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Response of garlic to foliar application of urea and micronutrients

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ABSTRACT: *A field experiment comprising four levels of urea (0.5, 1.0, 1.5 and 2.0%) and four micronutrients ($ZnSO_4$ 0.5%, $MnSO_4$ 0.5%, $FeSO_4$ 0.5% and $CuSO_4$ 0.2%) was conducted at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during* Rabi *season of 2014-15. Urea and micronutrients along with sticker were sprayed at 30, 45 and 60 days after planting. The total seventeen treatment combinations including control were laid out in randomized block design with three replications. The cloves of garlic cv. HG-17 were planted at a spacing of 15x10 cm in a plot size of 3.0x3.0 m. The observations were recorded on growth and yield parameters and the data were subjected to statistical analysis. The foliar spray of 0.5% zinc sulphate in combination with 1.5% urea three times at 15 days interval gave the superior results pertaining to all measured parameters than other treatments. The maximum plant height (53.80 and 75.20 cm) at 90 and 120 days after planting, number of leaves per plant (10.12), fresh and dry weight of leaves per plant (15.60 and 7.05 g), polar and equatorial diameter (5.24 and 4.86 cm), bulb weight (28.80 g) and total bulb yield (155.51 q/ha) was recorded with foliar application of 0.5% zinc sulphate in combination with 1.5% urea, which was followed by 2.0% urea application in combination with 0.5% zinc sulphate.*

Keywords: *Garlic, foliar spray, urea, micronutrients, bulb yield*

INTRODUCTION

Garlic (*Allium sativum* L.), which is a second most important bulb crop next to onion, is used in flavouring of various vegetarian and non-vegetarian dishes. It is mainly grown for its nutritive value, containing considerable amount of calcium, phosphorus and potassium, vitamin A and C [18]. Its pungency, strong flavour and keeping quality are found to be associated with its diallyl disulphide content. India ranks second in the world in respect of area and production after China. In India during 2013-14, the area and production of garlic was 230.59 thousand hectares and 1251.88 thousand metric tonnes with productivity of 5.43 t/ha [3].

Nitrogen is an essential element in all living system and a major indispensible source of protein and nucleic acid. It is also an integral part of chlorophyll, which is responsible for photosynthesis. It is required by plants in much greater amount than all other soil applied nutrients. The liberal application of nitrogen fertilizer can stimulate plant growth and increase zinc requirement beyond the available supply. The nitrogen application along with zinc fertilizer has a notable effect on zinc availability to crop plants. Nitrogen fertilizers that are acid forming will increase the uptake of both native and supplemental zinc. Although nitrogen nutrient is an essential to increase the growth, bulb size, yield and quality but its excessive use prevents proper ripening and results in poor keeping quality of bulbs.

Micronutrients also play a vital role in improving the growth and yield parameters of many crops [13]. Foliar application of urea at various levels in combination of micronutrients enhanced the effect on growth and yield attributes of garlic [25]. Zinc plays a pivotal role in metabolic activity of plant. Mainly, zinc acts as a metal activator of enzymes like dehydogenase. It is involved in the synthesis of tryptophane, a precursor of indole acetic acid (IAA), and it is also associated with water absorption and retention in plant body, therefore, the present study was undertaken to assess the "Response of garlic to foliar application of urea and micronutrients".

MATERIALS AND METHODS

The experiment was conducted at Research Farm of the Department of Vegetable Science, CCS Haryana

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Agricultural University, Hisar during winter season of 2014-2015. The soil of the experimental field was sandy loam, slightly high in pH, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potash. Four levels of urea fertilizer (0.5, 1.0, 1.5 and 2.0%) and four micronutrients [$ZnSO_4$ (0.5%), $MnSO_4$ (0.5%), $FeSO_4$ (0.5%) and $CuSO_4$ (0.2%)] were applied as foliar spray along with a surfactant at 30, 45 and 60 days after planting of garlic cv. HG-17. The cloves of uniformly medium size were planted on October 23, 2014 at 15 x 10 cm spacing. Total seventeen treatment combinations including control were arranged in a Randomized Block Design (RBD) with three replications. The plot size was 3.0 m x 3.0 m accommodating 600 plants per plot. The farmyard manure was applied @ 20 t/ha along with recommended dose of NPK. The other cultural practices and protection measures were adopted as per package of practices recommended for Haryana State. The observations on plant height were recorded at 90 and 120 days after planting, while the other observations were recorded at the time of harvest. Ten plants from each treatment plot were randomly selected and tagged for assessing the different parameters. Based on yield per plot, the total bulb yield per hectare was calculated. The recorded data of different parameters were subjected to statistical analysis following randomized block design with three replications for analysis of variance in OPSTAT (*http://14.139.232.166/opstat/index.asp*) statistical software developed by Chaudhry Charan Singh, Haryana Agriculture University, Hissar, Haryana, India [28]. The maximum and minimum temperature, relative humidity and rainfall during the crop growth period have been shown in Figure 1.

