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Review Article

A review on orchid nutrient management strategies

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Orchids are mostly epiphytes. They have some mechanisms to survive when nutrient availability is limited. Also domesticating the epiphytic orchids potted plants is quite difficult. Nutrient management for orchids is also very difficult. Generally nutrient solutions are applied to orchids, once in a week or two. Like other crops, for orchid also, scientific studies have put their major emphasize on N, P and K, beside N, P, K-Ca and Mg also required in huge quantity for different orchids. Some reports on integrated nutrient management of orchids are also available.

Key words: Orchid, nutrients, mineral nutrition, organic nutrition, growing media

INTRODUCTION

Like other plants, orchids also require all the seventeen essential nutrient elements for their growth. In nature for getting essential nutrients and water they possess some important adaptive mechanisms. Epiphytic orchids generally grow on accumulated humus in tree bark crevices. Orchids get C, H and O from air, N and to some extent S from rain water. For other essential nutrients they usually depend on bird droppings, accumulated humus and rotten tree barks. The symbiotic association between orchids and some mycorrhiza is another mechanism of orchids for acquiring water and nutrients (Biswas et al., 2021). Nutrient and water supply to orchids is uneven from season to season. Orchids are well adapted to this inadequate and irregular supply of water and nutrients. The velamen on orchid roots is an important adaptation of epiphytic orchids. It is formed from root's multiple epidermis layers. This spongy layer absorbs water and nutrient solution and minimizes losses. Nutrient solutions are taken up by dry velamen within seconds, but it takes several hours to evaporate from the velamen (Zotz et al., 2013). Irregular supply of nutrients and water is the main problem of epiphytic orchids (Zotz et al., 2001). The mechanisms of dealing with this difficulties are Arumugam et al., 2004 fast nutrient and water uptake as soon as they are available Barman et al., 2017 Storing them in storage organs (i.e. water in hydrenchyma or bulbs and nutrients in bulbs and other succulent organs, latter supply them to the growing part as per requirement) and Bhattacharjee, 1980 reducing water loss by Crassulacean Acid Metabolism (CAM) Zotz et al., 2001 or by highly impermeable cuticles (Helbsing et al., 2000). Mineral content of orchids are similar to non-orchidaceous plants, except Ca and Mg. In different orchid plant parts they may remain even more than N, P and K content (Naik et al., 2007). But N, P, K got more attention in the studies involving the use of inorganic fertilizer application as compared to Ca and Mg. Effectiveness of one nutrient element depends on balanced availability of other elements, so balanced and optimum supply of essential nutrient elements is required for optimum plant growth. Application of inorganic and organic fertilizers together has been proven to be better for orchids as compared to any one of them. Nutrient demand by orchids varies from season to season. During active growth period nutrient demand is very high, but during the period of natural dormancy (in winter months) nutrient demand reduces (Naik et al., 2009). This article reviews the nutrient management strategies used throughout the world for orchids. Literature Review Literature Review

MINERALS CONTENT OF ORCHIDS

The optimum range of nutrient concentration may change from plant to plant, from plant part to part also with stage of growth concentration of nutrient may differ. Dorofaeff, 1980 reported the range of different nutrient concentrations in recently matured fully opened cymbidium leaves (Table 1). Due to their very slow growth rate orchids take longer time to show nutrient deficiency symptoms as compared to other plants. Thus, there may be hidden hunger, which may hamper economic growth. Cattleya failed to show any deficiency symptom during seven months of growing them in a media having no Fe, whereas N, P and K deficiency appeared after one weak, two and three months, respectively after growing in a general medium. Phalaenopsis and Dendrobium leafs

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dropped before appearance of deficiency symptoms when they were gown with a solution lacking N, P, K, Ca and Mg (Poole and Sheehan, 1982). Nutrient deficiency symptoms in orchids are very rare but there is some report of having toxicity of Fe, Zn and B. Naik et al., 2007 reported that at vegetative stage in Bulbophyllum, Eria, Coelogyne, Paphiopedilum, and Dendrobium species, N concentration ranged from 0.2 to 0.87% amongst them highest N was in Dendrobium chrysanthum and lowest in Eria dayspogons. Leaf P content in different orchids ranged from 0.03 gm to 0.23 gm%, maximum was in Paphiopedilum insigne. K content ranged from 0.32 to 1.43% and maximum was in Bulbophyllum caudatum. Ca, Mg and S content ranged from 1.43 to 3.83, 0.24-2.84 and 0.016-0.086 %, respectively. Ca content was highest in Bulbophyllum caudatum. A significant positive correlation between water and P, K, Ca and Mg content and significant negative correlation between water and N and S content was also reported. Nair et al., 2002 injected 32P at the back bulb of Dendrobium "Sonia 28" and tested the younger growth for radio activity at regular interval, and radioactivity in younger shoots increased with time, that indicates gradual translocation of nutrients from pseudo bulb to newly growing organs. Nitrogen, P, K, Ca, Mg, S, Fe, Mn, Zn, B, Cu, Mo content in Phalaenopsis, Cymbidium, Aranda and Cattleya are above the optimum range of other non-orchidaceous plants and in general orchid leaves contains higher level of Ca (Khaw et al., 1980). Fe content in orchid roots is four times higher than the average value (Naik et al., 2009). Khaw et al., 1980 reported that K content was higher in inflorescence as compared to root, whereas P content was higher in roots for Phalaenopsis 'Dos Pueblos' and Aranda 'Noorah Alsagoff'.

