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Macro and Micro Nutritional Effect on Seed Yield of Onion

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Authors' contributions

This work was carried out in collaboration between all authors. Author MMH helped to design the study and carried out the research. Author KK designed and supervised the research. Author MEH performed the statistical analysis. Author MA wrote the manuscript and managed the data interpretation. Author MSAM managed the literature searches and helped to data collection. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was carried out at the Agronomy Research field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November, 2013 to April, 2014 with a view to observe the effect of micronutrients (Zn, B and Mn) with different levels of macronutrients (NPKS fertilizers) on onion (*Allium cepa* L.) seed yield. The experiment was conducted with four levels of micronutrients viz. M_1= Zn0B0Mn0 kg/ha, M_2= Zn4B1Mn2 kg/ha, M_3= Zn6B2Mn3 kg/ha and M_4= Zn8B3Mn4 kg/ha and three doses of macronutrients viz. F_1= N57P21K39S9 kg/ha, F_2= N114P42K78S18 kg/ha and F_3 =N171P63K117S27 kg/ha. All doses of micro and macronutrients are applied to the soil. Application of micronutrients and different doses of macronutrients increased

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number of umbels/plot, number of seeds per umbel, weight of seeds per umbel, seed yield per plant. The highest seed yield (879.9 kg/ha) were recorded from M_3 treatment and the lowest seed yield (787.4 kg/ha). The positive effects of micronutrients were found in order of M_3> M_4> M_2> M_1. The F_2 treatment produced the highest seed yield (957.6 kg/ha) and F_1 treatment produced lowest (776.6 kg/ha). The positive effects were found in order of F_2> F_3> F_1. Amongst the treatment combinations, M_3F_2 produced the highest seed yield (1027.0 kg/ha) and M_1F_1 produced the lowest yield (734.4 kg/ha).

Keywords: Allium cepa; macronutrients; micronutrients; fertilizer; onion seed; Taherpuri.

1. INTRODUCTION

Onion (*Allium cepa* L.), belongs to the family Alliaceae, is one of the most important spice as well as earliest vegetable crops of the world. Worldwide 60 million tons of dry onions are produced annually, with the crop being grown across 7.4 million acres in over 134 different countries. This represents a doubling in world production over the last ten years [1]. Among the spice crops grown in Bangladesh, onion ranks top in respect of production and area. The average yield rate is 3.33 M ton per acre [2]. However, seeds are produced by limited number of farmers in particular areas of Faridpur, Natore and Rajshahi districts of Bangladesh [3]. Moreover, seeds available at market are often very poor in quality in respect of germination, varietal purity and seed viability. Lower production in a limited area causes scarcity of quality onion seed during the growing season in Bangladesh. There are still a chance to increase the yield of onion seed by changing or modifying the cultivation practices including planting geometry, fertilization, irrigation and other cultural management practices. On the other hand, the price of onion seed is directly proportional to the price of the onion bulb for growing seed crop [4].

Many researchers have the opinion that some secondary and trace elements like zinc, boron and manganese can play vital role in escalating the yield of onion seed [5,6,7]. Zinc is the key structure part of some enzymes and is required for the plant enzymes formation; in addition, many enzymatic reactions activated by Zn [8]. In addition, Zn will contribute on the pollination by impact on pollen tube formation [9,10]. Zinc creates an immense influence on abiotic and biotic stresses resistance and protects against oxidative damage [11,12,13]. Boron is essential for cell division, nitrogen and carbohydrate metabolism, salt absorption and water relation in plant. Boron is also required in the translocation of sugars, starches, nitrogen and phosphorus and synthesis of amino acids and proteins [14]. Studies showed that boron at different doses had significant effects on the production of leaf, plant height, root numbers, seed yield and 1000 seeds weight [15,16]. Manganese (Mn) plays an elementary role in nitrogen metabolism, photosynthesis and forms several other compounds required for plant metabolism [17]. Due to the Mn deficiency, maturity is delayed [18]. Seed with 0.1% $MnSO_4$ solution increased germination by 36% and field emergence by 27% over untreated control [19].

Application of macronutrients (N, P, K and S fertilizers) is important for production of onion seed. Nitrogen (N) application increases umbels/bulb, flowering stalk length and 1000-seed weight of onion [20]. Phosphorus (P) is an essential plant nutrient. It plays an important role in formation of nucleic acid and phospholipids, enzyme activation, production of ADP and ATP [21]. Potassium (K) application increases the uptake of nitrogen by onion plants [22,23]. Sulphur (S) also carries out many important functions for plant growth. Sulphur fertilizer increases the seed yield and bulb pungency in onion [6].

