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Research Article

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Growth and yield of garlic (*Allium Sativum* L.) influenced by Zn and Fe application

Shariq Mahmood Alam[1], Imdad Ali Mahmood[2], Muhammad Arshad Ullah[2]*, Taj Naseeb[1], Nausherwan N. Nawab[1], Syed Ishtiaq Haider[2], Syeda Sana Aamir[1]

[1]Horticultural Research Institute, National Agricultural Research Centre, Islamabad 45500, Pakistan, [2]Land Resources Research Institute National Agricultural Research Centre, Islamabad 45500, Pakistan

ABSTRACT

A pot experiment was conducted to investigate the effect of Zn and Fe application on growth and yield of garlic (*Allium sativum* L.) var. Desi Sufaid at National Agricultural Research Centre, Islamabad during Rabi season 2018-2019. Eight kilogram of sandy clay loam soil was filled in the pots. Four garlic cloves were sown in each pot. The treatments of Zn, Fe and their mixture (1:1 ratio) @ 5 kg ha^{-1} along with basal dose of N, P and K (100, 75 and 50 mg kg^{-1}) fertilizer were applied at sowing following complete randomized design with three replications. The plants were allowed to stand till maturity and data on growth traits like plant height (cm), pseudo stem diameter (cm), leaf length (cm), leaves plant^{-1}, bulb diameter (cm), cloves (bulb^{-1}), clove weight (g) and bulb yield (g plant^{-1}) were recorded at harvest. The mean data were analyzed statistically. The highest growth attributes like plant height, number of leaves per plant, bulb diameter, cloves, clove weight and bulb yield were harvested with micronutrients (Zn and Fe) along with basal dose of N, P and K (100, 75 and 50 mg kg^{-1}) application which were significantly higher as compared to control. Though, all the treatments showed positive effect through growth characteristics and yield, however, the mixture of Zn and Fe application produced comparable garlic yield among all the treatments which was 6 and 4 (%) higher than that of sole application of Zn and Fe, respectively. Significant improvement in Zn and Fe concentration in garlic plant tissues was observed with the application of Zn and Fe respectively. Overall the combination of both micronutrients performed better than rest of the treatments through improved growth traits and bulb yield.

KEYWORDS: Garlic; Zn, Fe and their mixture; growth; yield; Zn and Fe concentration in plant

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***Corresponding Author:**
Muhammad Arshad Ullah
Email: arshadullah1965@gmail.com

INTRODUCTION

Garlic (*Allium sativum* L.) is one among the significant bulb crop after onion. It has used in culinary and medicinal field. In Pakistan, the production of garlic is not much satisfactory as compared to its consumption [1,2,3,4]. Besides, dehydrated garlic products are liked by people all over the world such as USA, Japan, UK, Italy, Turkey, Germany and France. Under high pH soils, the availability of micronutrients is reduced for crop plants. Garlic (*Allium sativum* L.) is very popular all over the world as spice and also for its medicinal properties. In Asia, garlic has been an integral part of the people's daily diet and its use is very common in almost all food preparations [5, 6]. The average yield of garlic in Pakistan is 8.99 t ha^{-1} as compared to the world's average production yield (9.67 t ha^{-1}). Currently, Pakistan is spending precious foreign exchange on the import of garlic due to high demand and low yield potential of existing varieties [7]. The total indigenous production of garlic in the country stands at 70,925 tonnes from an area of 7,882 hectares with an average yield of 8.99 tones per hectare. Due to shortage of land, there is no scope to extent cultivation area of garlic in Pakistan.

The per unit area yield of garlic can be increased by efficient use of manures and fertilizers. Therefore, in order to increase yield of local cultivars, different practices along with proper manuring and fertilization can play a vital role in this aspect. Previous studies dealt with the nutrient application and effects on yield and different cultivation aspects of garlic in different geographical regions [8-14]. There are only few studies on the effects of micronutrient effects on garlic. Therefore, the present experiment was undertaken to assess growth and yield of garlic (*Allium sativum* l.) influenced by Zn, Fe and their mixture application.