RESULTS AND DISSCUSSION

Growth Attributes

Different treatment combinations showed significant variation in plant height recorded at 90 and 120 days after planting. The foliar application of urea in combination with different micronutrients significantly influenced the plant height. The maximum plant height (36.38 and 53.80 cm, respectively) was recorded at 90 and 120 days after planting in treatment where crop was foliar sprayed three times at 30, 45 and 60 DAP with 1.5% urea + 0.5% zinc sulphate as compared to control (53.80 and 75.20 cm, respectively). The data presented in Table 1 clearly show that the increasing concentration of urea from 0.5 to 1.5% caused an increase in vegetative growth parameters of garlic plant but higher concentration (2.0%) of urea fertilizer decreased the plant growth parameters. The foliar application of zinc sulphate resulted in highest value for plant height followed by copper sulphate. The increment in plant height with urea fertilizer might be due to that nitrogen plays an important role in photosynthesis by improving leaf area index and chlorophyll content, thus, resulting in higher photosynthetic rate and higher vegetative growth of garlic plants. The favourable effect of micronutrients on plant height might be due to its role in many physiological processes and cellular functions within plants. In addition, they also play an important role in improving plant growth through biosynthesis of

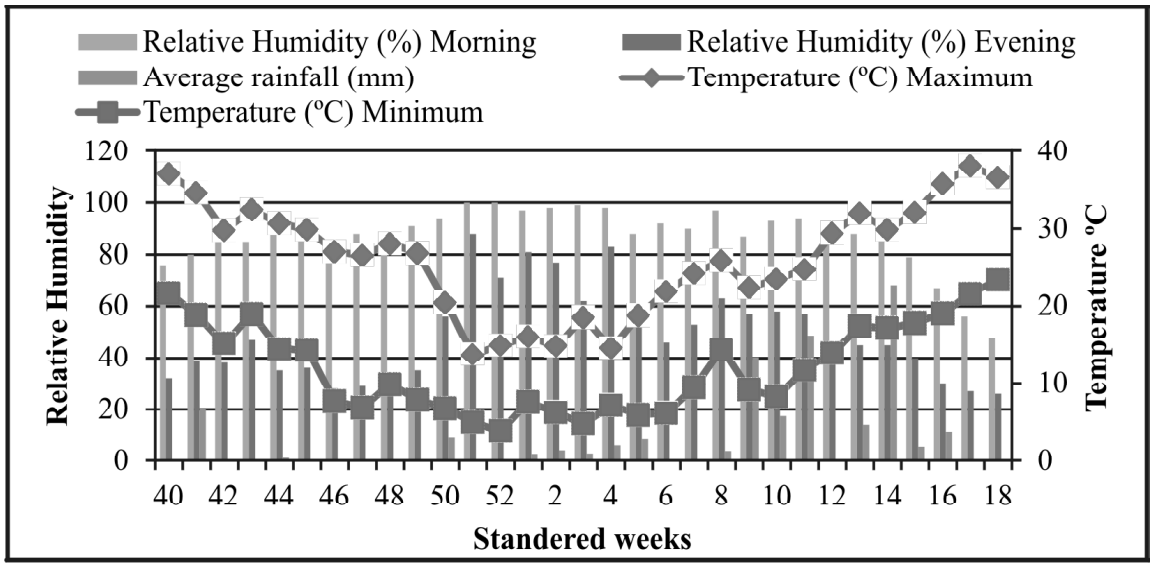

Figure 1: Maximum and minimum temperature, relative humidity and rainfall during the crop growth period 2014-15

endogenous hormones, which were responsible for promoting plant growth [6, 13].

The number of leaves per plant increased significantly with increasing levels of urea in combination of micronutrients. The maximum number of leaves per plant (10.12) was recorded with treatment T_9 (1.5% urea + 0.5% zinc sulphate), whereas, the control treatment recorded the minimum number of leaves per plant (5.62). Kakara *et al*. [15], Jilani [14], Aregawi [4], Gebrehawaria [12] and Farooqui *et al*. [11] have also reported significant effect of nitrogen on plant height and number of leaves per plant. Similar results were also recorded by Nasreen *et al*. [20] who found that the application of nitrogen 120 kg/ha significantly increased the number of leaves per plant, while nitrogen 160 kg/ha tended to decrease the number of leaves per plant.

