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Effect of foliar application of zinc and iron on growth, flowering and post-harvest life in lilium cv. Navona

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ABSTRACT

A research was conducted India to evaluate the necessity of micronutrients such as zinc and iron on growth, flowering and postharvest attributes in Asiatic lilium cv. Navona. The experiment comprised nine treatments, *viz*., $ZnSO_4$ 0.2%, $ZnSO_4$ 0.4%, $FeSO_4$ 0.2%, $FeSO_4$ 0.4%, $ZnSO_4$ 0.2% + $FeSO_4$ 0.2%, $ZnSO_4$ 0.2% + $FeSO_4$ 0.4%, $ZnSO_4$ 0.4% + $FeSO_4$ 0.2%, $ZnSO_4$ 0.4% + $FeSO_4$ 0.4% and control (distilled water) in a randomized block design with three replications. Significant effect was observed with the application of $ZnSO_4$ 0.4% + $FeSO_4$ 0.4%, which increased No. of leaves/ plant, stem diameter, plant height, fresh and dry weight of leaves/ plant, leaf area, chlorophyll content, No. of flower buds/ plant, flower stalk length, pedicel length, diameter of 1st flower, longevity of 1st, 2nd and 3rd flower, No. of buds opened, No. of buds opened at a time in vase, stem weight on 1st, 3rd and 5th day, and weight of stem after withering. Early flower colour show and days to opening of 1st bud were exhibited with $ZnSO_4$ 0.2% + $FeSO_4$ 0.4%, which was statistically at par with $ZnSO_4$ 0.2% + $FeSO_4$ 0.4% treatment. In general both individual and combined doses of zinc sulphate and iron sulphate gave significant results over control.

Key words: Flowering, iron, lilium, post-harvest life, vegetative growth, zinc.

INTRODUCTION

Lilium spp. are bulbous flowering plants which have originated in the south-western and Himalayan Asia. Asiatic lilies (*Lilium bulbiferum*) have been used as cut flowers, pot and garden plants for centuries. Major producers of lilies are China followed by Kenya and Japan (Hanks, 4). The yield and quality of horticultural crops are enriched with application of micronutrients in balanced ratios (Eskandari, 2). Zinc is most likely micronutrient, which is deficit in Indian soils. It is an important structural component and regulatory co-factor of several enzymes. Zinc deficient plants exhibit reduced rate of protein synthesis and is known to maintain structural integrity of ribosomes. Iron is fourth abundant element on earth, but its non-availability to plants can be attributed to low solubility of its minerals (Eskandari, 2). Iron plays important role in oxidation reduction reactions. It is required for enzyme activities in electron transport chain, chlorophyll synthesis and maintenance of chloroplast structure. It is also required at active site of glutamyl-tRNA reductase, which is needed for formation of 5-aminolevulinic acid, a precursor of chlorophyll (Kumar and Soll, 7). Iron also regulates respiration and photosynthesis.

Deficiency of micronutrients has been globally reported, and about one-third of world's agricultural soils are devoid of these because of injudicious use of phosphatic fertilizers (Mousavi, 11). Giving a thought to all above, this study was undertaken to evaluate the effect of zinc and iron on growth, flowering and postharvest aspects of lilium cv. Navona.

MATERIALS AND METHODS

The study has been conducted on Asiatic hybrid lily cv. Navona. This lily is worldwide popular owing to its numerous buds and bright white six-petaled flowers. For planting, healthy and disease-free bulbs were selected and planted in 27 plots, each of size 1.00 m × 0.8 m at a spacing of 25 cm × 20 cm. Planting of bulbs was carried out in the month of October. The experiment was conducted inside a polyhouse at Horticulture Research Farm, IAS, BHU, Varanasi, whereas postharvest study was exercised at the Postharvest Lab of Department of Horticulture. Plants were subjected to foliar application of zinc sulphate and iron sulphate at concentrations of 0.2 and 0.4%, individually and in combinations (Table 1). The experiment was conducted in randomized block design having three replications. Spraying was done twice at 30 and 45 days after planting. Cultural operations such as weeding, irrigation, staking and plant protection measures were undertaken as and when required.