MATERIALS AND METHOD

A pot experiment was conducted to investigate the effect of Zn and Fe application on growth and yield of garlic (*Allium sativum* L.) var. Desi Sufaid at National Agricultural Research Centre, Islamabad during Rabi season 2018-2019. Sandy clay loam soil was collected and eight kilogram was filled in the pots. Before filling in pots, the soil was prepared and a ram sample was stored for physic-chemical analysis (Table 1). Four garlic cloves were sown in each pot following complete randomized design with three replications. The treatments of Zn, Fe and their mixture (1:1 ratio) @ 5 kg ha^{-1} were applied in respective pots. Basal dose of N @ 100 mg kg^{-1} of soil as urea was applied in two splits (half at sowing time and remaining half at clove formation stage (~60 days after sowing) and P and K @ 75 mg kg^{-1} as SSP and 50 mg kg^{-1} as SOP were applied to all the plots at the time of sowing.

The soil sample collected before application of treatment was air-dried and sieved through a 5 mm sieve and their physical and chemical characteristics were determined. The samples were analyzed for soil textural class by hydrometer method [15]. Calcium carbonate was estimated by acid neutralization method and soil organic matter by oxidation with potassium dichromate in sulfuric acid medium under standardized conditions by Walkley and Black procedure [16]. Soil pH was determined in water (soil water ratio 1:1). Electrical conductivity (ECe) of the soil suspension was measured using conductivity meter. The P, K and Zn were determined by using AB-DTPA method [17]. The plants were allowed to stand till maturity and data on growth traits like plant height, pseudo stem diameter, leaf length, leaves $plant^{-1}$, bulb diameter, cloves ($bulb^{-1}$), clove weight (g) and bulb yield (g $plant^{-1}$) were recorded at the time of harvest. The data thus collected were subjected to statistical analysis and treatment differences were compared by using LSD [18].

Table 1: Physico-chemical characteristics of the soil used for the experiment

Parameters	Unit	Values .
pH	–	8.79
ECe	dS m^{-1}	0.24
$CaCO_3$	%	3.57
OM	%	0.41
NO_3-N	%	2.92
Extractable P (AB-DTPA)	mg kg^{-1}	2.47
Extractable K (AB-DTPA)	mg kg^{-1}	86.19
Zn (ABDTPA)	mg kg^{-1}	1.97
Fe (ABDTPA)	mg kg^{-1}	1.23
Sand	%	31.70
Silt	%	28.29
Clay	%	40.11
Textural Class	–	Sandy clay loam

RESULTS AND DISCUSSION

The research results statically provided us with the evidence of improving growth, yield and quality traits of garlic in response to the essential micro mineral nutrition. Overall significant data was collected from mixture treatment of Zn and Fe (1:1 ratio) as compared to control.

Growth Parameters

Garlic plants were responded very well to the treatment application of Zn and Fe @ 5 kg ha^{-1} separately as well as a mixture treatment over control. Discussing the growth parameters, the garlic plant gave maximum plant height (39.46 cm), pseudo stem diameter (0.42 cm) and leaf length (29.56 cm) with mixture of Zn and Fe (Table 2). Similarly, weight of single fresh leaf from garlic plant was visualized as maximum (1.93 g); while, number of fresh garlic leaves $plant^{-1}$ has counted maximumly (7.35) in mixture treated pots of Zn and Fe over control (4.14). The data in Table 1 shows the improved vegetable growth of garlic with application of essential micro nutrient (Zn and Fe), and the basic reason for this improved growth may be that, mineral components Zn and Fe are the key component of many enzymatic and protein synthesis, plays vital role in a several biochemical processes, such as hormone production and leaf elongation. Further, Fe is highly involved in chlorophyll production in plant leaves, which help plant to grow vigorously and healthy. Current findings were also supported by [8, 19, 20], who analyzed the improved vegetative growth of garlic in response to the micro mineral application.

