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HORTICULTURE

Effect of iron and zinc on growth, flowering and bulb yield in lilium

Raimani Hembrom*[1] and Anil K. Singh[2]

[1]Indian Institute of Horticultural Research, Division of Ornamental Crops, Hesaraghatta, 560 089, Bengaluru, India.
[2]Banaras Hindu University, Institute of Agricultural Sciences, Department of Horticulture, 221 005, Varanasi, India.

*Corresponding author: rai.summer@gmail.com

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ABSTRACT

Lilium is a bulbous plant having non-tunicate bulbs. They are popular throughout the world for their exotic colours and fragrance, making them ideal cut flowers. A trial was conducted to study the effect of foliar spray of iron and zinc in form of sulphate to see their effect on growth, flowering and bulb yield attributes in lilium. Bulbs of lilium cv. Tresor were planted under polyhouse condition and different combinations of iron sulphate and zinc sulphate at 0.2% and 0.4% were applied as foliar spray at 30 and 45 days after planting. Experiment was laid out in a randomized block design with 3 replications. Foliar application of FeSO4 0.2% promoted length of flower stalk and diameter of 1st flower, while its higher dose (FeSO4 at 0.4%) increased the number of buds plant-1 and weight of bulbs plant-1. Foliar treatment of ZnSO4 at 0.4% significantly enhanced the number of bulblets plant-1, number of scales bulb-1, diameter of 1st flower and diameter of bulb. Different treatment combinations of iron sulphate and zinc sulphate also affected various characters like number of leaves plant-1, diameter of stem, days to colour show and days to opening of 1st bud.

Highlights

- The combined spray of iron and zinc sulphate improved growth characteristics.
- Flowering parameters got enhanced by iron and zinc sulphate individually.
- Zinc sulphate increased bulb yield of lilium.

Keywords: Lilium, Iron sulphate, Zinc sulphate, Growth, Flowering, Bulb yield

Lily is a herbaceous flowering plant belonging to the genus Lilium and family Liliaceae. They have large prominent and fragrant flowers which bloom in rainbow colours. Liliums are propagated through non-tunicate bulbs. Most of the species of lilium are native to temperature northern hemisphere. Lily flowers make up brilliant cut flowers with their massive flowers and pleasant fragrance. It ranks 4th among top ten cut flowers in the world (Abd-Allah *et al.*, 2013). There are two major groups of lilium which dominate the world market i.e. Asiatic lily and Oriental lily. Asiatic lilies provide a wide range of colours of flowers, whereas Oriental lilies have obsolete fragrance. Prolonged vase life of lilium renders them to be excellent cut flower. Flowering bulbous plants require macro- and micronutrients for quality growth, flowering and bulb production. Recently, use of micronutrients essentially in fertilization of plants is gaining momentum due to their potentiality to enhance plant growth, flowering

and yield. But the deficiency of micronutrients especially iron and zinc is a major problem in most of the developing countries in the world (Sharma *et al.*, 2014). The deficiency of micronutrients results in different physiological abnormalities like chlorosis, rosetting and scorching etc. (Singh *et al.*, 2012). Iron is associated with formation of chlorophyll and acts as a catalyst in several reactions in plant metabolism. It plays a key role in photosynthesis and respiration pertaining to its property of being an oxygen carrier. Iron is also the most important element of all the micronutrients for plant tissue growth (George and Manuel 2013). Zinc participates in synthesis of auxins and hence, enhances plant growth (Sarwar *et al.*, 2012). It is also involved in carbon dioxide evolution, carbohydrate and phosphorus metabolism and synthesis of RNA. Foliar spray of iron and zinc is one of the best methods for rectifying their deficiency (Woltz 1972). Not much work has been done on the aspect regarding effect of iron and zinc on growth, flowering and yield particularly in Asiatic lilies. Therefore, this study was undertaken with objective to find out the response of Asiatic lily cv. Tresor to different doses of iron and zinc.

