessary cultural operations and management practices were employed whenever needed.

The research work was conducted with the bulb of onion cv. Taherpuri. Medium bulbs of uniform size (about 2.5 cm in diameter) were planted in the unit plot in six rows and there were 10 bulbs in each row. Sixty bulbs were planted in each unit plot. The distance between the rows and between the bulbs in a row was maintained at 25 cm and 10 cm respectively.

Data on plant height (cm), number of leaves per plant were collected at different growth stage from ten pre-selected plants of each plot. Data were also recorded on days required for first bolting and days required to the first anthesis. After harvest, the seeds of each treatment germinated in the laboratory to determine the germination percentage.

2.1 Seed Vigor Test

While evaluating the number of normal seedlings at the time of final count of germination test, the seedling length of ten randomly selected seedlings is also measured. Seed vigor index was calculated by multiplying germination percentage and seedling length (mm). The seed lot showing the higher seed vigor index is considered to be more vigorous [24]. The seed vigor index was calculated by the following formula:

Seed vigor index = Germination percentage × Seedling length (mm)

2.2 Statistical Analysis

The collected data on different parameters were statistically analyzed following the analysis of variance (ANOVA) technique using MSTAT-C computer package program. The differences between the pair of means were adjusted by Least Significance Difference (LSD) test taking the probability level 5% as the maximum unit of significance [25].

3. RESULTS AND DISCUSSION

3.1 Plant Height

Plant height was recorded from 30 days after planting (DAP) to 70 DAP at an interval of 10 days. The effect of micronutrients on the plant height was found to be highly significant at different days after planting. Plant height recorded at 60 DAP was the maximum (43.74 cm) from the M_3 ($Zn_6B_2Mn_3$ kg/ha) treatment. The minimum plant height (39.94 cm) was found from the M_1 ($Zn_0B_0Mn_0$ kg/ha) treatment at the same DAP (Fig. 1). This may be inferred that the increase in height may be due to the influence and absorption of nutrients and it might have played a dominant role in the growth of the plant. This finding is in agreement with the result of Howlader et al. [26]. In all micronutrient treatments, it was observed that the plant height increased gradually with the advancement of time reaching a pick at 60 DAP and then it began to decrease due to senescence and drying up the tips of the leaves.

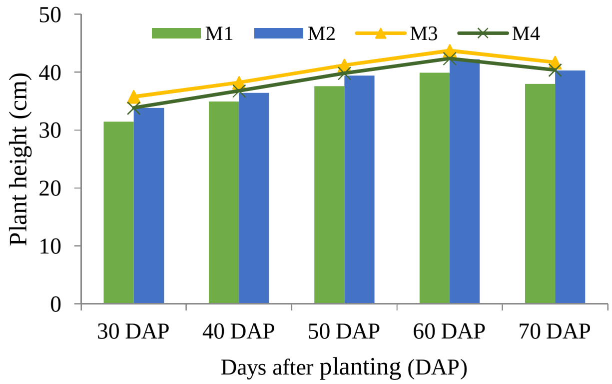

Fig. 1. Effect of micronutrients on plant height at different days after planting ($LSD_{0.05}$ = 1.59, 1.93, 1.45, 1.39 and 1.55 for 30, 40, 50, 60 and 70, respectively)
$M_1 = Zn_0B_0Mn_0$ kg/ha, $M_2 = Zn_4B_1Mn_2$ kg/ha, $M_3 = Zn_6B_2Mn_3$ kg/ha and $M_4 = Zn_8B_3Mn_4$ kg/ha

The effect of macronutrients on the plant height was significant by the application of macronutrients. The maximum plant height (46.10 cm) was recorded from F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) treatment at 60 DAP and minimum plant height (39.20 cm) was observed from F_1 ($N_{57}P_{21}K_{39}S_9$ kg/ha) treatment at the same DAP (Fig. 2). Mozumder et al. [27] also observed similar result by applying NKS fertilizers. Ghaffoor et al. [28] reported that application of different levels of NPK fertilizer in onion significantly improved plant height, leaf length and number of leaves per plant.

