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Short Communication

Growth and yield of garlic as influenced by foliar application of urea and micronutrients

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2014-15 to study the effect of foliar spray of different levels of urea (0.5, 1.0, 1.5 and 2.0%) in combination with micronutrients such as $ZnSO_4$, $MnSO_4$, $FeSO_4$ each at 0.5% and $CuSO_4$ at 0.2%. Urea and micronutrients along with sticker were applied at 30, 45 and 60 days after planting. 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 15×10 cm in a plot size of 3.0×3.0 m. Foliar feeding of 0.5% zinc sulphate in combination with 1.5% urea three times at 15 days interval gave superior results with respect to measured parameters. The maximum plant height (36.38 and 53.80 cm) at 30 and 60 days after planting, leaf length (28.17 cm), neck thickness (9.47 mm), number of cloves per bulb (37.17), clove length (25.05 mm), fresh and dry weight of individual clove (0.95 and 0.46 g), total plant biomass (44.40 g) and total bulb yield (155.51 q/ha) was registered with foliar application of 0.5% zinc sulphate in combination with 1.5% urea, followed by 2.0% urea application in combination with 0.5% zinc sulphate.

Key words: *Allium sativum*, urea, micronutrients, clove, bulb yield.

Garlic (*Allium sativum* L.) belonging to the family Alliaceae is one of the most important commercial bulb crops in the world. It is used as a spice or condiment throughout India. The significance of garlic is increasing owing to its wide range of medicinal properties, as it is carminative and gastric stimulant, thus, aids in digestion and absorption of food. The allicin present in garlic has a hypocholesterolaemic action, thus, reduces cholesterol concentration in the human blood. Inhalation of garlic oil or juice has generally been recommended by the doctors in cases of pulmonary tuberculosis, rheumatism, sterility, impotency, cough and red eyes. India ranks second in the world with respect to area and production after China.

Nitrogen occupies the most vital place in plant nutrition as a builder of protein in plants. The absence of sufficient nitrogen generally results in small yellow leaves, reddish bark, stunted growth and poor quality of bulb. The interest in foliar fertilizers arose due to the multiple advantages of foliar application methods. Application of micronutrients with recommended dose of fertilizers enhanced the growth and yield attributed of garlic (Rohidas *et al*., 7). The foliar application of microelements is more beneficial than soil application since application rates are lesser as compared to soil application (Zayed *et al*., 9) and also easily available by target organs provide a specific and rapid response to the plant. Foliar application of micronutrients affects the growth and production of some medicinal and aromatic plants (Joynul *et al*., 5).

The experiment comprising of four micronutrients, *i.e*., zinc (0.5%), iron (0.5%), manganese (0.5%) and copper (0.2%) in combination with four levels of urea fertilizers (0.5, 1.0, 1.5 and 2.0%) was conducted at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. 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. The treatment combinations presented in Table 1 were laid out in a Randomized Block Design (RBD) with three replications.

The cloves of garlic cv. HG-17 were planted on 23rd October 2014 in 3.0 m × 3.0 m plot size at 15 cm × 10 cm spacing. The micronutrients and urea along with sticker were sprayed 30, 45 and 60 days after planting as per treatment combinations. The field was irrigated before planting in order to provide ample moisture to cloves for better sprouting. Subsequent irrigations were applied at an interval of 10-12 days in autumn-winter and 7 days in spring-summer. The recommended dose of NPK fertilizers was incorporated in soil at the time of last ploughing and the other cultural practices were adopted as per the package of practices during the course of investigation. At the time of harvest, ten plants were randomly selected from each plot and tagged. The observations were recorded on plant height at 30 and 60 days after planting, leaf length and leaf breadth,

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Table 1. Effect of foliar spray of different levels of urea fertilizer and different micronutrients on vegetative growth parameter of garlic plants.

Treatments 30 DAP		Plant height (cm)		Leaf length (cm)	Leaf breadth (cm)	Neck thickness (mm)	Days to maturity
		30 DAP	60 DAP				
T_1	0.5% urea + 0.5% $ZnSO_4$	17.09	33.32	26.13	0.99	8.47	166.67
T_2	0.5% urea + 0.2% $CuSO_4$	15.44	32.67	25.71	0.96	8.09	167.67
T_3	0.5% urea + 0.5% $FeSO_4$	18.08	31.19	24.20	0.94	7.32	166.00
T_4	0.5% urea + 0.5% $MnSO_4$	14.41	31.60	24.83	0.95	7.76	167.00
T_5	1.0% urea + 0.5% $ZnSO_4$	18.83	34.59	26.70	1.16	8.90	172.00
T_6	1.0% urea + 0.2% $CuSO_4$	17.79	33.64	26.17	1.02	8.39	171.00
T_7	1.0% urea + 0.5% $FeSO_4$	14.82	32.78	24.55	0.97	7.61	168.00
T_8	1.0% urea + 0.5% $MnSO_4$	16.84	33.14	25.88	1.01	7.97	168.67
T_9	1.5% urea + 0.5% $ZnSO_4$	17.29	36.38	28.17	1.20	9.47	172.33
T_{10}	1.5% urea + 0.2% $CuSO_4$	18.21	35.54	27.48	1.10	8.74	171.66
T_{11}	1.5% urea + 0.5% $FeSO_4$	17.22	34.09	25.60	0.98	7.95	168.33
T_{12}	1.5% urea + 0.5% $MnSO_4$	18.08	35.36	26.68	1.04	8.46	170.00
T_{13}	2.0% urea + 0.5% $ZnSO_4$	18.13	35.18	27.70	1.18	9.07	174.67
T_{14}	2.0% urea + 0.2% $CuSO_4$	18.77	34.72	26.71	1.07	8.65	173.00
T_{15}	2.0% urea + 0.5% $FeSO_4$	16.83	32.68	23.98	0.92	7.74	169.33
T_{16}	2.0% urea + 0.5% $MnSO_4$	18.93	33.48	25.85	1.03	8.17	170.33
T_{17}	Control	17.60	31.15	22.69	0.87	7.25	164.67
	C.D. ($P \leq 0.05$)	NS	2.83	1.04	NS	0.88	NS