Materials and Methods

The experiment was carried out under polyhouse at Horticulture Research Farm, Institute of Agricultural Sciences, BHU, Varanasi, India in 2013-14. Healthy and disease free bulbs of lilium were planted at a spacing of 25 cm × 20 cm in individual plot size of 1.00 × 0.8 m^2. Pre-harvest treatments of iron sulphate and zinc sulphate were given, individually and in different combinations i.e. $FeSO_4$ 0.2%, $FeSO_4$ 0.4%, $ZnSO_4$ 0.2%, $ZnSO_4$ 0.4%, $FeSO_4$ 0.2% + $ZnSO_4$ 0.2%, $FeSO_4$ 0.2% + $ZnSO_4$ 0.4%, $FeSO_4$ 0.4% + $ZnSO_4$ 0.2% and $FeSO_4$ 0.4% + $ZnSO_4$ 0.4% as foliar application to lilium cv. Tresor at 30 and 45 days after planting. Experiment was laid out in Randomized Block Design with three replications for each treatment. All the cultural operations like weeding, staking, etc. were practiced when required. Various growth parameters like number of leaves/plant, diameter of stem, fresh and dry weight of a leaf, flowering parameters such as number of buds/plant, length of flower stalk, days to colour show and opening of 1st bud and diameter of 1st flower and bulb parameters viz., number of bulbs/plant, bulblets/plant and scales/bulb, weight of bulbs/plant and diameter of bulb were recorded from the treated plants and statistically analyzed.

Results and Discussion

Growth Characters

Data revealed in Table 1, clearly indicated that foliar spray of combination of iron sulphate and zinc sulphate was effective in influencing various growth parameters such as number of leaves/plant, fresh weight of a leaf, dry weight of a leaf and diameter of stem. However, all the treatments failed to produce any significant results for fresh weight of a leaf and dry weight of a leaf in the treated plants. Treatment combination of $FeSO_4$ 0.2% + $ZnSO_4$ 0.4% resulted into maximum number of leaves $plant^{-1}$ (88.67). It was significant to $ZnSO_4$ 0.2%, $ZnSO_4$ 0.4% and control. Foliar application of $FeSO_4$ 0.4% + $ZnSO_4$ 0.4% significantly increased the diameter of stem (15.99 mm) which was found to be significant over

Table 1 Effect of iron and zinc on growth characters

Treatment	Number of leaves $plant^{-1}$	Fresh weight of leaf (g)	Dry weight of leaf (g)	Diameter of stem (mm)
Control	65.33	0.25	0.03	11.16
FeSO4 0.2%	83.33	0.22	0.03	13.99
FeSO4 0.4%	80.67	0.24	0.03	15.48
ZnSO4 0.2%	74.00	0.17	0.02	11.75
ZnSO4 0.4%	71.66	0.20	0.03	12.55
FeSO4 0.2% + ZnSO4 0.2%	87.67	0.19	0.02	12.26
FeSO4 0.2% + ZnSO4 0.4%	88.67	0.14	0.02	12.28
FeSO4 0.4% + ZnSO4 0.2%	78.33	0.16	0.02	11.52
FeSO4 0.4% + ZnSO4 0.4%	86.33	0.22	0.03	15.99
C.D. at 5%	13.36	NS	NS	3.48

Table 2 Effect of iron and zinc on flowering characters

Treatment	Number of buds plant^{-1}	Length of flower stalk (cm)	Days to colour show	Days to opening of 1st bud	Diameter of 1st flower (cm)
Control	2.67	10.00	51.00	54.33	13.83
$FeSO_4$ 0.2%	4.00	13.83	51.67	53.33	15.07
$FeSO_4$ 0.4%	4.67	11.33	47.67	51.33	13.90
$ZnSO_4$ 0.2%	3.33	10.67	47.33	50.33	15.07
$ZnSO_4$ 0.4%	4.67	10.33	52.67	54.67	14.52
$FeSO_4$ 0.2% + $ZnSO_4$ 0.2%	4.33	8.67	45.33	47.33	14.32
$FeSO_4$ 0.2% + $ZnSO_4$ 0.4%	3.33	11.67	48.33	52.00	14.17
$FeSO_4$ 0.4% + $ZnSO_4$ 0.2%	4.00	10.87	47.00	49.33	14.46
$FeSO_4$ 0.4% + $ZnSO_4$ 0.4%	3.67	11.00	51.00	52.67	14.18
C.D. at 5%	1.04	2.90	5.73	5.83	0.95

untreated plants (11.16 mm). Iron and zinc were reported to act as important catalyst in several metabolic reactions occurring in plants and also contribute in accumulation of bio-synthates through various processes and hence vegetative growth is enhanced. These findings were in agreement with the results of Balakrishnan (2005) and Memon *et al.*, (2013).

