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STUDIES ON INFLUENCE OF NUTRIENT AND GROWTH REGULATOR INTERACTIONS ON GROWTH, YIELD AND QUALITY OF *DENDROBIUM* ORCHID CV. SONIA 17

A Patnaik, M Kannan, M Ganga, and S Vincent

Department of Floriculture and Landscape Gardening, Horticultural College and Research Institute, T.N.A.U., Coimbatore - 641 003, Tamil Nadu, India

Abstract

Dendrobium hybrids are very profitable enterprise for commercial cultivation but it has not taken the pace in India, due to lack of infrastructural facilities and varied agro-climatic conditions. Hence, presently a systematic study was undertaken in *Dendrobium* orchid cv. Sonia 17 (*D.* Caesar × *D.* Tomie Drake), through the use of different combinations of nutrients and growth regulators so as to maintain productivity and quality. Different ratios of N:P:K and concentration of GA_3 (Gibberelllic Acid: 200 ppm) and BA (Benzyladenine: 400 ppm) were applied as foliar sprays during vegetative and flowering stages at frequency of 7 days and 30 days interval respectively. The experiment was laid out in a Completely Randomized Design (CRD) with 17 treatments. The treatment T_6 was observed as optimal for vegetative growth, floral characters, and maximum vase life.

Introduction

ORCHIDS, WITH the most fascinating and beautiful flowers in God's creation, are unique with their wide variety in exotic colour, form, size, shape, amazingly long-lasting flowers and their adaptability to diverse habitats, from terrestrial to epiphytic. They belong to the family Orchidaceace, which is one of the largest families of the flowering plants. Taxonomically, it represents the most highly evolved family among monocotyledons with 600-800 genera and 25,000-35,000 species. Orchids are the major players in the multibillion dollar floriculture trade of the world. Today, orchids such as, *Cymbidium, Dendrobium, Oncidium,* and *Phalaenopsis* are marketed globally and the orchid industry has contributed substantially to the economy of many countries. The orchid cut flower industry is growing at the rate of 10-20 per cent annually (Pradhan, 2001). The USDA reported that in the United States, the wholesale value of potted orchids increased from $47 million in 1996 to $139 million in 2005 (Anonymous, 2009). The world's production of pot orchids were forecasted to continue increasing at a steady pace to reach a total of 305 million pots by 2014 (Wang, 2004). Hence, research on orchids is needed to support this fast expanding and profitable industry. The *Dendrobium* hybrids which thrive well under Coimbatore's climate are Sonia 17, Sonia 28 (purple and white flowers), Emma White, Sakura Pink *etc*. The cultivation of dendrobiums is a very profitable enterprise; commercial cultivation has not taken the pace in India, due to lack of infrastructural facilities and varied agro-climatic conditions which obstruct the cultivation in open fields. Hence, the present investigation has been carried out in the green house. Orchid hybrids require optimum amount of nutrients since their growth and flowering rates are slow. The type of nutrients, their quality and frequency of application play an important role for the quality of flower. Conventional nutritional application in liquid form has been found to be very effective in orchids. The major constraints encountered in orchid cultivation are growing conditions, long pre-blooming period, susceptibility to pest and diseases *etc*. The dry weight of *Dendrobium phalaenopsis* was severely affected by omission of N, P, K, Ca or Mg in nutrient solution and leaves dropped before deficiency symptoms appeared (Chin, 1966). Low temperature or short day treatment can affect the level of endogenous regulators (Evans, 1971; Zeevaart, 1975); it appears that the flowering response to low temperature or short day treatment in the sympodial orchids could have been resulted from change in the levels of endogenous growth regulators. Therefore, it is essential to provide continuous application of nutrients in optimum proportion and also growth regulators to produce sufficient growth, yield and quality spike. Hence, a systematic study was presently undertaken in *Dendrobium* orchid cv. Sonia 17 (*D.* Caesar × *D.* Tomie Drake), using different combination of nutrients and growth regulators so as to maintain productivity and quality.

Materials and Methods

Present study was conducted in a greenhouse with 75% shade at the Botanic Gardens of Department of Floriculture and Landscaping, Horticultural College and

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Research Institute, Tamil Nadu Agricultural University, Coimbatore during a period from August 2011 to April 2012. The plants were planted in specially made 15- 20 cm earthen pots with 10-11 drainage holes at the bottom and sides. The potting mixture containing a mixture of tile pieces, charcoal and brick pieces at ratio of 1:1:1 were used. The major nutrients N:P:K at different ratios were applied as foliar sprays during vegetative and flowering stages and frequency of application was at 7 days interval. Nutrient combinations were made using ammonium nitrate, orthophosphoric acid and potassium nitrate. The plant growth regulators such as GA_3 (200 ppm) and BA (400 ppm) were applied as foliar sprays and frequency of application was at 30 days interval. The experiment was laid out in a Completely Randomized Design (CRD) with 17 treatments (Table 1).

Table1. Details of nutrient composition used as foliar sprays during vegetative and flowering stages.

