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Research Article

EFFECT OF MULTI- MICRONUTRIENT FORMULATIONS ON GROWTH, FLOWERING BEHAVIOUR AND YIELD IN RATOON CROP OF SPIDER LILY (*Hymenocallis literolis* L.) *CV.* LOCAL

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Abstract- An experiment aspired to evaluate the effect of multi micronutrient formulations as foliar application as well as soil application on growth, flowering behaviour and yield of ratoon spider lily crop under field condition. The experimental material, spider lily is a principle loose flower crop in Gujarat state. The spider lily crop suffers from micronutrient deficiency when cultivated in black calcareous soil of Saurashtra region. The various standard grades of formulations consisted of five micro nutrients *i.e.* Fe, Mn, Zn, Cu and B and converted to a set of eight treatments as foliar as well as soil application and laid out in Randomized Block Design. The treatment grade-IV (Fe-4%, Mn-1%, Zn-6%, Cu-0.5% and B-0.5%) foliar application of micronutrients found to be significantly better for plant growth and flowering as compared to the other treatments including control (T_1). The treatment recorded significantly highest plant height (86.35 cm), number of leaves (96.13), leaf area (304.55 cm^2), chlorophyll content (24.23 CCI), number of flowers per stalk (23.27), flowers per plant (206.15) and ultimately flower yield per hectare (30,922 bundles/ha). Essentially, this foliar treatment effect found to be statistically at par with treatment T_8 (soil application of micronutrients as per soil test value). Application of multi micronutrient formulations found significant for improving growth and flowering of ratoon spider lily. Foliar application of multi micronutrient formulation grade – IV or equivalent micronutrient formulation or soil application of micronutrients as per soil test value would be effective to correct micronutrient imbalance and improve flower yield.

Keywords- Spider Lily, Micronutrients, Formulations, Foliar Spray, Soil Application

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Introduction

Spider lily or the Beach Spider lily (*Hymenocallis literolis*) is a bulbous flowering plant that belongs to the plant family *Amaryllidaceae*. It is bulbous perennial herb. The lovely white flowers have long, narrow reflexed petals behind a central cup. Several flowers are carried on each sturdy 70-90 cm stem. The farmers use popularly growing spider lily for remunerative prices, pleasant fragrance and attractive white flowers. It is used as loose flower for offering to the God, garland making, veni, gajra and for bridal car decoration, pergolas and stage decoration in various social functions. Therefore, it has year round market demand and has gained commercial importance. There is no any specific cultivar in this crop, but generally they are of two types; one is narrow with dark green leaves which flowers only in the rainy season and another with broad and medium green leaves which produce flowers round the year. Generally, unopened flower buds are harvested from the stalk during morning or evening every day so as to keep the flower buds fresh as they have short vase life. Due to the above mentioned important aspects and easy culture in the high rainfall zone, the crop gaining popularity among growers in south Gujarat, where the spider lily is cultivated in an area of approximately 900 ha with productivity of 27-30 lakh buds per ha/year.

The farmers of spider lily are facing constraints in cultivation due to various deficiency symptoms of micronutrients during the growing period of the crop. Spider lily expresses yellowing symptoms on leaves due to micronutrient deficiencies [15]. Among all the micronutrients which affect plant growth, Zinc and Iron plays a major role in plant growth and development. These micronutrients affect the growth of plants in terms of vegetative growth, flowering characters and flower yield and quality. The possible effects of multi-micronutrients formulations on flower yield are abundantly in the literature supported by the results of [5] in chrysanthemum; [9,14] in gladiolus; [4,17] in tuberose and [20] in gerbera.

Materials and Methods

The experiment was carried out at Horticulture Instructional Farm, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat state, during March 2015 to August 2015. Climate of this region is typically subtropical characterized by fairly cool and dry winter, hot and dry summer and warm and moderately humid monsoon. The experiment consisted of eight treatments; these treatments were of different grades of micronutrients involved four foliar applications and two soil applications notified by Gujarat government. Micronutrient mixtures were prepared with notified levels of Fe, Mn, Zn, Cu and B for each formulation. The detail of various treatments as follows:

T_1	Control
T_2	Local Formulation Grade – I (General) (Foliar spray)
T_3	Local Formulation Grade – II (for Zn deficiency) (Foliar spray)

T_4 Local Formulation Grade – III (for Fe deficiency) (Foliar spray)
T_5 Local Formulation Grade – IV (for Zn & Fe deficiency) (Foliar spray)
T_6 Local Formulation Grade – V (soil application @ 20 kg/ha)
T_7 Local Formulation Grade – V (soil application @ 40 kg/ha)
T_8 Micronutrient application as per soil test value (STV)

The treatments T_2, T_3, T_4 and T_5 are applied as micronutrient foliar spray @ 1%; treatments T_6 and T_7 are soil application @ 20 kg/ha and 40 kg/ha respectively. The treatment T_8 was a soil application as per soil test value (15 Kg $FeSO_4$ and 8 Kg $ZnSO_4$ per hectare). The leaf cutting of standing crop of spider lily had been carried out manually in March 2015. The crop cut down up to the neck of bulb or just above the ground level. Followed by leaf cutting the field was prepared with bunds and irrigation channels. There is a phenomenon called hysteranthous flowering in spider lily like football lily in which bulbs straightaway produce flower spikes and later develop the leaves. If the beginning stalks permitted to flower it may cause poor plant growth. Hence to maintain good plant vigour initial flower stalks were removed with sharp knife without causing damage to the plant.

