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Effect of Zinc and Boron on the growth and yield of gulabi variety of Garlic (*Allium sativum* L.) under agro-climatic condition of Peshawar, K. P

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Abstract

A field experiment was conducted to determine the effect of micronutrients on growth and yield of gulabi variety of garlic (*Allium sativum* L.) during 2014-2016 at Institute of Biotechnology and Genetic Engineering (IBGE) Agriculture University Peshawar. Seeds of garlic cultivar Lehson Gulabi were collected from local farmers. Zinc was applied in the form of zinc sulphate while boron was applied in the form of boric acid. Three levels of zinc 3ppm, 4ppm and 5ppm and three levels of boron 0.50ppm, 0.75ppm and 1ppm with different combinations of Zinc + Boron 3+0.50ppm, 4+0.75ppm, 5+1ppm were applied. The experiment was laid out under RCBD (Randomized Complete Block Design) having 10 treatments and three replications. Maximum number of leaves (8.45) and maximum dry weight of leaves (13.06g) was shown by T_3 (Zinc 5ppm@ 0.0123gha^{-1}). Maximum weight of bulb per plant (57.03g) and average yield hectare^{-1} (0.83) was shown by T_7 (3+0.50ppm @ 0.029g + 0.0074gha^{-1}. Maximum plant height (58.66cm) and maximum phenolic contents (1.77mg/g) were found in T_5 (Boron 0.075ppm @0.042gha^{-1}).

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Introduction

Garlic (*Allium sativum* L.) is one of the most important spice crops in Pakistan. It is important both for its culinary and medicinal uses. Garlic (*Allium sativum* L.) belongs to the family Alliaceae with chromosome number 2n=16. Garlic has originated from Central Asia (India, West China, Afghanistan, Russia etc) and spread to other parts of the world through migration and employment (Tidal, 1986). It is a vertical annual herb with the height of 75-90 cm and best grown in dry and mild winter (Brewster, 1994). Garlic is widely used for addition of flavor, in vegetables and especially meat dishes. It is also used fresh as well as fried. or in processed form. Its peppery flavor makes its valuable for seasoning provisions for both trimmings and bulbs (Adewale *et al*., 2008).

The micronutrients play an important role in the growth and yield of garlic. The advantage of micronutrients is not inadequate exclusively to the replacement of the micronutrient itself but in accumulation micronutrient acts as catalyst in the uptake and use of certain macronutrients (Phillips, 2004). Boron is one of the most important micro-nutrients, although it is required in very small quantity and regulates the carbohydrate metabolism and water relation in plant growth (Brady, 1990).

Boron deficiency in fresh market fruits is often not documented by growers. Boron deficiency, however, is widespread and can serious yield diminution and irregular ripening of fruit (Adams, 1978). Boron becomes less accessible to plants as soil pH increases (Bunt, 1956). Therefore, the practice of applying lime to improve the uptake of other nutrients can cause B deficiency (Fleming, 1980).

Zinc is one of the seven micronutrients vital for crop growth. Zinc plays a considerable role in various enzymatic and physiological activities and performs many catalytic functions in plant system besides alteration of carbohydrates, chlorophyll and protein synthesis. Deficiencies of zinc become so extensive that it ranks next to N and P in many states (Takkar and Randhawa, 1980). Zinc is also an important micronutrients concerned in metabolic processes, enzymatic system, seed production and rate of maturity in plants. It is essential for synthesis of tryptophan, which is originator of indoleacetic acid. It also plays an important role in starch metabolism in plants (Alloway, 2008). Zinc is crucial for plant growth because it controls the synthesis of indoleacetic acid, which noticeably regulates plant growth and also active many enzymatic reactions which is necessary for chlorophyll synthesis and carbohydrate formation (Vitosh, 1994).

The present study were conducted with a view to find out the appropriate doses of zinc and boron on growth, yield and quality of garlic under rain fed conditions of Peshawar, K.P.

Materials and methods

The present research work was carried out at Institute of Biotechnology and Genetic Engineering (IBGE) Agriculture University Peshawar. To find out the suitable doses of zinc and boron for local garlic var. Lehson gulabi. Variable doses of zinc (zinc sulphate) boron (boric acid) and zinc+boron in different combinations will be used as given below:

For Zinc

T_0 =control

T_1 = zinc 3ppm@ 0.0074gha^{-1}

T_2= Zinc 4ppm@ 0.0098gha^{-1}

T3=Zinc5ppm@0.0123gha^{-1}

For Boron

T_0 = Control

T_1= Boron 0.50ppm@ 0.029gha^{-1}

T_2= Boron 0.75ppm@ 0.042gha^{-1}

T_3= Boron 1ppm@ 0.00571ha^{-1}

Combination of Zinc and Boron

T_0=Control

T_1 =3+0.50ppm @ 0.029g+0.0074gha^{-1}

T_2 =4+0.75ppm @ 0.0429g+0.0098gha^{-1}

T_3 =5+1ppm @ 0.00571g+0.0123gha^{-1}

Nitrogen, Potassium and phosphorus were applied at the time of sowing in single dose.