Observations for growth, flowering and postharvest parameters were investigated. Record of growth specifications like No. of leaves/ plant, stem

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diameter, plant height, fresh weight of leaves/ plant, dry weight of leaves/ plant, leaf area and chlorophyll content was ventured. Flowering traits like No. of buds/ plant, flower stalk length, pedicel length, days to flower colour show, days to opening of 1st bud and diameter of 1st flower were examined. Postharvest parameters comprising of longevity of 1st, 2nd and 3rd flower, No. of buds opened, No. of buds opened at a time, weight of stem on 1st, 3rd day and 5th day, weight of stem after withering and vase-life were inspected in lab. Lilium stems were cut in a slant for postharvest study when the 1st bud was fully opened. After harvesting flower stems were placed in bucket containing water then brought from polyhouse to postharvest lab. One re-cut was given to all the flower stems then kept in a vase solution of 2% sucrose + 200 ppm 8-HQC. The observations recorded were subjected to statistical analysis.

RESULTS AND DISCUSSION

The effect of zinc and iron sprays on growth and flowering parameters has been presented in Table 1. The vegetative parameters like No. of leaves/ plant, stem diameter, plant height, fresh weight of leaves/ plant, dry weight of leaves/ plant, leaf area and chlorophyll content were significantly influenced due to the treatments. Plants treated with $ZnSO_4$ 0.4% + $FeSO_4$ 0.4% produced maximum No. of leaves/ plant (57.00), stem diameter (12.26 mm), plant height (52.00 cm), fresh weight of leaves/plant (8.33 g), dry weight of leaves/ plant (0.98 g) and leaf area (306.31 cm^2). This treatment was observed to be significant to all other treatments for No. of leaves/ plant. For stem diameter it produced conspicuously results over $ZnSO_4$ 0.2%, $FeSO_4$ 0.2%, $FeSO_4$ 0.4%, $ZnSO_4$ 0.2% + $FeSO_4$ 0.2% and $ZnSO_4$ 0.4% + $FeSO_4$ 0.2%. For plant height, same treatment accorded significant effect compared to $ZnSO_4$ 0.4% and $ZnSO_4$ 0.4% + $FeSO_4$ 0.2%. $ZnSO_4$ 0.4% + $FeSO_4$ 0.4% gave at *par* result for maximum leaf area with $ZnSO_4$ 0.4% and $FeSO_4$ 0.4%. Fresh and dry weight of leaves/plant influenced by ZnSO4 0.4% + FeSO4 0.4% were at *par* with $ZnSO_4$ and $FeSO_4$ at 0.4%. The results are in agreement with the study for combined application of zinc and iron on lilium cv. Tresor (Hembrom and Singh, 5). Chlorophyll content (73.33) was increased with $ZnSO_4$ 0.4% treatment which was at par with $ZnSO_4$ 0.4% + $FeSO_4$ 0.4%. Similar observations were made by Singh *et al.* (13) in lilium. Memon *et al.* (8) also described significance of zinc application in promoting the growth of phlox. Zinc is a constituent of metallo-enzymes, which is obligatory for many physiological reactions in plants (Uchida, 15). The enzyme carbonic anhydrase is peculiarly activated by zinc, which raises CO_2 volume in chloroplast thereby increasing carboxylation rate of the enzyme RuBisCO where CO_2 is converted into organic carbon sugars through photosynthesis. Severe inadequacy of iron has detrimental effect on cell division and therefore reduces growth of leaves (Mohamed and Aly, 9). It acts as an activator for several biochemical processes such as respiration, photosynthesis and symbiotic nitrogen fixation. These results validate the substantial role of zinc and iron in accumulation of photo-assimilates for growth and development of plants.

The aftermath of foliar spray of zinc and iron examined for flowering characters were found to exhibit significant influence (Table 2). Application of $ZnSO_4$ 0.4% + $FeSO_4$ 0.4% improved No. of flower buds/ plant (4.67), length of flower stalk (15.53 cm), length of pedicel (9.10 cm) and diameter of 1st flower (15.50 cm). Days to flower colour show (47.00) and

Table 1. Effect of foliar application of zinc and iron on growth parameters in lilium cv. Novana.