Four grades of foliar solution were prepared by dissolving prescribed micronutrients at precise quantity. These foliar sprays were applied at the rate of 1% spray in three intervals likely 30, 45 and 60 days after leaf cutting. On the other hand three treatments as soil application delivered. The treatments of soil application furnished as single time application after leaf cutting. Observations on flowering and flower yield parameters were recorded from first flower emergence to completion of flowering. Simultaneously growth parameters were recorded at full bloom stage. Statistical analysis of the individual data of various characters studied in the experiment was carried out as per Randomized Block Design (RBD) through computer. Analysis of variance was worked out using standard statistical procedures as described by [16].

Results and Discussion

The multi micronutrient formulations significantly influenced the vegetative growth on ratoon crop of spider lily. Treatments showed a considerable increase in plant biometric characters. Specifically the treatments of foliar application consist of five important micronutrients with special reference to Zinc and Iron influenced favourably. [Table-1] elucidates that the treatment T_5 (Grade – IV –Foliar spray) designed for both Zinc and Iron deficiency exhibited highest average of vegetative growth characters studied. Essentially the highest average plant height (86.35 cm), leaves per plant (96.13), leaf width (7.29 cm), leaf length (75.81 cm), leaf area (604.55 cm2) and chlorophyll content (24.23 CCI) observed from the treatment T_5.

Table-1 *Effect of multi- micronutrient formulations on growth parameters of ratoon crop of spider lily*

T. No.	Plant height (cm)	Number of leaves per plant	Leaf width (cm)	Leaf length (cm)	Leaf area (cm^2)	Chlorophyll content (CCI)
T_1	71.06	82.27	5.59	62.65	264.43	16.20
T_2	74.63	84.40	5.88	63.65	269.13	17.04
T_3	77.01	87.20	6.39	64.88	282.56	20.07
T_4	77.27	88.67	6.43	68.86	294.81	18.19
T_5	86.35	96.13	7.29	75.81	304.55	24.23
T_6	75.49	84.10	5.91	64.51	264.50	17.02
T_7	78.31	92.53	6.69	69.22	295.55	18.14
T_8	83.57	95.20	7.07	72.86	302.19	23.45
S.Em.±	2.72	3.10	0.27	2.53	9.95	1.09
C.D. at 5 %	8.27	9.42	0.83	7.67	30.19	3.30

Calcareous soils usually suffer from a lack of micronutrients, especially Zinc and Iron. Supply of essential micronutrients in the form of foliar spray can be easily absorbed by the plant tissue and correct the deficiency quickly. Bioavailability of all four metallic micronutrients is affected by soil pH, decreasing with increasing soil pH. Solubility of Iron decreases for each unit increase in soil pH in the range 4 to 9 [11]. Consequently, most Iron deficiencies occur on calcareous soils. Increase in plant growth due to Iron that acts as an important catalyst in the enzymatic reactions of the metabolism and would have helped in the larger biosynthesis of photo assimilates, thereby enhancing growth of the plants. These are component of many enzymes associated with energy transfer, nitrogen reduction and fixation, and lignin formation. Iron is associated with sulphur in plants to form compounds that catalyze other reactions [12]. Micronutrients are involved in all metabolic and cellular functions. Plants differ in their need for different micronutrients. These elements are active that makes them essential as catalytically active cofactors of enzymes, others have enzyme-activating functions, and yet others fulfil a structural role in stabilizing proteins. Improvement in growth characters due to micronutrient application might basically be due to enhanced photosynthetic and other metabolic activities related to cell division and elongation [7]. Iron deficiency is common in alkaline soil with typical chlorosis; the young leaves turning yellowish with veins remaining green. Iron application increased the levels of all leaf pigments, but the extent of increase in level depends on the pigment affected [19]. Boron is essential for plant growth, new cell division in meristematic tissue, translocation of sugar, starch, nitrogen, phosphorus, certain hormones, synthesis of amino acids and protein, regulations of carbohydrate metabolism, development of phloem etc. In the absence of adequate supply, middle lamella of new cell develops poorly and phloem tubes break down [2]. Similarly [1] reported that foliar spray of $ZnSO_4$ and $FeSO_4$ formulation increased leaf characters in crossandra.