The combined effect of micronutrient and macronutrients was statistically significant on plant height at different days of planting except for 30 DAP and 40 DAP. The maximum plant height (49.18 cm) was found from the treatment combination of M_3F_2 ($Zn_6B_2Mn_3$ kg/ha × $N_{114}P_{42}K_{78}S_{18}$ kg/ha) at 60 DAP whereas, minimum (37.22 cm) was found in M_1F_1 ($Zn_0B_0Mn_0$ kg/ha × $N_{57}P_{21}K_{39}S_9$ kg/ha) treatment (Table 1). This might be micronutrients and macronutrients supplied plant nutrients for proper growth of onion plants. The result revealed that combined application of Zn, B, and Mn in presence of macronutrients was found better for the growth of onion plant. Umma [29], who reported that plant height and number of leaves were significantly highest when plant received Zn, B and Cu with recommended doses of macronutrients, found the similar result.

3.2 Number of Leaves per Plant

Number of leaves per plant was recorded at 30 DAP to 70 DAP at an interval of 10 days.

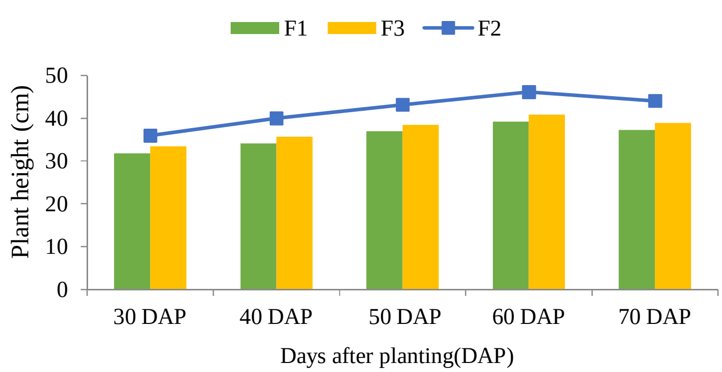

Fig. 2. Effect of macronutrients on plant height at different days after planting (LSD0.05 = 1.38, 1.67, 1.25, 1.20 and 1.34 for 30, 40, 50, 60 and 70 DAP, respectively)
$F_1 = N_{57}P_{21}K_{39}S_9$ kg/ha, $F_2 = N_{114}P_{42}K_{78}S_{18}$ kg/ha and $F_3 = N_{171}P_{63}K_{117}S_{27}$ kg/ha

Table 1. Combined effect of micronutrients and macronutrients on the plant height at different DAP of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Plant height (cm) at				
	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP
M_1F_1	29.63	32.73	35.23 f	37.22 f	35.53 g
M_1F_2	33.70	37.27	40.32 c	43.28 c	41.20 cd
M_1F_3	30.97	34.78	37.12 d-f	39.32 ef	37.33 fg
M_2F_1	31.93	34.33	36.78 ef	39.60 ef	37.58 e-g
M_2F_2	35.28	39.37	42.90 b	45.88 b	43.87 bc
M_2F_3	34.30	35.63	38.52 c-e	41.18 c-e	39.35 d-f
M_3F_1	33.35	34.95	37.92 c-e	40.02 de	37.92 e-g
M_3F_2	38.35	43.02	46.23 a	49.18 a	47.02 a
M_3F_3	35.60	36.65	39.45 cd	42.03 cd	40.07 de
M_4F_1	32.32	34.42	37.73 d-f	39.95 de	38.00 e-g
M_4F_2	36.37	40.20	43.05 b	46.05 b	44.13 b
M_4F_3	32.80	35.72	38.67 c-e	41.07 c-e	39.07 d-f
$LSD_{0.05}$	NS	NS	2.51	2.41	2.69
CV (%)	4.84	5.4	3.76	3.38	3.96

**Means in a column followed by the same letter do not differ significantly at 5 % level.*
$M_1 = Zn_0B_0Mn_0$ kg/ha, $M_2 = Zn_4B_1Mn_2$ kg/ha, $M_3 = Zn_6B_2Mn_3$ kg/ha and $M_4 = Zn_8B_3Mn_4$ kg/ha; $F_1 = N_{57}P_{21}K_{39}S_9$ kg/ha, $F_2 = N_{114}P_{42}K_{78}S_{18}$ kg/ha and $F_3 = N_{171}P_{63}K_{117}S_{27}$ kg/ha. NS= Non-significant

Significant variation was observed in the average number of leaves per plant due to the effect of micronutrients at different days after planting. Numerically leaf production was increased up to 60 DAP and thereafter decreased due to senescence. The highest number of leaves (22.06) per plant was recorded from M_3 ($Zn_6B_2Mn_3$ kg/ha) treatment and the lowest number of leaves (18.06) was recorded from M_1 ($Zn_0B_0Mn_0$ kg/ha) treatment at the same DAP (Fig. 3). Chowdhury et al. [30] also reported that the number of leaves per plant increased with the application of micronutrients.