Treatment	No. of leaves/ plant	Stem dia. (mm)	Plant height (cm)	Fresh wt. of leaves/ plant (g)	Dry wt. of leaves/ plant (g)	Leaf area (cm^2)	Chlorophyll content (SPAD value)
Control (distilled water)	54.00	11.56	44.00	4.13	0.58	194.66	39.67
$ZnSO_4$ 0.2%	47.00	10.67	48.67	4.17	0.55	168.24	42.33
$ZnSO_4$ 0.4%	50.33	11.22	36.33	7.45	0.94	275.47	73.33
$FeSO_4$ 0.2%	50.00	10.37	45.33	4.99	0.63	194.43	51.67
$FeSO_4$ 0.4%	49.67	9.96	47.67	6.15	0.82	279.82	61.33
$ZnSO_4$ 0.2% + $FeSO_4$ 0.2%	50.67	11.56	45.67	4.99	0.62	207.78	53.00
$ZnSO_4$ 0.2% + $FeSO_4$ 0.4%	43.33	10.46	46.33	5.47	0.62	208.34	54.33
$ZnSO_4$ 0.4% + $FeSO_4$ 0.2%	49.33	10.63	43.00	5.40	0.66	224.03	56.33
$ZnSO_4$ 0.4% + $FeSO_4$ 0.4%	57.00	12.26	52.00	8.33	0.98	306.31	68.33
CD at 5%	2.75	1.15	6.82	2.45	0.18	73.57	8.48

Table 2. Effect of foliar application of zinc and iron on flowering parameters in lilium cv. Novana.

Treatment	No. of buds/ plant	Flower stalk length (cm)	Pedicel length (cm)	Days to flower colour show	Days to opening of 1st bud	Diameter of 1st flower (cm)
Control (distilled water)	3.00	12.23	8.13	54.00	55.00	14.50
$ZnSO_4$ 0.2%	3.67	15.20	8.23	49.00	51.33	15.00
$ZnSO_4$ 0.4%	2.50	10.05	7.10	55.00	56.50	14.87
$FeSO_4$ 0.2%	2.33	11.37	8.23	52.67	54.33	15.17
$FeSO_4$ 0.4%	3.00	9.50	7.27	51.67	53.33	14.90
$ZnSO_4$ 0.2% + $FeSO_4$ 0.2%	3.33	12.87	7.87	49.00	51.00	13.87
$ZnSO_4$ 0.2% + $FeSO_4$ 0.4%	3.00	15.20	8.60	47.00	49.67	15.30
$ZnSO_4$ 0.4% + $FeSO_4$ 0.2%	3.00	12.07	8.63	47.00	50.33	14.37
$ZnSO_4$ 0.4% + $FeSO_4$ 0.4%	4.67	15.53	9.10	48.33	50.67	15.50
CD at 5%	1.23	3.84	1.23	3.82	4.21	1.20

days to opening of 1st bud (49.67) were noticed to be early with treatment $ZnSO_4$ 0.2% + $FeSO_4$ 0.4%. Treatment combination of zinc and iron gave exceptional outcomes over $ZnSO_4$ 0.4%, $FeSO_4$ 0.2% and $FeSO_4$ 0.4%. The results were in accord with findings of Hembrom and Singh (5) in lilium. Singh *et al.* (14) also reported beneficial effects of zinc on flowering parameters in gladiolus cv. Pink Friendship. Nasiri and Najafi (12) also reported role of zinc and iron for better flowering in chamomile. Zinc is required in synthesis of tryptophan which is precursor of indole acetic acid (IAA) that helps in axillary growth. It also enact in synthesis of RNA and protein (Moroney, 10). Iron governs reduction of nitrates and sulphates which are imperative for proper development and reproduction of plants (Eskandari, 2).