The analysis of variance presented that the treatment T_5 (Grade – IV foliar spray for both Zinc and Iron deficiency) to exhibit favourable influence on flowering parameters [Table-2] the highest flowering duration (12 days) and minimum days for first flower emergence (25 days). The significant influence on flower quality parameters *viz*., flower stalk length, flower diameter and length of flower buds recorded from soil application treatments. Treatment T_8 (Micronutrient application as per soil test value) recorded highest flower stalk length (70.59 cm). The highest flower diameter (25.03 cm) and flower bud length (19.74 cm) observed from the treatment T_7 (Grade – V Soil application at 40 kg/ha). As a constituent of various enzymes, Iron plays the part of a vital catalyst in the plant. Iron acts as catalyst in the synthesis of chlorophyll molecule and helps in the absorption of other elements. It is a key element in various redox reactions of respiration, photosynthesis and reduction of nitrates and sulphates [21,22]. Zinc is effective in plant nutrition for the synthesis of plant hormones and balancing intake of P and K inside the plant cells. Zinc also increases the green pigments of necrotic leaf of plants [19]. Copper is essential for photosynthesis and mitochondrial respiration, for carbon and nitrogen metabolism, for oxidative stress protection, and is required for cell wall synthesis [3]. The primary role of Boron in plants is to improve Calcium

metabolism and improved solubility and mobility of Calcium and helps in absorption of Nitrogen. It involves in metabolism and transport of carbohydrates, regulation of meristematic tissue cell synthesis, lignification, growth regulatory metabolism, phenol metabolism and integrity of membranes, root elongation, DNA synthesis, pollen formation and pollination [18]. The results are in accordance with findings [10] in China aster through the application of micronutrient mixtures of $ZnSO_4$ and $FeSO_4$. Similar reports cited from [13,20] in gerbera.

Table-2 *Effect of multi-micronutrient formulations on flowering and flower quality parameters of ratoon crop of spider lily*

T. No.	First flower emergence (Days)	Flowering duration (Days)	*in situ* longevity (Days)	Flower stalk length (cm)	Flower diameter (cm)	Length of flower buds (cm)
T_1	26.40	9.93	2.07	56.41	21.05	17.32
T_2	26.07	10.13	2.00	59.74	22.55	18.59
T_3	25.13	10.20	2.07	61.85	22.83	18.63
T_4	25.07	10.67	2.20	63.85	23.75	18.91
T_5	25.00	12.00	2.20	68.56	24.57	19.38
T_6	24.80	10.07	2.07	58.93	22.78	17.56
T_7	23.00	10.60	2.00	63.27	25.03	19.74
T_8	22.57	11.07	2.20	70.59	23.75	18.95
S.Em.±	0.79	0.29	0.08	2.88	0.67	0.43
C.D. at 5 %	2.40	0.90	NS	8.74	2.02	1.31

The results obtained on flower yield parameters [Table-3] were obviously improved by the foliar application of five important micronutrients. The foliar spray with improved Zinc and Iron concentration proved to be having a significant effect on flower yield. However, there was a decrease in the average flower yield as Iron and Zinc concentrations decreased. This elucidates the important role of Zinc and Iron micronutrients in plant growth as well as flower yield. The significant flower yield characters observed significantly highest are; flowers per stalk (23.27), flower stalks per plant (8.87) and flowers per plant (206.15) from the treatment T_5 (Grade – IV –Foliar spray for both Zinc and Iron deficiency). Ultimately the highest flower yield (30922 bundles /hectare) was also obtained from the treatment T_5.

Table-3 *Effect of multi- micronutrient formulations on flower yield parameters of ratoon crop of spider lily*

T. No.	Flowers per stalk	Flower stalks per plant	Flowers per plant	Flower yield (Bundles/ha)
T_1	16.33	6.47	105.83	15874.00
T_2	17.53	7.07	123.84	18576.00
T_3	18.73	7.20	135.09	20264.00
T_4	18.87	7.93	149.53	22430.00
T_5	23.27	8.87	206.15	30922.00
T_6	17.13	7.53	129.03	19354.00
T_7	19.80	7.73	153.00	22950.00
T_8	21.27	8.67	184.24	27636.00
S.Em.±	0.58	0.61	6.57	986.16
C.D. at 5 %	1.77	1.84	19.94	2991.50

* Each bundle consisted 50 flower buds.

Iron is also of great importance for life of plant. As redox-active metal, it is involved in photosynthesis, mitochondrial respiration, nitrogen assimilation, hormone biosynthesis (ethylene, gibberellic acid, jasmonic acid), production and scavenging of reactive oxygen species, osmoprotection and pathogen defense [6]. Zinc is important as a component of enzymes for protein synthesis and energy production and maintains the structural integrity of bio membranes. Zinc plays an important role in seed development and Zinc-deficient plants show delayed maturity. Zinc is required for the synthesis of auxin (IAA), carbohydrate metabolism, protein synthesis, internode elongation for stem growth and in pollen formation [18]. Zn^{2+} ions at low concentration (0.01 ppm) slightly enhance the activity of tryptophan synthesis leading to biosynthesis of auxin [8]. The possible effects of multi-micronutrient formulation on flower yield also supported by the results of [5] in chrysanthemum; [9] and [14] in gladiolus; [4,17] in tuberose and [20] in gerbera.

Conclusion

Foliar application of multi micronutrient formulation grade –IV or equivalent micronutrient formulation thrice at fortnight interval or soil application of micronutrients as per soil test value at the time of leaf cutting would be effective to correct micronutrient imbalance in the spider lily plant besides and improving flower yield in its ratoon crop of spider lily.

Conflict of Interest: None declared

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