The fresh and dry weight of leaves per plant was significantly influenced by foliar application of different levels of urea combined with micronutrients on garlic (Table 1). The fresh and dry weight of garlic leaves per plant increased significantly with increased levels of urea in combination of micronutrients. The maximum value for fresh and dry weight of leaves per plant (7.05 and 10.12 g) was recorded in crop sprayed with 1.5% urea + 0.5% zinc sulphate (T_9), which was statistically at par with treatment T_{10} (1.5% urea + 0.2% copper sulphate) and T_{13} (2.0% urea + 0.5% zinc sulphate), whereas, the minimum fresh and dry weight of shoots per plant (11.21 and 4.41 g) was registered with control treatment (T_{17}) where crop was water sprayed only. A marked improvement in fresh and dry weight of leaves per plant with foliar application of zinc in combination of urea might be due to the beneficial effects of zinc on the physiological and other activities of plants. The better absorption of nutrients under zinc treatment resulting in efficient physiological activities in plant might have contributed largely to good growth of plant, increasing fresh and dry weight of plant. The present study are in good accordance with the findings of Lujiu *et al*. [17] and Aregawi [4] who reported a significant increase in shoot dry weight of garlic due to application of nitrogen at higher rate. The results obtained are also in agreement with the results of Tohamy *et al*. [31], Lal *et al*. [16] and Alam *et al*. [2] who reported that the application of micronutrients positively affected the growth parameters in onion.

Yield attributes

The data presented in Table 2 indicate that different levels of urea in combination with different micronutrients had significant effect on various yield attributes *viz*., polar and equatorial diameter of bulb, weight of bulb and total bulb yield of garlic. The maximum polar and equatorial diameter of bulb (5.24 and 4.86 cm) was observed with the foliar application of 1.5% urea and 0.5% zinc sulphate, while the

Table 1
Influence of foliar application of urea in combination with micronutrients on growth attributes of garlic

Treatments	*Plant height (cm)*		*No. of leaves per plant*	*Fresh wt. of leaf per plant (g)*	*Dry wt. of leaf per plant (g)*
	90 DAP	*120 DAP*			
T_1: 0.5% urea + 0.5% $ZnSO_4$	47.45	70.33	13.63	5.90	8.14
T_2: 0.5% urea + 0.2% $CuSO_4$	46.74	69.67	12.18	5.11	7.92
T_3: 0.5% urea + 0.5% $FeSO_4$	43.80	67.33	11.25	4.44	6.70
T_4: 0.5% urea + 0.5% $MnSO_4$	45.85	68.80	11.86	4.91	7.26
T_5: 1.0% urea + 0.5% $ZnSO_4$	49.33	72.07	14.73	6.20	9.02
T_6: 1.0% urea + 0.2% $CuSO_4$	48.66	70.27	13.17	5.58	8.13
T_7: 1.0% urea + 0.5% $FeSO_4$	46.90	68.33	11.56	4.60	6.89
T_8: 1.0% urea + 0.5% $MnSO_4$	47.46	69.40	12.00	5.04	7.40
T_9: 1.5% urea + 0.5% $ZnSO_4$	53.80	75.20	15.60	7.05	10.12
T_{10}: 1.5% urea + 0.2% $CuSO_4$	51.40	72.00	14.75	6.61	9.03
T_{11}: 1.5% urea + 0.5% $FeSO_4$	49.70	70.07	13.53	5.75	7.60
T_{12}: 1.5% urea + 0.5% $MnSO_4$	50.86	71.13	14.28	6.25	8.27
T_{13}: 2.0% urea + 0.5% $ZnSO_4$	52.60	72.53	15.00	6.74	9.32
T_{14}: 2.0% urea + 0.2% $CuSO_4$	49.85	71.60	13.77	5.99	8.56
T_{15}: 2.0% urea + 0.5% $FeSO_4$	48.80	68.73	12.53	5.23	7.12
T_{16}: 2.0% urea + 0.5% $MnSO_4$	49.40	70.47	13.42	5.77	8.00
T_{17}: Control	42.02	61.17	11.21	4.41	5.62
C.D. at 5% level of significance	2.91	5.30	1.03	0.71	0.69

minimum polar and equatorial diameter of bulb (3.45 and 3.37 cm) was registered with control. The increase in bulb size might be due to the increase in height and number of leaves, which were influenced directly by urea fertilizer. This might have accumulated more carbohydrates, resulting in an increase in bulb diameter. The results of this study are in good accordance with the findings of other workers [2, 11,19] in garlic and Desuki *et al*. [10] in onion. All of them reported that the increasing nitrogen fertilization rates led to significant increase in polar as well as equatorial diameter of garlic bulb. Zinc was found to be responsible for larger bulb size (polar and equatorial diameter). This effect of zinc might be due to improved foliage activities like photosynthesis, by which, the food is synthesized by the plant and translocated to the bulb. Zinc helps in translocation of constituents from one to other parts of the plant, so, zinc was a responsible factor for increasing bulb diameter of garlic. The results are in conformity with the finding of Singh and Tiwari [29] and Samad *et al*. [27] in garlic.

