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Research Article

Optimization of Zinc, Magnesium and Calcium on Growth and Flowering of *Rhynchostylis retusa* L.

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Abstract

In order to assess the optimization of zinc, magnesium and calcium on growth and flowering of *Rhynchostylis retusa* L. an experiment was carried out in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, under the shade net house using CRD with three replication during 2014-15 and 2015 - 2016. The treatments viz., T_1 (RDF + Zn 250 ppm), T_2 (RDF + Zn 500 ppm), T_3 (RDF + Zn 750 ppm), T_4 (RDF + Mg 250 ppm), T_5 (RDF + Mg 500 ppm), T_6 (RDF + Mg 1000 ppm), T_7 (RDF + Ca 250 ppm), T_8 (RDF + Ca 500 ppm), T_9 (RDF + Ca 1000 ppm) were applied as foliar spray at an interval of 15 days along with fertilizer mixture 19 NPK @ 2 gm per liter and T_{10} (control) was sprayed only with fertilizer mixture 19 NPK. The result revealed that T_8 (RDF + Ca 500 ppm) was the best treatment for increasing the growth characters viz., plant height (41.30 cm), number of leaves per plant (8.71), and leaf area per plant (1025.55 cm^2) and T_3 (RDF + Zn 750 ppm) was found superior in respect of all flower characters viz. bud visibility to first floret open (79.16 days), full bloom (83.84 days), spike length (42.22 cm), floret diameter (3.50 cm), number of florets per spike (89.34), number of spike per plant (4.08), self-life (16.54 days) and vase life (11.48 days).

Keywords: Calcium; Growth; Flowering; Magnesium; Rhynchostylis retusa L.; Zinc

Introduction

Foxtail orchid (*Rhynchostylis retusa* L.) is a monopodial, epiphytic orchid species with beautiful flowers arranged in racemose inflorescence, which make the species popular among the people of Assam and North East India. Traditionally *Rhynchostylis retusa* L. is popularly used during *Rongali Bihu* festival for adorning hair by the young ladies. In recent years due to its special flower shape, multitude of flower color, long-lasting flowers and fragrance *Rhynchostylis retusa* L. is gaining popularity as a potted plant. Additionally, reliable manipulation of flowering time and ability to produce high quality spikes are important commercial consideration. Application of adequate amount of nutrients is one of the simplest and beneficial practice used to exploit the yield potential of this crop because mineral nutrients play an important role in various metabolic processes in the plant cells [1]. In order to commercialize and quality production of *Rhynchostylis retusa* L. there is need standardization of nutrition supplement. When nutrient requirements are not met or are only partially met plants exhibit characteristic deficiency symptoms that, if severe enough, result in plant death [2]. Frequent application of fertilizers in low concentrations is the best way of feeding of orchids. To get quality flowers, nutrient optimization is required and there is a need of estimation of its growth pattern, consumption of nutrients and relative effectiveness of different nutrient levels on its health and vigor.

Materials and Methods

The experiment was conducted in the shade net house of the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2014-15 and 2015-16, to study the "optimization of zinc, magnesium and calcium on growth and flowering of *Rhynchostylis retusa* L". The experiment was laid out in Completely Randomized Design (CRD) with 10 treatments replicated thrice. The treatments were T_1 (RDF + Zn 250 ppm), T_2 (RDF + Zn 500 ppm), T_3 (RDF + Zn 750 ppm), T_4 (RDF + Mg 250 ppm), T_5 (RDF + Mg 500 ppm), T_6 (RDF + Mg 1000 ppm), T_7 (RDF + Ca 250 ppm), T_8 (RDF + Ca 500 ppm), T_9 (RDF + Ca 1000 ppm) T_{10} (control). The source of zinc, magnesium and calcium were zinc sulphate heptahydrate ($ZnSO_4.7H_20$), magnesium sulphate heptahydrate ($MgSO_4.7H_20$) and calcium nitrate tetrahydrate ($Ca(NO_3)_24H_20$), respectively. All the treatments applied as foliar spray at 15 days interval (from October 2014 to September 2016). The planting materials used were collected from Naharkotia area during the month of April 2014. Bamboo basket was used as support and Coco- husk as growing media which were treated for termites and growing supports were placed in 60 cm raised platforms (Bench system). Fertilizer mixture NPK- 19:19:19 @ 2g/L was given twice a week as foliar spray.