Flowering Characters

It is inferred from the data given in Table 2 that $FeSO_4$ and $ZnSO_4$ at various concentrations have altered different flowering parameters studied i.e. number of buds plant^{-1}, length of flower stalk, days to colour show, days to opening of 1st bud and diameter of 1st flower. Length of flower stalk and diameter of 1st flower was observed to be enhanced to a maximum measurement of 13.83 cm and 15.07 cm, respectively at foliar dose of $FeSO_4$ 0.2%, whereas number of buds plant^{-1} (4.67) was found to be maximum in plants treated with $ZnSO_4$ at 0.4% dose. Both the treatments have shown effects which were significant over control plants. Iron and zinc might be responsible for synthesis of bio-assimilates which leads to more number of leaves and eventually partitioning of floral growth. Foliar dose of $ZnSO_4$ at 0.2% was also noticed to increased diameter of 1st of flower (15.07 cm). Foliar spray of combination of iron sulphate and zinc sulphate both at 0.2% contributed to early days to colour show (45.33 days) and opening of 1st bud (47.33). Involvement of iron and zinc in photosynthesis with enhanced carbohydrate assimilation results in luxurious vegetative and floral growth. Iron has been reported to induce production of healthy green leaves and hence lead to greater distribution of assimilates to floral parts. Khalifa *et al.*, (2011) also observed similar effects of iron and zinc on treated plants.

Bulb Characters

Foliar application of zinc sulphate was registered to be more effective as compared to iron sulphate in enhancing the yield attributes in lilium by increasing the number of bulblets plant^{-1}, number of scales bulb^{-1}, weight of bulbs plant^{-1} and diameter of bulb (Table 3). However all the doses of zinc sulphate and iron sulphate failed to exert any conspicuous effect on number of bulbs plant^{-1} and weight of bulblets plant^{-1}. $ZnSO_4$ at 0.4% treated plants showed significant increase in number of bulblets plant^{-1} (5.00), number of scales bulb^{-1} (11.00), weight of bulblets plant^{-1} (0.42 g) and diameter of bulb (3.05 cm). All the plants treated with foliar dose of $ZnSO_4$ at 0.4% gave better results than control plants for these characters. Zinc is known to be involved in formation of auxins which eventually leads to development of seeds. These findings were supported by Eid *et al.*, (2010) and Singh *et al.*, (2012). Application of foliar $FeSO_4$ at 0.4% treatment performed significantly and the treated plants were observed for attaining maximum weight of bulbs (12.61 g). This result was in accord with the findings of Rao (2005).

Table 3. Effect of iron and zinc on bulb parameters

Treatments	Number of bulbs plant^{-1}	Number of bulblets plant^{-1}	Number of scales bulb^{-1}	Weight of bulbs plant^{-1} (g)	Weight of bulblets plant^{-1} (g)	Diameter of bulb (cm)
Control	1.00	1.00	7.67	5.90	0.06	2.58
$FeSO_4$ 0.2%	1.00	2.00	5.33	9.02	0.26	2.91
$FeSO_4$ 0.4%	1.00	2.33	5.33	12.61	0.17	2.93
$ZnSO_4$ 0.2%	1.00	1.33	9.00	6.40	0.04	2.93
$ZnSO_4$ 0.4%	1.00	5.00	11.00	10.02	0.42	3.05
$FeSO_4$ 0.2% + $ZnSO_4$ 0.2%	1.00	3.33	7.67	10.63	0.32	2.87
$FeSO_4$ 0.2% + $ZnSO_4$ 0.4%	1.00	1.67	7.67	7.13	0.07	2.68
$FeSO_4$ 0.4% + $ZnSO_4$ 0.2%	1.00	2.33	7.33	6.52	0.13	3.02
$FeSO_4$ 0.4% + $ZnSO_4$ 0.4%	1.00	1.00	9.67	10.50	0.35	2.88
C.D. at 5%	NS	1.60	4.22	5.94	NS	0.24

Conclusion

On the basis of above findings it may be concluded that foliar spray of combination of iron sulphate and zinc sulphate were observed to be significant in improving the plant growth. Both iron sulphate and zinc sulphate individually and in combination helped in strikingly improving its flowering characteristics. However, application zinc sulphate rendered more bulbs and bulblets in lilium than iron sulpahte. Thus it can be assumed that application of micronutrients such as iron and zinc should not be overlooked in flower crops. Further researches are required to determine other micronutrients which are inevitable in quality improvement of flowers.

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