Table 1. Average concentration of essential nutrients in *Cymbidium* leaves

Nutrient	Form in which taken up by the plant	Concentration
N	NH_4^+, NO_3^-	1.3% to 2.1%
P	$H_2PO_4^-$, HPO_42^-, PO_4^{3-}	0.15% to 2.4%
K	K^+	1.3% to 2.5%
S	SO_4^{2-}	0.12% to 0.27%
Ca	Ca^{2+}	0.41% to 1.5%
Mg	Mg^{2+}	0.12 to 0.22%
Fe	Fe^{2+}	41 ppm to 120 ppm
Mn	Mn^{2+}	40 ppm to 300 ppm
Zn	Zn^{2+}	18 ppm to 22 ppm
Cu	Cu^{2+}	4 ppm to 15 ppm
B	H_3BO_3, $H_2BO_3^-$, HBO_3^{2-}, BO_3^{3-}	20 ppm to 120 ppm
Source: Dorofaeff (1980)		

FERTILIZING IN ORCHIDS

Penningsfeld et al., 1970 has recommended N: P: K for Cymbidium 1.0: 0.4: 0.8, Cattleya 1.0: 0.4: 0.8, Phalaenopsis 1.0: 0.8: 1.5, Paphiopedilum 1.0: 0.8: 1.0, Aranda 'Wendy Scott' 1:6.3:8.1, Aranda 'Noorah Alsagoff'4.3:1.0:3.7, Dendrobium 'Pompadour' 1.5: 1.5: 1.0. For Cattleya, Phalaenopsis and Aranda 'Noorah Alsagoff' recommended N: P: K: Mg ratio is 1.25: 0.4: 0.75: 0.1, 12: 1: 15: 3 and 13: 3: 11: 1 respectively. Bichsel et al., 2008 reported that 100 ppm N, 25 ppm P and 100 ppm K solution was optimum for growth and flowering of Dendrobium nobile. Naik et al., 2013 had reported that fertilizer solution having EC up to 1 mS cm-1 was optimal for flowering and nutrient solutions having EC more than 1 mS cm-1 reduced the flowering of Cymbidium "Sleeping Nymph". Barman et al., 2017 that Cymbidium "Baltic Glacier Mint Ice" grown in leaf mould, brick bits and coconut husk (2:1:1) medium and sprayed with NPK (@ 200 ppm each) along with BA and GA3 (@ 50 ppm each for breaking juvenility and @ 200 ppm each for enhancing flowering frequencies) was optimum for best growth. These treatments had provided maximum number of spikes per clump, maximum spike length and rachis length as well as most number of flowers per spike. Pun, 2018 reported that Cymbidium erythrostylum growing in media having pine bark had provided maximum number of flowers. Plants with sucker gave maximum vegetative growth and sucker removed plants provided maximum flowering. Application of NPK (19:19:19) once in two months provided best flower yield. Mantovani et al., 2018 reported that application of N fertilizer solutions containing higher proportion of ammonia resulted in decreased green colour index and N, K, Ca and Mg uptake in Phalaenopsis and Dendrobium, (40-50)% of the total N applied in the form of ammonia was beneficial and when it exceeded 75% of the total N, it became toxic for both the orchids. Nutrient solutions applied to the orchids contained 136, 31, 234, 200, 48, 64, 0.5, 0.5, 0.5, 0.02, 0.01, 5 ppm of N, P, K, Ca, Mg, S, B, Mn, Zn, Cu, Mo, Fe, respectively. Poole et al., 1974 reported that application of 100 ppm N was optimal for Phalaenopsis and Cymbidium plant growth and 50 ppm N was optimal for Cattleya plant growth, 50 ppm K was optimal for the growth of Cattleya, Cymbidium and Phalaenopsis, 25 ppm Mg was optimal for Phalaenopsis and Cymbidium plant growth and 50 ppm Mg was optimum for Cattleya growth.