2. MATERIALS AND METHODS

The experiment was carried out during winter season (October to March) of 2013-2014, at the Agronomy Research field of Sher-e-Bangla Agricultural University, Dhaka-1207. The experimental field was located at 90°22’ E longitude and 23°4’ N latitude at an altitude of 8.6 meters above the sea level, which falls under the sub-tropical monsoon climate. The soil type of the experimental field belongs to the Shallow Red Brown Terrace type under Tejgaon Series of Madhupur Tract of Agro ecological Zone (AEZ) 28, which is characterized by loamy texture.

The experimental plot was outlined in Randomized Complete Block Design (RCBD) with three replications and twelve treatment plots. The space between blocks and unit plot were maintained 50 cm and 50 cm respectively for proper management. The unit plot size was 1.5 m in length and 1.0 m in breadth. Total experimental plot size was 94 m^2. An improved onion cultivar named "Taherpuri" was used as planting material. An average weight of onion bulb was 25 gm. The experiment consisted of two factors. Factor-A conducted with four levels of micronutrients viz. (M_1, M_2, M_3 & M_4) (Table 1) and Factor-B conducted with three doses of macronutrients viz. (F_1, F_2 & F_3) (Table 2).

Table 1. Micronutrients application rates

Micronutrients (Factor-A)	Nutrient dose (Kg/ha)		
	Zn	B	Mn
M_1	0	0	0
M_2	4	1	2
M_3	6	2	3
M_4	8	3	4

Table 2. Fertilizers (Macronutrients) application rates

Fertilizers	Nutrient dose (Kg/ha)			
(Factor-B)	N	P	K	S
F_1	57	21	39	9
F_2	114	42	78	18
F_3	171	63	117	27

The source of zinc, boron and manganese was zinc sulphate ($ZnSO_4.H_2O$), boric acid (H_3BO_3) and manganese sulphate ($MnSO_4.H_2O$) respectively. Urea [$CO(NH_2)_2$], TSP [$Ca_3(H_2PO_4)_2$], MoP (KCl) and Gypsum ($CaSO_4.2H_2O$) was used as the source of nitrogen, phosphorus, potassium and sulphur respectively.

Land was prepared by three successive ploughings and cross-ploughings. Each ploughing was followed by laddering to have a desirable fine tilth. The land was prepared a month before planting the bulbs. All necessary cultural operations and management practices were employed whenever needed.

Data were recorded on Number of umbels per plot, Number of seeds per umbel, Weight of seeds per umbel (g), Weight of 1000 seeds (g), Seed yield per plant (g), Seed yield per plot (g), Seed yield per hectare (kg). The results were subjected to analysis of variance (ANOVA) using MSTAT-C statistical software and treatment effects were compared using the Least Significant Differences test at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Number of Umbels per Plot

The number of umbels per plot was highly significant due to the variation among the micronutrients levels. In M_3 (Zn6B2Mn3 kg/ha) treatment, number of umbels per plot was maximum (95.33) compared to M_1 (Zn0B0Mn0 kg/ha) treatment (64.89) (Table 3). Rashid et al. [24] also reported to have obtained higher number of umbels per plot with the application of boron. Howlader et al. [25] stated that the number of umbels per plot increased by 30% extra boron application.

The number of umbels per plot differed significantly with the application of different levels of macronutrients. The highest number of umbels (102.50) was found in F_2 (N114P42K78S18 kg/ha) treatment and the F_1 (N57P21K39S9 kg/ha) treatment produced the lowest number of umbels (68.75) (Table 4). Shasha et al. [26] stated similar result in presence of adequate moisture by using different levels of nitrogen and phosphorus and recommended doses of potassium and sulphur.

On the production of umbels per plot, micronutrients and macronutrients interaction occurred a significant variation. The highest number of umbels per plot (124.0) was observed from the M_3F_2 (Zn6B2Mn3 kg/ha × N114P42K78S18 kg/ha) treatment combination while the lowest (55.0) was obtained from the M_1F_1 (Zn0B0Mn0 kg/ha × N57P21K39S9 kg/ha) treatment combination (Table 5). This helped for getting proper vegetative growth as well as maximum number of umbels per plant. These results indicated that the different level of micronutrients when used with macronutrients combinedly supplied plant nutrients and provide better growing conditions which helped for getting proper vegetative growth as well as maximum number of umbels per plant. Pena et al. [27] reported that application of NPKS+ Zn, B in onion significantly increased crop yield. Rashid et al. [24] also reported that plant height, number of leaves, number of flowers/umbel, number of fruits/umbel, higher seed yield of BARI piaz-1 with the application of 100 kg S + 5kg B.