neck thickness, days to maturity, number of cloves per bulb, clove length, number of bulbils per plot, fresh and dry weight of individual clove, total plant biomass and total bulb yield. Experimental data of different parameters were subjected to statistical analysis (Panse and Sukhatme, 6).

The data presented in Table 1 clearly indicate that increasing rate of nitrogen fertilization from 0.5 to 2.0% in combination of different micronutrients (Zn, Cu, Fe and Mn) caused an increase in vegetative growth parameters of garlic plant. Foliar application of zinc sulphate combined with urea on plants resulted in highest values for vegetative growth parameters. The maximum plant height (36.38 cm) was recorded in T_9 (1.5% urea + 0.5% $ZnSO_4$) and minimum (31.15 cm) in control treatment at 60 days after planting but plant height at 30 days after planting was found non-significant. The higher plant height was associated with medium concentration of urea (1.5%) in combination with 0.5% zinc sulphate and the highest concentration led to reduction in plant height.

All the treatment combinations significantly affected the leaf length (Table 1). The leaf length (28.17 cm) was observed maximum with foliar application of 1.5% urea in combination with 0.5% zinc sulphate, closely followed by T_9 (2.0% urea + 0.5% $ZnSO_4$) and the minimum was recorded in control treatment. The effect of various treatment combinations on leaf breadth was found non-significant. The maximum neck thickness (9.47 mm) was recorded in treatment T_9 (1.5% urea + 0.5% $ZnSO_4$), which was statistically at par with treatment T_{13} (2.0 urea + 0.5% $ZnSO_4$), and the minimum (7.25 mm) neck thickness was noticed in control treatment.

Nitrogen fertilization in combination with some micronutrients (Zn, Cu, Mn and Fe) had no significant effect on number of days required for the garlic crop to attain physiological maturity (Table 1). Nitrogen fertilization regardless of its rates extended the physiological maturity by about 10 days over the control (165 days), which might be extended vegetative growth period due to the application of nitrogen fertilizer, which consequently increased the number of days required for physiological maturity. The delay in maturity with high levels of nitrogen (2.0%) might be attributed to delayed senescence of garlic crop canopy and extended photosynthetic activity. The results are in line with the findings of Shawol (8) who reported that too much nitrogen promoted excessive vegetative growth and delayed maturity in onion.

The increment in vegetative growth parameters of garlic plant by using the highest rate of nitrogen fertilization was probably due to that the nitrogen plays a vital role in plant photosynthesis by improving the leaf area index and chlorophyll content, resulting in higher photosynthetic rate and higher plant vegetative growth.

The improvement in all the growth parameters of garlic with foliar application of medium concentration of urea (1.5%) in combination with 0.5% zinc sulphate might be due to its role in many physiological processes and cellular functions within the plant. The foliar application of zinc improves root system, which helps the plant to absorb water and uptake of nutrients better and consequently improves different organs and entire plant as well. The favourable effect might also be attributed to the fact that zinc is essential in nitrogen metabolism. Foliar application of different micronutrients plays an important role in improving the plant growth through the biosynthesis of endogenous hormones, which are responsible for promoting of plant growth (Hansch and Mendel, 4). These results are in close conformity with the findings of Rohidas *et al*. (7), Chanchan *et al*. (2), and Chanchan and Hore (1) in garlic.

The perusal of data in Table 2 reveals that the foliar application of different concentration of urea fertilizer in combination with some micronutrients (Zn, Cu, Fe and Mn) significantly affected the yield attributing characters, *i.e.*, number of cloves per bulb, clove length, fresh and dry weight of individual clove, total plant biomass and bulb yield.

The number of cloves per bulb and clove length varied significantly with the foliar application of different levels of nitrogen fertilizer in combination with different micronutrients (Table 2). The number of cloves per bulb (37.17) and clove length (25.05 mm) showed a trend of slower increase with increasing nitrogen levels (0.5 to 1.5%) and further increase in level of nitrogen fertilizer (2.0% urea) caused reduction in number of cloves per bulb. The results are in accordance with the findings of Rohidas *et al*. (7) and Choudhary *et al*. (3) in garlic. The effect of nitrogen fertilizer and micronutrients application on clove length of garlic was found significant (Table 2). The maximum clove length (25.05 mm) was found in treatment T_9 (1.5% urea + 0.5% zinc sulphate).