Number of leaves per plant was significantly influenced by the application of macronutrients in onion. The maximum number of leaves per plant (23.58) was found in F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) treatment at 60 DAP and the minimum number of leaves per plant (18.02) was found in F_1 ($N_{57}P_{21}K_{39}S_9$ kg/ha) treatment at the same DAP (Fig. 4). Mozumder et al. [27] also observed similar result by applying NKS fertilizers and Ghaffoor et al. [28] observed by applying NPK fertilizers.

The combined effect of micronutrient and macronutrients was statistically significant in respect of number of leaves per plant at different days of planting except 30 and 40 DAP. The maximum number of leaves per plant (27.07) was found from the combination of M_3F_2

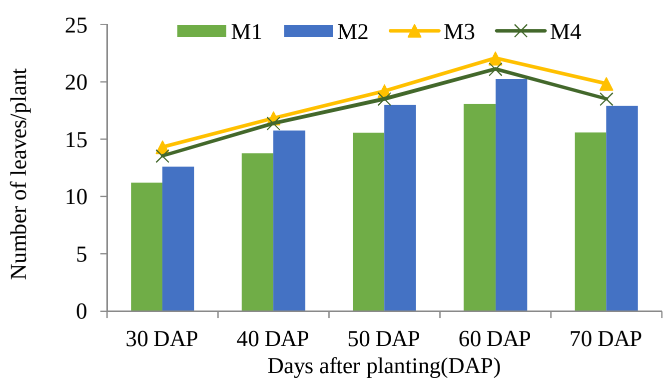

Fig. 3. Effect of micronutrients on number of leaves per plant at different days after planting ($LSD_{0.05}$ = 0.68, 1.22, 1.27, 1.34 and 1.13 for 30, 40, 50, 60 and 70, respectively)
$M_1 = Zn_0B_0Mn_0$ kg/ha, $M_2 = Zn_4B_1Mn_2$ kg/ha, $M_3 = Zn_6B_2Mn_3$ kg/ha and $M_4 = Zn_8B_3Mn_4$ kg/ha

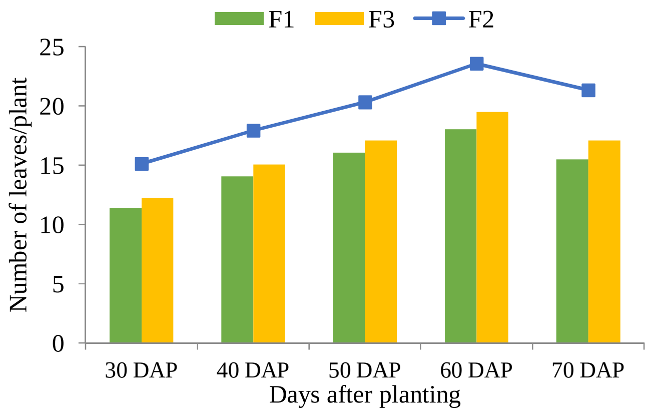

Fig. 4. Effect of macronutrients on number of leaves per plant at different days after planting (LSD0.05 = 0.59, 1.06, 1.10, 1.16 and 0.98 for 30, 40, 50, 60 and 70, respectively)
F_1 = $N_{57}P_{21}K_{39}S_9$ kg/ha, F_2 = $N_{114}P_{42}K_{78}S_{18}$ kg/ha and F_3 = $N_{171}P_{63}K_{117}S_{27}$ kg/ha

($Zn_6B_2Mn_3$ × $N_{114}P_{42}K_{78}S_{18}$ kg/ha) treatment at 60 DAP whereas minimum number of leaves per plant (15.80) was found from the in M_1F_1 ($Zn_0B_0Mn_0$ kg/ha × $N_{57}P_{21}K_{39}S_9$ kg/ha) treatment (Table 2). From the results of the present study, it can be concluded that the treatment M_3F_2 provided better growing condition perhaps due to the supply of adequate plant nutrients, resulting in the maximum number of leaves per plant.