FERTILIZING ORCHIDS BEFORE FLOWERING STAGE

Availability of essential nutrients in optimum quantity will cause optimum flowering to any plants, it is same for orchids also. Wong et al., 1975 observed that effect of N application was affected by application of other minerals in Cattleya and Aranda. In Cattleya, Ca and K content decreased after P application which is similar to other agricultural crops. That indicated excessive application of one nutrient reduce the uptake of other, may even lead to deficiency of other nutrients in orchids.

The growth of roots and leaves of Cymbidium sinense was fastest when the plant was grown with both ammonia and nitrate as the nitrogen source (Wen and Hew, 1993). The chlorophyll content and photosynthetic rate gradually increased.

FERTILIZING ORCHIDS AT FLOWERING STAGE

Bhattacharjee, 1981 reported that Dendrobium moschatum (grown in blocks of hard wood charcoal were fertilized fortnightly with N, P2O5 and K2O @ 0,500 and 1000 ppm) had shown noticeable improvement in vegetative growth and flowering with increasing fertilizers dose. Treatments having N @500 ppm had earliest flower bud. Fertilizer application was beneficial up to the level of 500 ppm beyond that level fertilizer application was not beneficial. Higaki et al., 1987 reported that increasing the level of N increased the flower size of Vanda 'Miss Joaquim'. Rajeevan et al., 2003 reported that application of NPK (10:20:10) @ 0.2% twice a week along with of BA and GA3 @ 500 ppm and 10 ppm, respectively, once in a month had produced the highest number of spikes in Dendrobium "Sonia 17". Treatments having NPK (10:20: 10) @ 0.2% had provided maximum number of spikes, spike length, most number of florets, maximum rachis length and inter nodal length. Arumugam et al., 2004 reported that 75% shade was optimum for enhancing the growth as well as flowering of Dendrobium "Sonia-17". Bhattacharjee, 1980 had reported that well drained and aerated growing media like-coconut fibre, tile bits+coconut fibre, brick pieces+coconut fibre etc. are good for better growth, root formation and flowering of orchids. Naik et al., 2007 had reported that Cymbidium 'Show Girl Cook's Bridge' grown in media containing perlite+coco chips+brick pieces+leaf mould (1:1:1:1), the spike length and rachis length increased with the increased application of N and obtained maximum spike length of 45.0 and 30.25 cm, respectively with the application of NPK (20:5:5) @0.3%. The number of flowers per spike increased with increasing concentration 'of nitrogen and found maximum of 5.5 with the application of NPK (15:5:5) @0.3%.

ORGANIC NUTRITION FOR ORCHIDS

Dendrobium "Sonia 17" root dipped in Azospirillum+ Phosphobacteria before planting and treated with NPK (10:5:10) @ 0.2% twice in a week, produced maximum plant height (50.1 cm), maximum number of shoots per plant (12) and maximum number of florets (10.7) (AICRP on Floriculture, 2003-04). The treatment having NPK (30: 10: 10) @ 0.2% along with 3% Panchgavya once in a week, had provided maximum plant height (30 cm) and maximum number of leaves per plant (7.32) of Dendrobium nobile, the treatment having NPK (30:10:10) @ 0.2%+3% Panchgavya+3% Manchurian tea once in a weak had provided maximum number of shoot per plant (4.57) and the maximum length and breadth of leaves. Cymbidium "Red Star" grown with NPK (30: 1 0:1 0) @ 0.2%+3% Panchgavya+3% Manchurian tea+3% Vermiwash once in a week had produced tallest plant (113.61 cm) as compared to other treatments (AICRP on Floriculture, 2004-05).

Chua, 1976 reported that 100 gm and 50 gm of chicken manure per plant once in 3 months increased flower yield and flower spike length in Dendrobium 'Louisae Dark' and Oncidium 'Goldiana', respectively as compared to chemical fertilizer treatment. Chiken manure applied at a higher rate (200 gm per plant once in three months) had decreased Oncidium flower yield. After manure application generally orchid growth increase, but after few months it may effect adversely, because decaying and decomposing manures can cause water stagnation and hamper air circulation, so while using manure to an orchid, one should be careful about watering and orchid should be kept under regular observation.

CONCLUSION

Orchids are mainly very slow growing perennial epiphytes having survival strategies under low nutrient and water supply. They rarely show nutrient deficiency symptoms particularly micronutrient deficiency symptoms. But inadequate nutrient management can cause hidden hunger for orchids that can cause damage to the economic growth of orchids. Also over dose of micronutrients can be toxic for orchids, so proper and judicious management of nutrients is necessary for successful orchid growing. During vegetative growth period higher dose of N compared to P and K are recommended, and before flowering P and K application rate need to be increased as compared to N. Frequency of fertilizer application must be reduced during flowering.

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CONFLICT OF INTEREST

None declared

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