The impact of foliar spray of zinc and iron on post-harvest quality of lilium are enlisted in Table 3. Postharvest quality determined by longevity of 1st, 2nd and 3rd flower and vase-life has been illustrated in Fig. 1 and 2, respectively. Plants treated with $ZnSO_4$ 0.4% + $FeSO_4$ 0.4% produced spectacular results for all the quality parameters. $ZnSO_4$ 0.4% + $FeSO_4$ 0.4% sprayed plants had the highest longevity of 2nd flower (9.33 days), which was at par with $FeSO_4$ 0.4% and $ZnSO_4$ 0.2% + $FeSO_4$ 0.2% (Fig. 1). Same treatment was observed to be significant to $ZnSO_4$ 0.2%, $ZnSO_4$ 0.4% and $FeSO_4$ 0.4% for longevity of 3rd flower (9.00 days). Higher dose combination of zinc and iron, *i.e.* $ZnSO_4$ 0.4% + $FeSO_4$ 0.4% displayed highest No. of buds opened (4.33) and No. of buds opened at a time (3.33) in vase which was at par with $ZnSO_4$ 0.2% and $ZnSO_4$ 0.2% + $FeSO_4$ 0.2%. Weight of stem on 1st (31.91 g), 3rd (29.48 g) and 5th (23.71) day in vase solution was recorded to be highest in the treatment $ZnSO_4$ 0.4% + $FeSO_4$ 0.4%. Pre-harvest

Table 3. Effect of foliar application of zinc and iron on post-harvest life in lilium cv. Novana.

Treatment	No. of buds opened	No. of buds opened at a time	Stem wt. (g)			Stem wt. (g)
			1st day	3rd day	5th day	
Control (distilled water)	3.00	2.67	23.31	21.61	18.30	7.30
$ZnSO_4$ 0.2%	3.33	3.00	29.55	26.81	23.56	9.43
$ZnSO_4$ 0.4%	2.50	2.50	24.66	23.52	20.68	5.36
$FeSO_4$ 0.2%	2.33	2.33	21.18	19.25	16.93	6.98
$FeSO_4$ 0.4%	2.67	2.33	21.70	20.18	18.06	7.49
$ZnSO_4$ 0.2% + $FeSO_4$ 0.2%	3.33	3.00	26.65	24.82	22.08	8.85
$ZnSO_4$ 0.2% + $FeSO_4$ 0.4%	3.00	3.00	25.07	21.56	19.39	9.31
$ZnSO_4$ 0.4% + $FeSO_4$ 0.2%	3.00	2.67	25.19	21.86	19.74	8.39
$ZnSO_4$ 0.4% + $FeSO_4$ 0.4%	4.33	3.33	31.91	29.48	23.71	10.79
CD at 5%	1.30	0.49	4.53	4.05	3.36	1.85