3.3 Days Required to First Bolting

Days required to first bolting were not significantly varied by different micronutrients treatment. First bolting was earlier in M_3 ($Zn_6B_2Mn_3$ kg/ha) treatment (59.11 days) than M_1 ($Zn_0B_0Mn_0$ kg/ha) treatment (60 days) (Fig. 5). The days required to first bolting decreased with the application of zinc and boron at a higher dose [31].

Significant variation was found among the different levels of macronutrients in respect of days required to first bolting. The longest period (60 days) was required for first bolting in F_3 ($N_{171}P_{63}K_{117}S_{27}$ kg/ha) treatment while shortest period (58.67 days) in F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) treatment (Fig. 5). Ali et al. [32] stated similar result by using nitrogen and potassium but phosphorus and sulfur at recommended doses.

Table 2. Combined effect of micronutrients and macronutrients on the number of leaves per plant at different DAP of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Number of leaves per plant at				
	30 DAP	**40 DAP**	**50 DAP**	**60 DAP**	**70 DAP**
M_1F_1	9.000	11.80	13.53 e	15.80 g	13.93 h
M_1F_2	13.60	15.67	17.73 c	20.60 c-e	17.87 de
M_1F_3	11.00	13.80	15.37 de	17.77 fg	15.00 gh
M_2F_1	11.40	14.50	16.40 cd	18.18 f	15.33 f-h
M_2F_2	14.30	17.60	20.07 b	22.70 bc	20.67 bc
M_2F_3	12.13	15.17	17.50 cd	19.87 d-f	17.77 de
M_3F_1	12.60	14.62	16.80 cd	18.30 ef	15.50 f-h
M_3F_2	17.37	20.10	23.10 a	27.07 a	25.13 a
M_3F_3	13.00	15.80	17.73 c	20.80 cd	18.90 cd
M_4F_1	12.50	15.27	17.50 cd	19.80 d-f	17.20 d-f
M_4F_2	15.27	18.30	20.37 b	23.97 b	21.70 b
M_4F_3	12.87	15.57	17.70 c	19.60 d-f	16.63 e-g
$LSD_{0.05}$	NS	NS	2.21	2.33	1.97
CV (%)	5.45	7.99	7.32	6.75	6.49

**Means in a column followed by the same letter do not differ significantly at 5 % level. M_1 = $Zn_0B_0Mn_0$ kg/ha, M_2 = $Zn_4B_1Mn_2$ kg/ha, M_3 = $Zn_6B_2Mn_3$ kg/ha and M_4 = $Zn_8B_3Mn_4$ kg/ha; F_1 = $N_{57}P_{21}K_{39}S_9$ kg/ha, F_2 = $N_{114}P_{42}K_{78}S_{18}$ kg/ha and F_3 = $N_{171}P_{63}K_{117}S_{27}$ kg/ha; NS= Non-significant*

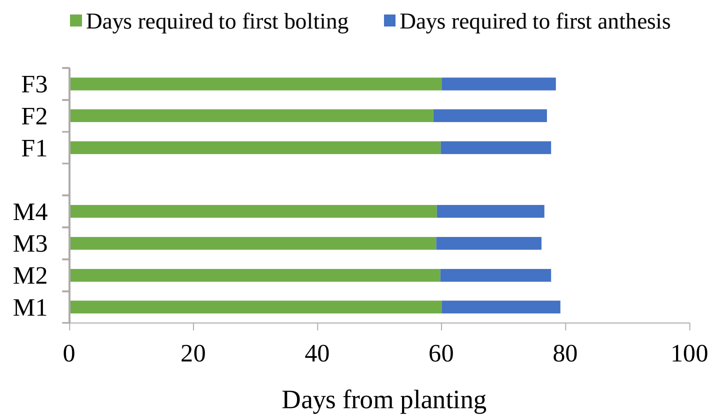

Fig. 5. Effect of micronutrients and effect of macronutrients on bolting and anthesis of onion (*Allium cepa* L. cv. Taherpuri) [$LSD_{0.05}$ = 1.05 (Days required to first bolting) and $LSD_{0.05}$ = 0.99 (Days required to first anthesis) for macronutrients]