The data presented in Table 2 indicate that the foliar application of urea significantly influenced the fresh and dry weight of individual clove of garlic. The fresh and dry weight of individual clove (0.95 and 0.46 g) increased with increasing level of foliar application of urea (1.5% urea), however, the further

Table 2. Effect of foliar spray of different levels of urea fertilizer and different micronutrients on yield parameter of garlic.

Sr. No.	Treatments	No. of cloves per bulb	Clove length (mm)	Fresh wt. of clove (g)	Dry wt. of clove (g)	No. of bulbils per plot	Total plant biomass (g)	Yield (q/ ha)
T_1	0.5% urea + 0.5% $ZnSO_4$	33.25	23.25	0.82	0.35	4.00	40.09	140.81
T_2	0.5% urea + 0.2% $CuSO_4$	32.17	22.57	0.81	0.34	4.02	37.63	138.43
T_3	0.5% urea + 0.5% $FeSO_4$	30.42	21.40	0.79	0.31	3.00	35.83	134.60
T_4	0.5% urea + 0.5% $MnSO_4$	31.08	21.93	0.80	0.33	3.33	36.93	136.78
T_5	1.0% urea + 0.5% $ZnSO_4$	35.10	24.30	0.87	0.39	5.00	42.43	147.57
T_6	1.0% urea + 0.2% $CuSO_4$	34.57	23.09	0.86	0.38	6.67	39.98	143.43
T_7	1.0% urea + 0.5% $FeSO_4$	31.46	21.52	0.84	0.32	4.67	35.90	140.03
T_8	1.0% urea + 0.5% $MnSO_4$	33.17	22.41	0.85	0.36	5.00	37.94	142.25
T_9	1.5% urea + 0.5% $ZnSO_4$	37.17	25.05	0.95	0.46	5.67	44.40	155.51
T_{10}	1.5% urea + 0.2% $CuSO_4$	35.27	23.57	0.94	0.44	5.00	42.13	149.73
T_{11}	1.5% urea + 0.5% $FeSO_4$	32.83	22.75	0.88	0.40	2.67	38.93	143.70
T_{12}	1.5% urea + 0.5% $MnSO_4$	34.27	23.04	0.91	0.42	4.00	40.41	148.33
T_{13}	2.0% urea + 0.5% $ZnSO_4$	36.25	24.61	0.93	0.45	5.70	42.80	153.53
T_{14}	2.0% urea + 0.2% $CuSO_4$	35.41	23.07	0.92	0.43	4.67	40.70	149.08
T_{15}	2.0% urea + 0.5% $FeSO_4$	32.08	22.12	0.89	0.37	3.33	37.23	142.84
T_{16}	2.0% urea + 0.5% $MnSO_4$	34.25	22.67	0.90	0.41	5.00	39.32	147.00
T_{17}	Control	28.21	20.49	0.77	0.30	3.60	35.12	132.92
	C.D. ($p \leq 0.05$)	1.74	0.89	0.02	0.07	NS	2.28	6.78

increased level of nitrogen fertilizer decreased the clove fresh and dry weight. The findings of this investigation are in close conformity with those of Chanchan *et al*. (2) and Chanchan and Hore (1). For a growing plant, the availability of nitrogen is of prime importance as it is major and indispensable constituent of protein and nucleic acid molecules. An adequate supply of nitrogen is associated with vigorous vegetative growth and more efficient use of available inputs finally leading to higher productivity. No significant difference was found among all the treatment combinations for number of bulbils per plot.

The total plant biomass and bulb yield of garlic increased with increasing rate of foliar application of urea (0.5 to 1.5%) combined with some micronutrients (Zn, Cu, Fe and Mn). There was a reduction in total plant biomass and bulb yield with further increase in the levels of nitrogen fertilizer (2.0% urea). The maximum total plant biomass (44.40 g) and bulb yield (155.51 q/ha) with foliar application of urea (1.5 %) in combination with 0.5% zinc sulphate might be due to medium concentration of urea fertilizer producing taller plants with higher number of leaves leading to increased formation of vegetative structure for nutrient absorption, photosynthesis and production of assimilates to fill the sink, which resulted in increased bulb size and weight, ultimately increased the total plant biomass and yield. Zinc plays pivotal role in regulating the permeability of cell wall, which allowed the mobilization of more water and minerals to sink, and 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 improved vegetative growth of plant and yield attributing characters due to zinc application also had direct relation with bulb development and bulb yield. The control treatment receiving no foliar fertilizer produced the lowest yield (132.92 q/ha). The results are in conformity with the findings of Choudhary *et al*. (3) in garlic.

From the above results, it could be concluded that the combination of 1.5% concentration of nitrogen fertilization as urea with foliar spraying of 0.5% zinc sulphate gave the best results with respect to growth and yield parameters of garlic.

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