Production and Quality Traits

Significant enhancements induced in production and quality of garlic regarding Zn and Fe micro mineral application were listed in Table 3. It is clear from the data that with the use of Zn and Fe mineral mixture (1:1 ratio) the total bulb yield $plant^{-1}$ (48.13 g) which was 22 % higher than that of obtained from control treatment. While, quality of bulb in response to micro minerals were also enhanced in terms of bulb diameter (3,07 cm), number of cloves (17.49 $bulb^{-1}$) and average clove weight (0.72 g) over control treated plants as (1.99 cm), (11.91 $bulb^{-1}$) and (0.45 g), respectively. The fact behind this trend of improved yield and quality of the garlic might be due to the active intake of micro nutrients (Zn and Fe) throughout the growth and development of the garlic, which has taken place in several metabolic development, and cell enlargement of cloves with in the plant. Due to sufficient Fe availability with in the plant the number of chlorophyll contents increased simultaneously,

Table 2: Growth parameters of garlic (Allium sativum L.) influenced by Zn and Fe application conducted at NARC, Islamabad during 2018-19 (Average of three Repeats)

Treatments	Plant height (cm)	Pseudo stem Diameter (cm)	Leaf Length (cm)	Leaves $plant^{-1}$	Fresh weight $leaf^{-1}$ (g)
0 kg Zn/Fe ha^{-1}	28.43 c	0.21 c	18.31 c	4.14 b	0.91 b
5 kg Zn ha^{-1}	34.37 b	0.37 b	25.54 b	6.53 a	1.20 ab
5 kg Fe ha^{-1}	34.54 b	0.36 b	25.83 b	6.97 a	1.19 ab
Mixture (1:1)	39.46 a	0.42 a	29.56 a	7.35 a	1.93 a
LSD	3.6698	5.4714	4.1524	1.8791	0.4512

Means bearing same letter (s) in each column are statistically similar at $p \leq 0.05$

Table 3: Effect of Fe and Zn application on clove size and bulb yield of garlic conducted at NARC, Islamabad during 2018-19 (Average of three Repeats)

Treatments	Bulb diameter (cm)	No. of Cloves (Bulb^{-1})	Clove Weight (g)	Bulb Yield(g plant^{-1})	% Yield Increase over Control
0 kg Zn/Fe ha^{-1}	1.99 b	11.91 c	0.45 c	39.40 c	–
5 kg Zn ha^{-1}	2.48 ab	14.66 b	0.53 bc	45.63 b	15.81
5 kg Fe ha^{-1}	2.63 ab	16.84 ab	0.69 ab	46.50 b	17.99
Mixture (1:1)	3.07 a	17.49 a	0.72 a	48.13 a	22.16
LSD	1.3471	1.4829	0.2743	1.0476	

Means bearing same letter (s) in each column are statistically similar at $p \leq 0.05$

Table 4: Zn and Fe concentration (mg kg^{-1}) in plant tissues of garlic (*Allium sativum* L.) influenced by Zn and Fe application (Average of three Repeats)

Treatments	Zn (mg kg^{-1})		Fe (mg kg^{-1})	
	Leaves	Cloves	Leaves	Cloves
0 kg Zn/Fe ha^{-1}	9.13 d	7.95 d	0.071 c	0.026 c
5 kg Zn ha^{-1}	24.95 a	18.63 a	0.076 c	0.049 b
5 kg Fe ha^{-1}	15.83 c	11.91 c	0.156 a	0.090 a
Mixture (1:1)	21.13 b	14.95 b	0.127 ab	0.078 ab
LSD	2.7140	3.1116	0.0214	0.0896

Means bearing same letter (s) in each column are statistically similar at $p \leq 0.05$

which maintained maximum photosynthesis potential of plant. Meanwhile, both the minerals Zn and Fe dynamically take place in several enzymatic and biochemical events for better yield and quality of garlic. Similar response of micro mineral nutrition was reported to be effectively improved yield and quality of garlic which is in settlement to the current findings [3, 9, 10, 13, 21].

Zn and Fe Mineral Status

Minimum amount minerals (Zn and Fe) accumulation in plant tissues was seen in control treatment; while, higher values were noticed in Zn (24.95 mg kg^{-1}) and (18.63 mg kg^{-1}) treated plants and Fe (0.156 mg kg^{-1}) and (0.090 mg kg^{-1}) treated plants among leaves and cloves respectively (Table 4). The mixture treatment of Zn and Fe was noticed as average available minerals which were significantly higher as compared to the control treatment. The reason might be the active and greater translocation rate of micronutrients for better metabolism and absorption in plant, which were also reported by [13, 22].

CONCLUSION

Micro minerals (Zn and Fe @ 5 kg ha^{-1}) supplementation played a vital role in enhancing the growth, yield and quality of garlic, especially in case of mixture (1:1 ratio) of both Zn and Fe proved to be superior and was very effective to enhance growth and yield of garlic.

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