Foliar application of zinc and boron were applied in two doses. First dose were applied after two week of sprouting and second dose were applied after two week before harvesting.

Chemical properties of soil used in experiment

pH	7.75
Total zinc (g kg^{-1})	1.11
Boron (g kg^{-1})	3.22

Results and discussions

Number of leaves plant^{-1}

The results regarding number of leaves plant^{-1} were significantly increased by application of zinc, boron and their combinations are presented in table 3. Maximum number (8.45) of leaves plant^{-1} was noted when zinc 5ppm@0.0123g hectare^{-1} (T_3) was applied while minimum numbers (7.78) of leaves plant^{-1} were observed at zinc 3ppm@ 0.0074g ha^{-1} (T_2) and (7.78) was observed at zinc 4ppm@ 0.0098g ha^{-1} (T_1). The maximum number of leaves plant^{-1} (8.03) was observed when boron 1ppm@ 0.00571g ha^{-1} were applied while the minimum number of leaves plant^{-1} (7.10) was noted by treatment containing boron 0.50@ 0.029g ha^{-1} (T_5). It is evident from the table 3 that maximum number of leaves plant^{-1} (8.32) was observed when 5+1ppm @ 0.00571g+0.0123g ha^{1} were applied while the minimum number of leaves plant^{-1} (12.40g) was noted by treatment containing 3+0.50ppm @ 0.029g+0.0074g ha^{-1}. Maximum number of leaves plant^{-1} was obtains by the application of zinc as compared to others (T_3). This might be because zinc increases the vegetative growth and development process of the plant that result in the more number of leaves per plant. The photosynthesis occurs in leaf cells and carbohydrates are formed here. Minhaj *et al.* (2005) found that number of leaves plant of garlic was significantly increased by application of zinc. Similar Results have been reported by Rohidas *et al.* (2010) who found that more number of leaves plant^{-1} in a high concentration of boron and zinc as compared to rest of the concentration of boron and zinc including the control treatment.

Dry weight of leaves (g)

The result pertaining leaf dry weight of garlic showed significant differences among various treatments by the application of different doses of zinc, boron and their combinations. The maximum dry leaf weight (13.05g) was observed when zinc 5ppm@ 0.0123g ha^{-1} (T_3) were applied while the minimum dry leaf weight (11.81g) was noted by treatment containing zinc 3ppm @ 0.0074g ha^{-1} (T_1). It is evident from the table 5 that maximum dry leaf weight (12.81g) was observed when boron 0.75ppm @ 0.042g ha^{-1} (T_5) and boron1ppm @ 0.00571ha^{-1} (T_6) were applied while the minimum dry leaf weight (11.12g) was noted by treatment containing boron0.50ppm @ 0.029g ha^{-1} (T_4). It is evident from the table 5 that maximum dry leaf weight (13.05g) was observed when 3+0.50ppm @ 0.029g+0.0074g ha^{-1} (T_7) were applied while the minimum dry leaf weight (11.60g) was noted by treatment containing5+1ppm @ 0.00571g+0.0123g ha^{-1} (T_9). Maximum dry weight of leaves was observed in T_3) by the application of zinc as compared to others. These findings were justified by Sad Al Abdel Kareem Sheikha (2011) he revealed that dry weight of leaves is highly affected by the concentration of zinc.

Weight of bulb plant^{-1} (g)

The perusal of table 1 revealed that weight of bulbplant^{-1} (g) of garlic was significantly influenced by application of different doses of zinc, boron and their combinations. The maximum weight of bulbplant^{-1} (56.33g) was observed when zinc 4ppm@ 0.0098g ha^{-1} (T_2) were applied while the minimum weight of bulbplant^{-1} (45.54g) was noted by treatment containing zinc 3ppm@ 0.0074g ha^{-1} (T_1). It is evident from the table 7 that maximum weight of bulbplant^{-1} (49.84g) was observed when boron 1ppm @ 0.00571g ha^{-1} (T_6) were applied while the minimum weight of bulbplant^{-1} (40.74g) was noted by treatment containing boron 0.50ppm @0.029g ha^{-1} (T_4). It is evident from the table 7 that maximum dry leaf weight (57.03g) was observed when 3+0.50ppm@ 0.029g+0.0074g ha^{-1} (T_7) were applied while the minimum weight of bulbplant^{-1} (40.51g) was noted by treatment containing=4+0.75ppm@ 0.0429g+ 0.0098g ha^{-1} (T_8). Maximum weight of bulbplant^{-1} of leaves was observed in (T_7) by the application of zinc and boron combination as compared to others. This may be due to the fact that zinc and boron can increase bulb size, number of cloves/bulb and yield of garlic and onion (Ahmed, 1998).