3.2 Number of Seeds per Umbel

The effects of micronutrients on the number of seeds per umbel were statistically significant in onion. The M_3 (Zn6B2Mn3 kg/ha) treatment was produced the maximum number of seeds per umbel (562.90) and M_1 (Zn0B0Mn0 kg/ha) treatment was produced the minimum number of seeds per umbel (503.80) (Table 3). Khan et al. [28] also reported to have obtained higher number of fruits per umbel with the application of zinc. Kumar et al. [29] also stated the similar opinion but they did not use manganese.

Number of seeds per umbel was highly significant by the application of different levels of macronutrients. The maximum number of seeds per umbel (555.20) was found from F_2 (N114P42K78S18 kg/ha) treatment and the minimum number of seeds per umbel (494.00) was found from F_1 (N57P21K39S9 kg/ha) treatment (Table 4). The results revealed that number of seeds per umbel increased with the doses of NPKS until it reached the optimum then it decreased. Mozumder et al. [30] stated that application of N, K and S significantly increased yield and yield attributes.

Combined application of micronutrients and macronutrients were statistically significant on number of seeds per umbel. M_3F_2 (Zn6B2Mn3 kg/ha × N114P42K78S18 kg/ha) treatment combination produced the highest number of seeds per umbel (575.0). Whereas M_1F_1 (Zn0B0Mn0 kg/ha × N57P21K39S9 kg/ha) treatment combination produced the lowest number of seeds per umbel (481.2) (Table 5).

3.3 Weight of Seeds per Umbel

The weight of seeds per umbel showed significant differences among micronutrients plots. Treatment M_3 (Zn6B2Mn3 kg/ha) produced the highest weight of seeds per umbel (1.77 g). M_1 (Zn0B0Mn0 kg/ha) treatment produced the lowest (1.62 g) followed by M_2 (Zn4B1Mn2 kg/ha) treatment (1.66 g), which is the second lowest (Table 3). Chattopadhyay and Mukhopadhyay [31] also reported that the weight of seeds per umbel increased with the application of boron and zinc at higher dose.

A significant variation on the seed weight per umbel was found due to NPKS treatments. The maximum weight of seeds per umbel (1.89 g) was found from F_2 (N114P42K78S18 kg/ha) treatment and the minimum weight of seeds per umbel (1.58 g) was found from F_1 (N57P21K39S9 kg/ha) treatment (Table 4). Similar result was found by Tiwari et al. [20] who observed that plant height, length of flower stalk, number of umbels per bulb, 1000- seed weight and seed yield increased with N80 kg/ha application.

Combined effect of micronutrients and macronutrients were significant on weight of seeds per umbel. M_3F_2 (Zn6B2Mn3 kg/ha × N114P42K78S18 kg/ha) treatment combination produced the maximum weight of seeds per umbel (1.95 g) and M_1F_1 (Zn0B0Mn0 kg/ha × N57P21K39S9 kg/ha) treatment combination produced the minimum weight of seeds per umbel (1.50 g) (Table 5).

3.4 Weight of 1000 Seeds

1000 seeds weight of different micronutrients treatments showed highly significant different. The highest weight (3.40 g) of 1000 seeds was found from M_3 (Zn6B2Mn3 kg/ha) treatment followed by M_4 (Zn8B3Mn4 kg/ha) treatment which was statistically similar (3.37 g) and the lowest (3.11 g) was found from M_1 (Zn0B0Mn0 kg/ha) treatment (Table 6). These results are in

Table 3. Effect of micronutrients on the yield contributing characters of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Number of umbels per plot	Number of seeds per umbel	Weight of seeds per umbel (g)
M_1	64.89 d	503.80 c	1.62 c
M_2	78.00 c	512.40 c	1.66 c
M_3	95.33 a	562.90 a	1.77 a
M_4	85.67 b	538.80 b	1.71 b
$LSD_{0.05}$	1.55	23.6	0.28
CV (%)	1.95	6.25	6.60

** Means in a column followed by the same letter do not differ significantly at 5 % level. M_1 = Zn0B0Mn0 kg/ha, M_2 = Zn4B1Mn2 kg/ha, M_3 = Zn6B2Mn3 kg/ha and M_4 = Zn8B3Mn4 kg/ha.*
NS=Non-significant