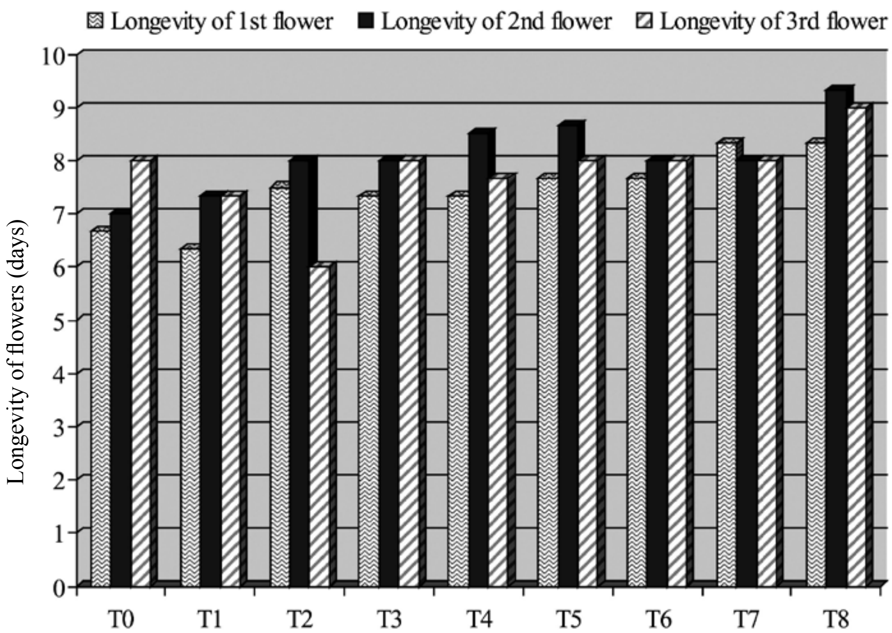

Fig. 1. Longevity of lilium flowers as affected by different treatments of zinc and iron. T0 = control (distilled water), T1 = $ZnSO_4$ 0.2%, T2 = $ZnSO_4$ 0.4%, T3= $FeSO_4$ 0.2%, T4 = $FeSO_4$ 0.4%, T5 = $ZnSO_4$ 0.2% + $FeSO_4$ 0.2%, T6 = $ZnSO_4$ 0.2% + $FeSO_4$ 0.4%, T7 = $ZnSO_4$ 0.4% + $FeSO_4$ 0.2%, and T8 = $ZnSO_4$ 0.4% + $FeSO_4$ 0.4%.

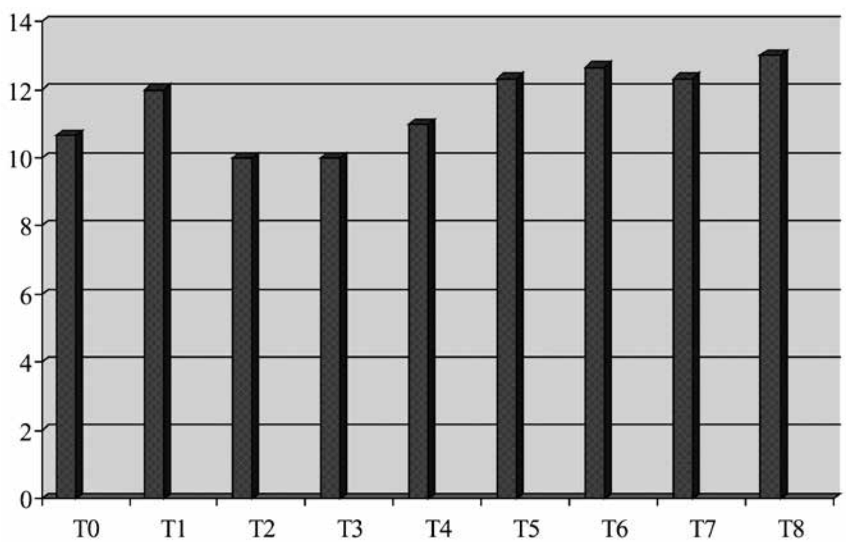

Fig. 2. Vase-life of lilium as affected by different treatments of zinc and iron. T0 = control (distilled water), T1 = $ZnSO_4$ 0.2%, T2 = $ZnSO_4$ 0.4%, T3 = $FeSO_4$ 0.2%, T4 = $FeSO_4$ 0.4%, T5 = $ZnSO_4$ 0.2% + $FeSO_4$ 0.2%, T6 = $ZnSO_4$ 0.2% + $FeSO_4$ 0.4%, T7 = $ZnSO_4$ 0.4% + $FeSO_4$ 0.2%, and T8 = $ZnSO_4$ 0.4% + $FeSO_4$ 0.4%.

treatment of $ZnSO_4$ 0.4% + $FeSO_4$ 0.4% also led to increase in the weight of stem after withering (10.79 g) and enhanced vase-life (13.00 days), which was at par with treatments $ZnSO_4$ 0.2% and $ZnSO_4$ 0.2% + $FeSO_4$ 0.4% (Fig. 2). Singh *et al.* (13) also observed cumulative effect of zinc and iron on various post-harvest parameters in lilium. Fahad *et al.* (3) reported application of zinc and iron to improve vase-life and other postharvest parameters of gladiolus. Similar findings were also cited by Chopde *et al.* (1) in gladiolus and Karuppaiah (6) in chrysanthemum. Zinc has been reported to increase permeability of plasma membranes and stabilizes the bio-membranes. It also determines structural orientation of macromolecules present within membranes and controls the membrane integrity. Therefore, zinc aids in proper absorption and translocation of vase solution and helps in maintaining turgidity and integrity of cells so that flowers can be kept in vase for longer duration. This study has demonstrated the positive effect of micronutrients like zinc and iron on growth and development of lilium.

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