Our results are supported by Asana *et al.* (1971) who also reported that the moderate concentration of the zinc gave the better results for the bulb weight plant^{-1}. Activity of photosynthesis increases with the application of zinc as a result growth of the plant enhanced. By the application of zinc root system of the plant improved and help in maximum absorption of soil moisture and other essential nutrient dissolved in it. As a result plants growth is very good due to which plant produced maximum bulb weight plant^{-1}.

Plant height (cm)

The result pertaining for plant height of garlic showed significant differences among various treatments by the application of different doses of zinc, boron and their combinations. The maximum plant height (54.88cm) was observed when zinc 4ppm@ 0.0098g ha^{-1} (T_2) were applied while the minimum plant height (49.07cm) was noted by treatment containing zinc 5ppm@ 0.123g ha^{-1} (T_3). It is evident from the table 2 that maximum plant height (88.68cm) was observed when boron 00.75ppm@ 0.042g ha^{-1} (T_5) were applied while the minimum plant height (56.69cm) was noted by treatment containing boron 1ppm @0.00571g ha^{-1} (T_6). It is clear from the table 2 that maximum plant height (58.60cm) was observed when 4+0.75ppm@ 0.0429g+0.0098g ha^{-1} (T8) were applied while the minimum plant height (55.99cm) was noted by treatment containing=5+1ppm@ 0.00571g+0.0123g ha^{-1} (T_9). The cultivars were basically evaluated to determine their characteristics and suitability in term of plant height. The higher plant height is due to higher mother clove size during planting. These results are similar to the finding of Narukha *et al* (2000). They found that boron increase plant height, number of fruit, fruit diameter and fruit yield. However, increasing levels resulted increasing in growth and high fruit yield. Maximum plant height was observed in (T_5) by the application of boron as compared to others. Boron concentration significantly increased the plant height of garlic. This may be due to the fact that boron increased cell- wall development, cell division, phloem development, and the movements of sugars. If boron is deficient, young growing cells (meristem) are discolored, disrupted, and die; and the plants are stunted. Young leaves become brittle, thick, and discolored (Kausar, 1979). All other treatments showed in between results.

Phenolic content (mg/g)

It is clear from table 1 that different doses of zinc, boron and their combinations significantly influenced on increased the phenolic content of garlic. The maximum phenolic content (1.37) was observed when zinc 3ppm@0.0074g ha^{-1} (T_1) was applied while the minimum phenolic content (1.13) was noted by treatment containing zinc 4ppm@0.0098gha^{-1} (T_2). It is evident from the table 12 that maximum phenolic content (1.77) was observed when boron 0.75ppm @0.042g ha^{-1} (T_5) were applied while the minimum phenolic content (1.38) was noted by treatment containing boron 1ppm@ 0.00571g ha^{-1} (T_6). It is clear from the table 12 that maximum phenolic content (1.53) was observed when 5+1ppm @ 0.00571g+0.0123g ha^{-1} were applied while the minimum phenolic content (1.33) was noted by treatment containing 3+0.50ppm @ 0.029g+0.0074g ha^{-1}. Maximum was observed in (T_5) by the application boron as compared to others. Cho *et al* (2008) showed same results and justified that boron significantly increased the phenolic contents and it is presented in table 1.

Average yield ha^{-1} (kg)

It is clear from table 1 that different doses of zinc, boron and their combinations significantly influenced on yield of garlic. The maximum yield (10.31) was observed when zinc3ppm@0.0074g ha^{-1} (T_1) was applied while the minimum yield (9.65) was noted by treatment containing zinc 4ppm@0.0098gha^{-1} (T_1). It is evident from the table 14 that maximum yield (12.87) was observed when boron 1ppm@ 0.00571g ha^{-1} (T_6) were applied while the minimum yield (11.17) was noted by treatment containing boron 0.75ppm@0.042g ha^{-1} (T_5). It is clear from the table 14 that maximum yield (14.25) was observed when 3+0.50ppm@ 0.029g+0.0074gha^{-1} were applied while the minimum yield (10.87) was noted by treatment containing 4+0.75ppm@ 0.0429g+ 0.0098g ha^{-1}. Maximum was observed in (T_8) by the application of zinc and boron combination. These results are justified with Nasreen *et al.* (2007). They found that yield/ha of garlic were significantly increased by the application of zinc and boron combination.

Conclusions and recommendations

The study revealed that application of Zinc 5ppm @ 0.0123g ha^{-1} gave best results for number of leaves $plant^{-1}$, dry weight of leaves, pH of extract, chlorophyll content, and ascorbic acid. Boron 1ppm @ 0.00571g ha^{-1} gave more number of leaves $plant^{-1}$, leaves fresh weight, leaves dry weight, acidity, weight of bulb $plant^{-1}$, chlorophyll content, pH of extract, ascorbic acid and yield ha^{-1}. Based on the above findings, it may be concluded that the zinc application @ 0.0123g ha^{-1} along with boron @ 0.00571g ha^{-1} is suitable dose for the best production of garlic under Peshawar condition. However, the application of micronutrients mixture is more beneficial in comparison to the same nutrient applied alone.

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