Table 4. Effect of macronutrients on the yield contributing characters of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Number of umbels per plot	Number of seeds per umbel	Weight of seeds per umbel (g)
F_1	68.75 c	494.00 b	1.58 b
F_2	102.5 a	555.20 a	1.89 a
F_3	71.67 b	494.40 b	1.60 b
$LSD_{0.05}$	1.33	18.06	0.09
CV (%)	1.95	6.25	6.60

**Means in a column followed by the same letter do not differ significantly at 5% level. F_1 =N57P21K39S9 kg/ha, F_2 = N114P42K78S18 kg/ha and F_3 = N171P63K117S27 kg/ha*

Table 5. Combined effect of micronutrients and macronutrients on the yield contributing characters of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Number of umbels per plot	Number of seeds per umbel	Weight of seeds per umbel (g)
M_1F_1	55.00 i	481.2 e	1.50 e
M_1F_2	81.00 d	534.5 b	1.82 bc
M_1F_3	58.67 h	498.4 d	1.56 de
M_2F_1	68.00 g	481.3 e	1.61 d
M_2F_2	95.00 c	539.5 b	1.85 b
M_2F_3	71.00 f	500.4 c	1.52 de
M_3F_1	80.00 d	498.7 cd	1.68 c
M_3F_2	124.0 a	575.0 a	1.95 a
M_3F_3	82.00 d	513.1 bc	1.67 c
M_4F_1	72.00 f	485.2 de	1.53 de
M_4F_2	110.0 b	571.8 ab	1.93 ab
M_4F_3	75.00 e	500.4 c	1.67 cd
$LSD_{0.05}$	2.68	16.15	0.03
CV (%)	1.95	6.25	6.60

**Means in a column followed by the same letter do not differ significantly at 5 % level. M_1 = Zn0B0Mn0 kg/ha, M_2 = Zn4B1Mn2 kg/ha, M_3 = Zn6B2Mn3 kg/ha and M_4 = Zn8B3Mn4 kg/ha. F_1 =N57P21K39S9 kg/ha, F_2 = N114P42K78S18 kg/ha and F_3 = N171P63K117S27 kg/ha.*
NS= Non significant

Table 6. Effect of micronutrients on the yield and quality parameters of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Weight of 1000 seeds (g)	Seed yield per plant (g)	Seed yield per plot (g)	Seed yield per hectare (kg)
M_1	3.11 c	3.21 c	118.1 c	787.4 c
M_2	3.25 b	3.49 bc	125.3 b	835.0 b
M_3	3.40 a	3.94 a	132.0 a	879.9 a
M_4	3.37 a	3.68 ab	130.5 a	870.2 a
$LSD_{0.05}$	0.12	0.44	3.48	23.19
CV (%)	3.76	12.59	2.81	2.81

**Means in a column followed by the same letter do not differ significantly at 5 % level. M_1 = Zn0B0Mn0 kg/ha, M_2 = Zn4B1Mn2 kg/ha, M_3 = Zn6B2Mn3 kg/ha and M_4 = Zn8B3Mn4 kg/ha.*

apparent with the findings of Khan et al. [28]. Gabal et al. [32] also stated that foliar application of 100 ppm Mn increased the weight of 1000 seeds.

Different levels of macronutrients had significant effect on the weight of 1000 seeds of onion. The maximum production weight (3.42 g) was gained from F_2 (N114P42K78S18 kg/ha) treatment and the minimum (3.18 g) was from F_1 (N57P21K39S9 kg/ha) treatment (Table 7). Tiwari et al. [20] stated that 1000-seed weight was affected significantly by nitrogen and phosphorus, potassium and sulphur at recommended doses.

The combined effects of micronutrients and macronutrients on the weight of 1000 seeds were found to be statistically significant. Maximum weight of 1000 seeds (3.63 g) was found in the treatment combination of M_3F_2 (Zn6B2Mn3 kg/ha × N114P42K78S18 kg/ha). On the other hand, the minimum weight (3.03 g) of 1000 seeds was obtained from the treatment combination of M_1F_1 (Zn0B0Mn0 kg/ha × N57P21K39S9 kg/ha) (Table 8). Increase of 1000 seeds weight with the application of micronutrients and optimum dose of macronutrients may be due to better syntheses of carbohydrates and their translocation to the seed.