$M_1 = Zn_0B_0Mn_0$ kg/ha, $M_2 = Zn_4B_1Mn_2$ kg/ha, $M_3 = Zn_6B_2Mn_3$ kg/ha and $M_4 = Zn_8B_3Mn_4$ kg/ha; $F_1 = N_{57}P_{21}K_{39}S_9$ kg/ha, $F_2 = N_{114}P_{42}K_{78}S_{18}$ kg/ha and $F_3 = N_{171}P_{63}K_{117}S_{27}$ kg/ha

The combined effect of micronutrients and macronutrients was found to be statistically not significant on the days required to first bolting. Minimum time (58.00 days) required for first bolting was found from the treatment combination of M_3F_2 ($Zn_6B_2Mn_3$ kg/ha × $N_{114}P_{42}K_{78}S_{18}$ kg/ha). On the other hand, the maximum time (60.67 days) was required on the treatment combination of M_1F_3 ($Zn_0B_0Mn_0$ kg/ha × $N_{171}P_{63}K_{117}S_{27}$ kg/ha) (Table 3). This might be due to the optimum level of Zn, B, and Mn with macronutrients, which influence C: N ratio.

3.4 Days Required for the First Anthesis

The effect of micronutrients on days required for the first anthesis was found insignificant. Minimum time (76.11 days) from the planting to first flower opening was required in M_3 ($Zn_6B_2Mn_3$ kg/ha) treatment and maximum time (79.11 days) for first flower opening were required in M_1 ($Zn_0B_0Mn_0$ kg/ha) treatment (Fig. 5). Mishra et al. [31] also reported that days required for the first anthesis decreased with the application of zinc at a higher dose. Chowdhury et al. [30] also

Table 3. Combined effect of micronutrients and macronutrients on the bolting and anthesis of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Days required to first bolting	Days required to the first anthesis
M_1F_1	60.00	78.67
M_1F_2	59.33	78.33
M_1F_3	60.67	80.33
M_2F_1	60.00	77.67
M_2F_2	59.00	77.33
M_2F_3	60.33	78.00
M_3F_1	59.33	76.67
M_3F_2	58.00	74.33
M_3F_3	60.00	77.33
M_4F_1	59.33	76.67
M_4F_2	58.33	76.00
M_4F_3	59.67	77.00
$LSD_{0.05}$	NS	NS
CV (%)	2.09	1.52

**Means in a column followed by the same letter do not differ significantly at 5 % level. $M_1 = Zn_0B_0Mn_0$ kg/ha, $M_2 = Zn_4B_1Mn_2$ kg/ha, $M_3 = Zn_6B_2Mn_3$ kg/ha and $M_4 = Zn_8B_3Mn_4$ kg/ha; $F_1 = N_{57}P_{21}K_{39}S_9$ kg/ha, $F_2 = N_{114}P_{42}K_{78}S_{18}$ kg/ha and $F_3 = N_{171}P_{63}K_{117}S_{27}$ kg/ha. NS= Non-significant* reported that days required for the first anthesis decreased with the application of boron at a higher dose but they both did not use manganese.

Statistically significant variation was found among the different levels of macronutrients in respect of days required to the first anthesis. The Longest period was required (78.42 days) for first flower opening in F_3 ($N_{171}P_{63}K_{117}S_{27}$ kg/ha) treatment while shortest period (77.00 days) was found in F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) treatment (Fig. 5). Ali et al. [32] stated similar result by using nitrogen and potassium but phosphorus and sulfur at recommended doses.

The combined effect of micronutrients and macronutrients on the days required for the first anthesis was found to have insignificant influence. Minimum time required for first flower opening (74.33 days) was found in the treatment combination of M_3F_2 ($Zn_6B_2Mn_3$ kg/ha × $N_{114}P_{42}K_{78}S_{18}$ kg/ha). On the other hand, the maximum time (80.33 days) was required for the treatment combination of M_1F_3 ($Zn_0B_0Mn_0$ kg/ha × $N_{171}P_{63}K_{117}S_{27}$ kg/ha) (Table 3).

3.5 Seed Germination Percentage

The effect of micronutrients had statistically significant influence on the seed germination percentage of onion. The highest percentage of seed germination (88.89) was found from M_3 ($Zn_6B_2Mn_3$ kg/ha) treatment and the lowest (84.44) was found from M_1 ($Zn_0B_0Mn_0$ kg/ha) treatment (Fig. 6). Haque et al. [33] stated similar opinion by using zinc and boron at a higher dose than the present experiment but they did not use of manganese.