Growth attributes (plant height, number of leaves per plant and leaf area) and the flower attributes (days taken from bud visibility to first floret open, days to full bloom from bud visibility, spike length, number of florets per spike, number of spikes per plant, floret diameter, self-life of spike and vase life of spike) were recorded for 2 consecutive years of 2014-15 and 2015-16. Averages were taken on two years of datasets and analysed using Fisher's method of analysis of variance in CRD as described by Panse and Sukhatme [3].

Result and Discussion

Growth attributes

There were significant differences in the treatments for all the growth characters. Application of Ca 500ppm significantly increased the plant growth characters like plant height, number of leaves per plant and leaf area per plant in both the years. The highest plant height of 41.30cm was recorded by T_8 (RDF + Ca 500 ppm) followed by T_3 (RDF + Zn 750 ppm) showing 40.45cm compared to control treatment (T_{10}). Similar observations of increasing the plant height due to increased level of calcium were made by Valasakumari., *et al.* [4] in Anthurium and Naik., *et al.* [5] in *Cymbidium* hybrid. Similarly, number of leaves per plant registered 8.71 and leaf area registered 1025.55 cm^2 with the above application dose of Ca followed by T3 (RDF + Zn 750 ppm) showing 7.75, 950.34 cm^2 respectively as compared with control. The favourable effect of calcium in promoting the growth of the plant might be due to Calcium is having a major influence on cell metabolism, cell wall structure and integral part of the cell wall, involved in cross linkage of pectic molecules. They also reported that calcium involved a number of growth responses include mitosis, cytoplasmic streaming, gravitropism, phytochromes responses and the action of cytokine, gibberellin and auxin [6].

Flower attributes

Application of Zn 750 ppm positively influenced the flowering characters like days from bud visibility to first floret open,days to full bloom from bud visibility, spike length, number of florets per spike, number of spikes per plant, self-life of spike and vase life of spike. The minimum days taken from bud visibility to first floret open and full bloom from bud visibility were recorded in T_3 (RDF + Zn 750 ppm) 79.16 and 83.84 days respectively. This treatment resulted earliness in flowering which recorded 10 days reduction to full bloom compared to the control. Zinc application improves the nutritional status within plants which moves from leaves to shoot apical meristem to induce early flowering [7]. This was followed by M8 (RDF + Ca 500ppm) i.e. 83.06 days and 86.88 days respectively. Similarly, Khosa., *et al.* [8] reported that foliar application of micro nutrients (Zn, B, Fe, Mn) in combination with macro nutrients have positive impact which influenced the days to first flower emergence in *Gerbera jamesonii*. This might be due to the fact that zinc exhibits proper hormonal level within plants [9], which induces early maturity and thus causes early flowering [10]. The maximum spike length of 42.22 cm was exhibited by T_3 (RDF + Zn750 ppm) which was followed by T_8 (RDF + Ca 500 ppm) i.e. 39.82 cm. The increase in spike length might be due to the fact that zinc concentration induces accumulation of amino acids and reducing sugars in plant tissue which are needed for improvement of spike [11]. Maximum and significant increase in number of florets per spike (89.34) and number of spikes per plant (4.08) had been recorded for same treatment and were followed by T_8 (RDF + Ca 500 ppm). The increase of these characters could be attributed to increase in photosynthesis with enhanced carbohydrate fixation in plants treated with zinc which might have caused luxurious vegetative growth and helped in increasing flower numbers. These all finding are in close agreement with Ganga., *et al.* [12] in *Dendrobium* cv. Sonia 17 and Aruna., *et al.* [13] in crossanda. Moreover, the maximum floret diameter was exhibited by T_3 (RDF + Zn 750 ppm) i.e. 3.50 cm, significantly higher than rest of the treatments which was followed by T_8 (RDF + Ca 500 ppm) 3.34 cm, T_6 (RDF + Mg 1000 ppm) 3.27cm and T_7 (RDF + Ca 250 ppm) 3.26 cm and these all were at par. T_3 (RDF + Zn 750 ppm) recorded the highest self life (16.54 days) and vase life (11.48) compared to control (9.26 days and 5.97 days, respectively). The increase in self life of the flowers due to foliar application of zinc was observed in present study could be attributed to the role of zinc in retarding the formation of abscission layer in flower pedicel leading to prevention of flower drop. Again, Zn being an activator of certain enzyme could regulate anti-oxidative activities. Therefore, it could potentially enhance the vase life by scavenging the reactive oxygen species (ROS) to cope with oxidative damage and retaining the membrane integrity [14]. Similar results were reported by Ganga., *et al.* [12] in Dendrobium orchid cv. Sonia 17 and Nagaraju., *et al.* [15] in Rose.