3.5 Seed Yield per Plant

Micronutrients had highly significant influence on the seed yield per plant. M_3 (Zn6B2Mn3 kg/ha) treatment gave the maximum (3.94 g) and M_1 (Zn0B0Mn0 kg/ha) treatment (3.21 g) treatment gave minimum seed yield per plant (Table 6). Khan et al. [28] also stated that seed yield per plant increased with the application of zinc. This might be due to optimum Zn, B, Mn improved pollen germination and pollen tube growth resulting viable seeds. Boron is needed for the production and translocation of sugars to be used as energy source of pollen tube [33]. Kumar et al. [29] also stated that seed yield per plant increased with the application of boron.

Seed yield per plant differed significantly due to the different levels of macronutrients application. F_2 (N114P42K78S18 kg/ha) treatment produced the maximum seed yield per plant (4.21 g) and F_1 (N57P21K39S9 kg/ha) treatment produced the minimum seed yield per plant (3.20 g) (Table 7). The reason for higher seed yield per plant due to the increase of photosynthesis rate and translocation of food materials to seed. Howlader et al. [34] stated the similar result, but present experiment showed the lowest seed yield per plant than Howlader et al. [34] who used of nitrogen and sulphur at recommended doses.

The combined effects of micronutrients and macronutrients on the seed yield per plant were highly significant. Maximum seed yield per plant (4.74 g) was found in M_3F_2 (Zn6B2Mn3 kg/ha × N114P42K78S18 kg/ha). Besides, the minimum seed yield per plant (2.80 g) was obtained in M_1F_1 (Zn0B0Mn0 kg/ha × N57P21K39S9 kg/ha) (Table 8). The fact might be Zn, B, Mn nutrients with optimum level of macronutrients supplied sufficient plant nutrients for vigorous plant growth. Jana and Mukhopadhaya [35] reported that the combined effect of B and Zn showed significant increase in number of primary inflorescence stalks, pods per plant and seed yield of onion.

3.6 Seed Yield per Plot

Different levels of Zn, B and Mn fertilizers treatment had highly significant effect on the seed yield of onion per plot. The maximum and minimum seed yield of onion per plot (132.0 g) was found from M_3 (Zn6B2Mn3 kg/ha) treatment and from M_1 (Zn0B0Mn0 kg/ha) treatment respectively (Table 6). The reason for higher seed yield per plot may be due to be influenced pollen tube growth, Zn increased auxin production and Mn increased important physiological and biological processes which resulted increased fruit set and ultimately increased no. of seed with seed yield per plot. Kumar et al. [29] reported that the seed yield per plot increased with the application of zinc at higher dose. Rashid et al. [24] also stated the similar opinion. The seed yield per plot increased with the application of boron, zinc and manganese.

The different levels of macronutrients treatments exerted significant effect on the seed yield per plot of onion. The maximum seed yield per plot (143.6 g) was found from F_2 (N114P42K78S18 kg/ha) treatment and the minimum seed (116.5 g) was observed from F_1 (N57P21K39S9 kg/ha) treatment (Table 7). In the present study, a balanced combination of macronutrient (NPKS) elements might have increased seed yield of onion. The fact might be the fertilizer sufficiently supplied major plant nutrients for vigorous growth and seed yield of onion. Mozumder et al. [30] reported that application of NKS significantly increased yield and yield attributes of onion. Santhi et al. [36] observed similar results. Ali et al. [37] also reported similar result. They obtained higher seeded fruits, number of seeded fruits/umbel, weight of seeds/umbel, seed yield, germination percentage and seed vigor index with the application of different levels of N and K.

The combined effects of micronutrients and macronutrients on the seed yield per plot showed statistically significant influence. Maximum seed yield per plot (154.1 g) was found in the treatment combination of M_3F_2 (Zn6B2Mn3 kg/ha × N114P42K78S18 kg/ha) and the minimum seed yield per plot (110.2 g) was obtained from the treatment combination of M_1F_1 (Zn0B0Mn0 kg/ha × N57P21K39S9 kg/ha) (Table 8).