The variation in the percent germination of the produced seed exerted significant influence due to the different levels of NPKS treatments. The highest percentage of seed germination (90.67) was found in F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) treatment and the F_1 ($N_{57}P_{21}K_{39}S_9$ kg/ha) treatment gave the lowest percentage of seed germination (85.25) (Fig. 6). Ali et al. [32] stated similar result by using nitrogen, potassium, phosphorus, and sulfur at recommended doses.

The combined effects of micronutrients and macronutrients on the percentage of seed germination also showed significant variation. Maximum percentage of seed germination (94.00) was found in the treatment combination of M_3F_2 ($Zn_6B_2Mn_3$ kg/ha × $N_{114}P_{42}K_{78}S_{18}$ kg/ha). On the other hand, the minimum percentage of seed germination (82.67) was obtained from the treatment combination of M_1F_1 ($Zn_0B_0Mn_0$ kg/ha × $N_{57}P_{21}K_{39}S_9$ kg/ha) (Table 4).

3.6 Seed Vigor Index

Micronutrients gave highly significant influence on the seed vigor index of onion seed. The highest vigor index of seed (2084.77) was found from M_3 ($Zn_6B_2Mn_3$ kg/ha) treatment and the

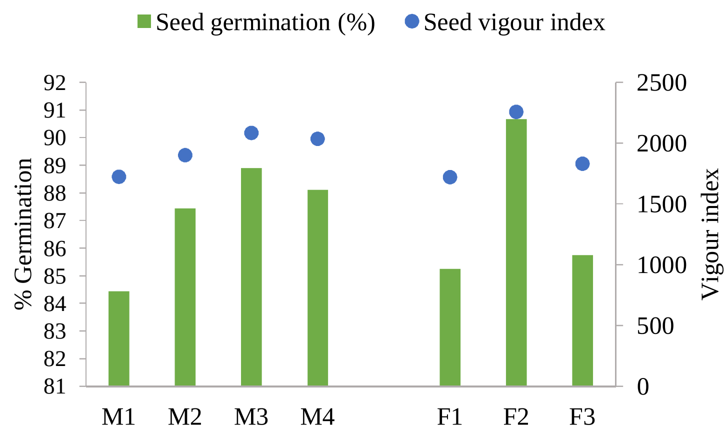

Fig. 6. Effect of micronutrients and effect of macronutrients on the quality parameters of onion (*Allium cepa* L. cv. Taherpuri) [$LSD_{0.05}$ = 1.11 (Seed germination) and LSD 0.05 = 100.00 (Seed vigor index) for micronutrients and $LSD_{0.05}$ = 0.96 (Seed germination) and $LSD_{0.05}$ = 86.61 (Seed vigor index) for macronutrients]

$M_1 = Zn_0B_0Mn_0$ kg/ha, $M_2 = Zn_4B_1Mn_2$ kg/ha, $M_3 = Zn_6B_2Mn_3$ kg/ha and $M_4 = Zn_8B_3Mn_4$ kg/ha; $F_1 = N_{57}P_{21}K_{39}S_9$ kg/ha, $F_2 = N_{114}P_{42}K_{78}S_{18}$ kg/ha and $F_3 = N_{171}P_{63}K_{117}S_{27}$ kg/ha

lowest (1724.26) was found from M_1 ($Zn_0B_0Mn_0$ kg/ha) (Fig. 6). Haque et al. [33] found similar effects from their experiment. They observed that seed quantity, seed quality, and highest germination were obtained when Zn and B were applied to the medium to higher levels.

Table 4. Combined effect of micronutrients and macronutrients on the quality parameters of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Seed germination (%)	Vigor index
M_1F_1	82.67 d	1488.66
M_1F_2	87.00 c	2005.02
M_1F_3	83.67 d	1680.11
M_2F_1	85.67 c	1726.76
M_2F_2	90.00 b	2180.39
M_2F_3	86.67 c	1800.88
M_3F_1	86.00 c	1807.66
M_3F_2	94.00 a	2537.33
M_3F_3	86.67 c	1907.33
M_4F_1	86.67 c	1864.11
M_4F_2	91.67 b	2310.04
M_4F_3	86.00 c	1935.97
$LSD_{0.05}$	1.91	NS
CV (%)	1.30	5.28