Treatments	Plant height (cm)	Number of leaves per plant	Leaf area (cm^2)
T_1 (RDF + Zn 250 ppm)	36.90	5.28	745.13
T_2 (RDF + Zn 500 ppm)	37.89	6.06	767.02
T_3 (RDF + Zn 750 ppm)	40.45	7.75	950.34
T_4 (RDF + Mg 250 ppm)	36.85	6.95	815.30
T_5 (RDF + Mg 500ppm)	36.90	6.39	777.81
T_6 (RDF + Mg 1000 ppm)	37.80	6.78	824.45
T_7 (RDF + Ca 250 ppm)	37.76	7.05	800.47
T_8 (RDF + Ca 500ppm)	41.30	8.71	1025.55
T_9 (RDF + Ca 1000 ppm)	37.69	6.56	729.74
T_{10} (Control)	35.67	4.67	633.18
Mean	37.92	6.62	806.90
S.Ed	0.50	0.44	20.94
C.D 0.05	1.04	0.93	43.76

Table 1: Effect of zinc, magnesium and calcium on growth characters of *Rhynchostylis retusa* L. (from October 2014 to September 2015 and October 2015 to September 2016).

Treatments	Days to bud visibility to first floret open (days)	Days to full bloom from bud visibility (days)	Spike length (cm)	Number of florets per spike
T_1 (RDF + Zn 250 ppm)	83.95	88.72	31.93	68.89
T_2 (RDF + Zn 500 ppm)	83.33	87.39	36.08	80.06
T_3 (RDF + Zn 750 ppm)	79.16	83.84	42.22	89.34
T_4 (RDF + Mg 250 ppm)	83.17	88.11	38.50	78.61
T_5 (RDF + Mg 500 ppm)	84.22	88.67	35.89	74.00
T_6 (RDF + Mg 1000 ppm)	84.67	87.22	36.22	67.61
T_7 (RDF + Ca 250 ppm)	85.33	89.28	36.40	80.22
T_8 (RDF + Ca 500 ppm)	83.06	87.11	39.82	84.48
T_9 (RDF + Ca 1000 ppm)	84.72	88.33	35.34	79.34
T_{10} (Control)	86.89	94.84	30.98	53.28
Mean	83.85	88.35	36.34	75.58
S.Ed	0.73	0.61	0.56	1.66
C.D0.05	1.53	1.28	1.17	3.47

Table 2: Effect of zinc, magnesium and calcium on days to bud visibility to first floret open, days to full bloom from bud visibility spike length and number of floret per spike of *Rhynchostylis retusa* L. (March 2015 to May 2015 and March 2016 to May 2016).

Treatments	Number of Spike per plant	Floret diameter (cm)	Self life (days)	Vase life (days)
T_1 (RDF + Zn 250 ppm)	2.00	3.16	11.61	8.34
T_2 (RDF + Zn 500 ppm)	2.39	3.23	11.95	8.67
T_3 (RDF + Zn 750 ppm)	4.08	3.50	16.54	11.48
T_4 (RDF + Mg 250 ppm)	2.39	3.22	11.45	7.78
T_5 (RDF + Mg 500 ppm)	2.17	3.28	12.33	8.61
T_6 (RDF + Mg 1000 ppm)	2.06	3.27	12.61	8.28
T_7 (RDF + Ca 250 ppm)	2.17	3.30	12.34	9.06
T_8 (RDF + Ca 500 ppm)	3.03	3.34	15.61	10.33
T_9 (RDF + Ca 1000 ppm)	2.28	3.25	12.33	9.11
T_{10} (Control)	1.67	3.04	9.26	5.97
Mean	2.42	3.26	12.60	8.76
S.Ed	0.43	0.09	1.20	0.69
C.D0.05	0.89	0.19	2.51	1.44

Table 3: Effect of zinc, magnesium and calcium on number of spikes per plant, floret diameter, self-life and vase life of *Rhynchostylis retusa* L. (March 2015 to May 2015 and March 2016 to May 2016).

Conclusion

From obtained results it was concluded that application of adequate amount of mineral nutrients favourably contributed towards growth and flowering of *Rhynchostylis retusa* L. T_3 (RDF + Zn 750 ppm) and T_8 (RDF + Ca 500 ppm) significantly increased the growth and flower characters of *Rhynchostylis retusa* L. respectively. These treatment merits consideration for commercial application to bring about timely and quality flower production of *Rhynchostylis retusa* L. during the festival (April) month of *Rangali Bihu.*

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