Table 7. Effect of macronutrients on the yield and quality parameters of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Weight of 1000 seeds (g)	Seed yield per plant (g)	Seed yield per plot (g)	Seed yield per hectare (kg)
F_1	3.18 b	3.20 b	116.5 b	776.6 b
F_2	3.42 a	4.21 a	143.6 a	957.6 a
F_3	3.25 b	3.33 b	119.3 b	795.2 b
$LSD_{0.05}$	0.10	0.38	3.01	20.08
CV (%)	3.76	12.59	2.81	2.81

**Means in a column followed by the same letter do not differ significantly at 5 % level. F_1 = N57P21K39S9 kg/ha, F_2 = N114P42K78S18 kg/ha and F_3 = N171P63K117S27 kg/ha*

Table 8. Combined effect of micronutrients and macronutrients on the yield and quality parameters of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Weight of 1000 seeds (g)	Seed yield per plant (g)	Seed yield per plot (g)	Seed yield per hectare (kg)
M_1F_1	3.03 e	2.80 e	110.2 g	734.4 g
M_1F_2	3.16 cd	3.79 b-d	128.7 c	857.8 c
M_1F_3	3.13 de	3.03 de	115.5 fg	769.8 fg
M_2F_1	3.20 cd	3.23 d	116.1 e-g	774.3 e-g
M_2F_2	3.36 bc	4.10 bc	141.4 b	942.7 b
M_2F_3	3.20 cd	3.15 de	118.2 d-f	788.0 d-f
M_3F_1	3.20 cd	3.45 cd	117.7 d-f	784.9 d-f
M_3F_2	3.63 a	4.74 a	154.1 a	1027.0 a
M_3F_3	3.30 cd	3.64 b-d	119.8 d-f	798.7 d-f
M_4F_1	3.30 cd	3.32 cd	121.9 de	812.7 de
M_4F_2	3.53 ab	4.23 ab	150.4 a	1003.1 a
M_4F_3	3.36 bc	3.50 b-d	123.6 cd	824.1 cd
$LSD_{0.05}$	0.10	0.42	6.1	40.2
CV (%)	3.76	12.59	2.81	2.81

**Means in a column followed by the same letter do not differ significantly at 5 % level. M_1 = Zn0B0Mn0 kg/ha, M_2 = Zn4B1Mn2 kg/ha, M_3 = Zn6B2Mn3 kg/ha and M_4 = Zn8B3Mn4 kg/ha. F_1 = N57P21K39S9 kg/ha, F_2 = N114P42K78S18 kg/ha and F_3 = N171P63K117S27 kg/ha.*
NS= Non significant

3.7 Seed Yield per Hectare

The application of different levels of micronutrients had significantly influenced on the Seed yield per hectare of onion. The maximum seed yield per hectare (879.9 kg) was gained from M_3 (Zn6B2Mn3 kg/ha) treatment and minimum seed yield per hectare (787.4 kg) was obtained from M_1 (Zn0B0Mn0 kg/ha) treatment (Table 6). This result is in agreement with the result obtained by Haque et al. [38]. They observed that onion seed quantity and quality could be benefited when Zn and B are applied at medium to higher levels of both in combination.

Seed yield per hectare significantly varied by the application of different levels of NPKS fertilizer. The maximum seed yield per hectare (957.6 kg) was found from F_2 (N114P42K78S18 kg/ha) treatment and the minimum seed (776.6 kg) was observed from F_1 (N57P21K39S9 kg/ha) treatment (Table 7). The results indicate that optimum levels of macronutrients application had increased seed yield per hectare. Ghaffoor et al. [39] observed that application of different level of NPK fertilizers in onion significantly affected plant height, leaf length and number of leaves per plant, bulb diameter and total yield per hectare of onion. Haq and Mallarino [40] reported that foliar application of N, P and K at reproductive stage increased seed yield due to increased pod number.

The combined effects of micronutrients and macronutrients on the seed yield per hectare were highly significant. Maximum seed yield per hectare (1027.0 kg) was found in M_3F_2 (Zn6B2Mn3 kg/ha × N114P42K78S18 kg/ha) treatment combination. Besides, the minimum seed yield per hectare (734.4 kg) was obtained from the M_1F_1 (Zn0B0Mn0 kg/ha × N57P21K39S9 kg/ha) treatment combination (Table 8).

4. CONCLUSION

The results of present research revealed that application of micronutrients in presence of different levels of macronutrients had significant effect on yield and other yield contributing characters of onion seed cv. Taherpuri. The highest yields of seeds were 879.9, 957.6 and 1027.0 kg/ha at M_3 (Zn6B2Mn3 kg/ha), F_2 (N114P42K78S18 kg/ha) and combination of them, respectively. Considering the above results, it may be summarized that, high yield and good quality seeds of onion cv. Taherpuri, can be obtained by the application of 6 kg Zn, 2 kg B and 3 kg Mn in combination with 114 kg N, 42 kg P, 78 kg K and 18 kg S per hectare.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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