The maximum fresh weight of bulb (28.80 g) was obtained from the foliar spray of 1.5% urea and 0.5% zinc sulphate (T_9), which increased about 16.27% as compared to control, however, the further increase in rates of urea application did not bring significant change (Table 2). The improvement in bulb weight with foliar application of urea and micronutrients might be attributed to increased plant height, number of leaves per plant, leaf length, assimilates production and their allocation to the bulbs. Zinc also plays role in physiological activities and as a cofactor in number of plant enzymes and in protein metabolism. The same trend was also observed by many authors in garlic [1, 2, 7, 8, 9, 13, 14, 21, 23, 26].

The maximum total bulb yield (155.51 q/ha) was obtained from the foliar spray of 1.5% urea and 0.5% zinc sulphate (T_9). There was a reduction in total bulb yield with further increase in the levels of nitrogen fertilizer. Increase in bulb yield with medium concentration of urea + zinc sulphate might be due to the production of taller plants with higher number of leaves, leading to increased formation of vegetative structure for nutrients absorption, photosynthesis and production of assimilates to fill the sink, which results in increased bulb weight. Zinc as an essential catalyst in the synthesis of auxin from tryptophan might have encouraged the auxin biosynthesis in the active sinks, which led to higher transport and accumulation of assimilates in the bulb. The control treatment receiving no fertilizer produced the lowest yield (132.92 q/ha). The results are in conformity with the findings of Srivastava *et al*. [30], Nayyef [22], Nasreen *et al* .[21], Tohamy *et al*. [31], Abedin *et al*. [1] and Choudhary *et al*. [9] in garlic and Ballabh *et al*. [5], Trivedi and Dhumal [32] and Rizk *et al*. [24] in onion.

Table 2
Influence of foliar application of urea in combination with micronutrients on yield attributes of garlic

Treatments	*Bulb diameter (cm)*		*Bulb weight (g)*	*Bulb yield (q/ha)*
	Polar	*Equatorial*		
T_1: 0.5% urea + 0.5% $ZnSO_4$	4.27	4.00	26.46	140.81
T_2: 0.5% urea + 0.2% $CuSO_4$	4.02	3.75	25.78	138.43
T_3: 0.5% urea + 0.5% $FeSO_4$	3.75	3.61	24.41	134.60
T_4: 0.5% urea + 0.5% $MnSO_4$	3.98	3.72	25.07	136.78
T_5: 1.0% urea + 0.5% $ZnSO_4$	4.60	4.13	27.73	147.57
T_6: 1.0% urea + 0.2% $CuSO_4$	4.22	4.02	26.80	143.43
T_7: 1.0% urea + 0.5% $FeSO_4$	3.86	3.88	24.33	140.03
T_8: 1.0% urea + 0.5% $MnSO_4$	4.02	3.94	25.94	142.25
T_9: 1.5% urea + 0.5% $ZnSO_4$	5.24	4.86	28.80	155.51
T_{10}: 1.5% urea + 0.2% $CuSO_4$	4.99	4.28	27.13	149.73
T_{11}: 1.5% urea + 0.5% $FeSO_4$	4.08	4.08	25.40	143.70
T_{12}: 1.5% urea + 0.5% $MnSO_4$	4.42	4.14	26.13	148.33
T_{13}: 2.0% urea + 0.5% $ZnSO_4$	4.81	4.17	28.05	153.53
T_{14}: 2.0% urea + 0.2% $CuSO_4$	4.25	4.10	26.93	149.08
T_{15}: 2.0% urea + 0.5% $FeSO_4$	3.73	3.96	24.69	142.84
T_{16}: 2.0% urea + 0.5% $MnSO_4$	4.05	4.00	25.90	147.00
T_{17}: Control	3.45	3.37	23.91	132.92
C.D. at 5% level of significance	0.47	0.30	1.98	6.78

Based on the above findings, it could be concluded that for efficient production of garlic, it is judicial to use foliar application of 1.5% urea + 0.5 % zinc sulphate solution at three times *i.e.*, 30, 45 and 60 DAP in the presence of recommended dose of fertilizers.

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