**Means in a column followed by the same letter do not differ significantly at 5 % level.*
$M_1 = Zn_0B_0Mn_0$ kg/ha, $M_2 = Zn_4B_1Mn_2$ kg/ha, $M_3 = Zn_6B_2Mn_3$ kg/ha and $M_4 = Zn_8B_3Mn_4$ kg/ha; $F_1 = N_{57}P_{21}K_{39}S_9$ kg/ha, $F_2 = N_{114}P_{42}K_{78}S_{18}$ kg/ha and $F_3 = N_{171}P_{63}K_{117}S_{27}$ kg/ha.
NS= Non-significant

The variation in the vigor of produced seed was highly significant in onion due to the application of different levels of NPKS fertilizer. It was observed that the highest seed vigor index (2258.20) was found in F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) treatment and the F_1 ($N_{57}P_{21}K_{39}S_9$ kg/ha) treatment gave the lowest seed vigor index (1721.05) (Fig. 6). Ali et al. [32] stated similar result by using nitrogen, potassium, phosphorus, and sulfur at recommended doses.

The combined effects of micronutrients and macronutrients on the vigor of seed were not significant. Maximum seed vigor index (2537.33) was found in the treatment combination of M_3F_2 ($Zn_6B_2Mn_3$ kg/ha × $N_{114}P_{42}K_{78}S_{18}$ kg/ha). On the other hand, the minimum seed vigor index (1488.66) was obtained from the treatment combination of M_1F_1 ($Zn_0B_0Mn_0$ kg/ha × $N_{57}P_{21}K_{39}S_9$ kg/ha) (Table 4).

4. CONCLUSION

The results of the present research indicated that application of micronutrients in presence of different levels of macronutrients had a significant effect on yield and quality of onion seed cv. Taherpuri. The highest percentages of germination were 88.89%, 90.67%, and 94.00% and the highest seed vigor index was 2084.77, 2258.20 and 2537.33 at M_3 ($Zn_6B_2Mn_3$ kg/ha), F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) and the combination of them, respectively. This result suggests that, high yield and good quality seeds of onion cv. Taherpuri can be obtained with the application of M_3 ($Zn_6B_2Mn_3$ kg/ha) in combination with F_2 ($N_{114}P_{42}K_{78}S_{18}$ kg/ha) per hectare at Dhaka region of Bangladesh. Considering the above results, it may abridge that, quality seeds of onion can be obtained by the application of 6 kg Zinc, 2 kg Boron and 3 kg Manganese in combination with 114 kg Nitrogen, 42 kg Phosphorus, 78 kg Potassium and 18 kg Sulphur per hectare.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Jones HA, Mann LK. Onion and their allies. Leonard Hill (Books) Limited, London. 1963;169.
2. FAO. Food and Agriculture Organization of the United Nations, Italy, Rome. 2006;57.
3. BBS. Bangladesh Bureau of Statistics, Statistical Yearbook of Bangladesh, Statistics Division, Ministry of Planning, GOB; 2011.
4. Rahim MA, Hussain A, Siddique MA. Seed production ability of three cultivars. Bangladesh Hort. 1982;10(1):31-38.
5. Mondal MF, Choudhury MSH. Effect of size of mother bulb on seed yield of onion. Bangladesh Hort. 1980;8(2):21-23.
6. Sing SP, Verma AB. Response of onion (*Allium cepa* L.) to potassium application. Indian J. Agron. 2001;46:182-185.
7. Pedler JF, Parker DR, Crowley DE. Zinc deficiency-induced phytosiderophore release by the Triticaceae is not consistently expressed in solution culture. Planta. 2000;211:120-126.

8. Pandey N, Pathak GC, Sharma CP. Zinc is critically required for pollen function and fertilisation in lentil. J. Trace Elem. Medic. Biol. 2006;20:89-96.
9. Marschner H. Mineral nutrition of higher plants. Second Edition. Academic Press, London, UK; 1995.
10. Alloway BJ. Zinc-the vital micronutrient for healthy, high-value crops. International Zinc Association (IZA); 2008.
11. Cakmak I. Enrichment of cereal grains with zinc: Agronomic or genetic biofortification? Plant and Soil. 2008;302:1-17.
12. Potarzycki J, Grzebisz W. Effect of zinc foliar application on grain yield of maize and its yielding components. Plant Soil Environ. 2009;55(12):519-527.
13. Tisdate SL, Nelson WL, Beaton JD. Soil fertility and fertilizers, 4th ed. Macmillan Pub. Comp., New York. 1984;285.
14. Maurya AN, Lal S. Boron in relation to the growth and development of onion (*Allium cepa* L.). Bangladesh Hort. 1975;3(1):1-7.
15. Bhonde SR, Dod VN, Bharad SG, Gholap SV, Jadhao BJ. Seed production of onion as influenced by the application of growth regulators. Indian J. Soils and Crops. 1999;9(1):78-79.
16. Stout PR, Arnon DI. Experimental methods for the study of the role of copper, manganese, and zinc in the nutrition of higher plants. American J. Bot. 1939;26: 144-149.
17. Park YH, Lee JY, Kim SC, Kim PJ. Distribution characteristics of micronutrients in soils and vegetable plants in Korea. In: Proceedings of International Workshop on Micronutrient in Crop Production, Held November 8-13. National Taiwan University, Taipei, Taiwan ROC; 1999.
18. Babaeva EY, Volobueva VF, Yagodin BA, Klimakhin GI. Sowing quality and productivity of *Echinacea purpurea* in relation to soaking the seed in manganese and zinc solutions. Izvestiya Timiryazevskoi Sel'skokhozyaistvennoi Akademii. 1999;4:73-80.
19. Halder NK, Zaman MWU, Chowdhury MMU, Ullah MH, Nag BL. Effect of nitrogen and phosphorus on the uptake of different nutrient elements by onion bulb. Bangladesh J. Sci. Indust. Res. 1998;33(3):404-408.
20. Thompson LR, Torch FR. Soils and soil fertility. McGraw Hill Book Co. New York. 1978;226-283.
21. Vigidal SM, Pereira PRG, Pacheco DD. Mineral nutrition and fertilization of onion. Informe. Agropecuario. 2002;23:36-50.
22. Paterson DR. Sulphur fertilization effect on yield and pungency. Progress Report NO. PR-3551, Texas Agril. Exp. Stat. 1979;2.
23. Rashid MA, Singh DP. A manual on vegetables seed production in Bangladesh. AVRDC-USAID-Bangladesh Project, Horticulture Research Centre, Joydebpur, Gazipur-1701. First Edition. 2000;81-85.
24. Abdul-Baki AA, Anderson JD. Vigour determination in soybean by multiple criteria. Crop Sci. 1973;13:630-633.
25. Gomez KA, Gomez AA. Statistical procedure for agricultural research. Second Edn. Intl. Rice Res. Inst., John Wiley and Sons. New York; 1984.
26. Howlader MM, Kamruzzaman MM, Chowdhury MEK, Yousuf MN. Effect of phosphorus, potassium and boron on onion seed production. Research Report. Spices Research Centre. Bangladesh Agric. Res. Inst. 2010;13-17.
27. Mozumder SN, Moniruzzaman M, Halim MA. Effect of N, K and S on the yield and storability of transplanted onion (*Allium cepa* L.) in the hilly region. J. Agric. Rural Dev. 2007;5(1&2):58-63.
28. Ghaffoor A, Jilani MS, Khaliq G, Waseem K. Effect of different NPK levels on the growth and yield of three onion (*Allium cepa* L.) varieties. Asian J. Plant Sci. 2003;2(3):342-346.
29. Umma H. Response of onion to different micronutrients. M.S. Thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh. 2012;26-38.
30. Chowdhury SH, Ali Hossain MS, Ahmed MA, Hoque MM. Effect of boron and sulphur on yield and quality of onion seed. Bangladesh J. Agric. Sci. 2004;22:179-184.
31. Mishra HP, Singh KP, Yadow JP. Influence of zinc, iron, boron, and manganese and their uptake on onion (*Allium cepa* L.) growth in calcareous soil. Haryana J. Hort. Sci. 1990:19(1-2):153-159.

32. Ali MK, Alam MF, Alam MN, Islam MS, Khandaker SMAT. Effect of nitrogen and potassium level on yield and quality seed production of onion. J. Appl. Sci. Res. 2007;3(12):1889-1899.

33. Haque MR, Robbani M, Hasan MM, Asaduzzaman M, Hasan MM, Jaime A. Zinc and boron affect yield and quality of onion (*Allium cepa* L.) seed. Intl. J. Veg. Sci. 2014;20(2):131-140.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/22239