Treatment	NPK Ratio
T_1 (Control)	NPK 10:10:10(0.1%)
T_2	NPK 20:20:20(0.2%)
T_3	NPK 20:20:20(0.4%)
T_4	NPK 20:20:10(0.2%)
T_5	NPK 20:20:10(0.4%)
T_6	NPK 20:10:10(0.2%)
T_7	NPK 20:10:10(0.4%)
T_8	NPK 10:20:10(0.2%)
T_9	NPK 10:20:10(0.4%)
T_{10}	NPK 20:20:20(0.2%) + GA_3 200 ppm + BA 400 ppm
T_{11}	NPK 20:20:20(0.4%) + GA_3 200 ppm + BA 400 ppm
T_{12}	NPK 20:20:10(0.2%) + GA_3 200 ppm + BA 400 ppm
T_{13}	NPK 20:20:10(0.4%) + GA_3 200 ppm + BA 400 ppm
T_{14}	NPK 20:10:10(0.2%) + GA_3 200 ppm + BA 400 ppm
T_{15}	NPK 20:10:10(0.4%) + GA_3 200 ppm + BA 400 ppm
T_{16}	NPK 10:20:10(0.2%) + GA_3 200 ppm + BA 400 ppm
T_{17}	NPK 10:20:10(0.4%) + GA_3 200 ppm + BA 400 ppm

The observations on growth parameters like plant height, number of leaves per plant, leaf area, number of shoots per plant, number of pseudobulbs per plant, number of back bulbs per plant, shoot diameter and internodal length and the floral parameters *i.e.* days taken to flower bud initiation, number of spikes per plant, spike length, number of florets per spike, floret size, spike longevity on plant, pedicel length and post harvest vase life of spikes were taken. The experimental data were analysed statistically by ANOVA (analysis of variance) technique (Panse and Sukhatme, 1985).

Results

The data generated from the pot culture experiment was pooled to study the plant growth, flower initiation and nutrient composition of *Dendrobium* orchid cv. Sonia 17 plants as influenced by the application of nutrients and growth regulators from planting to nine months after planting.

Vegetative Growth Parameters

Observations have been recorded for plant height, number of leaves per plant, number of shoots per plant, number of pseudobulbs per plant, number of back bulbs per plant, shoot diameter and number of keikis per plant, at 45 days intervals.

The application of different levels of nutrients and growth regulators has significantly influenced the plant growth and the progressive increase was due to the overall treatment effect (Table 2).

The plant height at 270 DAP (days after planting) was the highest in the treatment of T_6 (24.65 cm). At 270 DAP, the leaf area was measured, the increased leaf area was observed in the treatment T_6 (41.05 cm^2). It has been observed that at 270 DAP, the treatment T_6 produced more number of shoots (9.00). The number of pseudobulbs were high in the treatment T_6 (4.00) at 270 DAP. The least number of backbulbs (0.50) were produced in the treatment T_8. At 270 DAP, the highest shoot diameter (4.52 cm) and internodal length (4.25 cm) were observed in the treatment T_6. At 270 DAP, highest number of keikis per plant (1.33) were observed in the treatment T_{14}.

Floral Parameters

Floral characters were recorded for the plants treated with nutrients starting from T_1 to T_9 whereas combination of nutrient and growth regulator treated plants had not shown any flowering (Table 3).

It was observed that the plants of treatment T_6 was found to show the earliest flower bud initiation within 112.83 days. No flowering was noticed in treatments T_5, T_7 and T_9 till 270 DAP. Treatment T_6 had the highest number of spikes per plant (1.50), longest spike length on the plant (57.50 cm), the highest number of florets per spike (10.50), the largest floret size on the plant (8.42 x 8.33 cm), the highest spike longevity on the

Table 2. Effect of nutrients and growth regulators on growth parameters of *Dendrobium* orchid cv. Sonia 17 at 270 DAP.

Treatment	Plant height (cm)	Leaf area (cm^2)	Number of shoots/plant	Number of pseudobulbs/ plant	Number of backbulbs/ plant	Shoot diameter (cm)	Internodal length/shoot (cm)	Number of keikis/ plant
T_1	23.35	26.31	6.83	2.17	0.67	3.43	3.58	-
T_2	23.45	28.14	7.50	2.83	0.83	3.60	3.90	-
T_3	24.15	34.92	6.50	3.33	0.67	4.07	4.10	-
T_4	23.65	31.18	7.50	2.67	1.00	3.83	3.75	-
T_5	23.55	29.21	6.50	1.83	1.00	3.50	3.65	-
T_6	24.65	41.05	9.00	4.00	1.00	4.52	4.25	-
T_7	24.35	38.46	8.33	3.00	0.83	4.35	4.12	-
T_8	23.55	28.56	7.50	2.50	0.50	3.67	3.65	-
T_9	23.47	27.29	6.33	2.00	1.33	3.48	3.53	-
T_{10}	20.12	19.90	3.00	0.67	3.00	3.22	3.05	1.00
T_{11}	19.92	18.60	3.00	0.67	3.00	3.12	2.65	1.00
T_{12}	20.12	19.36	3.00	0.67	3.00	3.16	2.92	0.83
T_{13}	20.00	18.76	3.00	0.33	3.00	3.08	2.73	0.33
T_{14}	20.18	21.45	3.00	1.00	3.00	3.30	3.32	1.33
T_{15}	20.12	20.70	3.00	0.67	3.00	3.22	3.22	0.50
T_{16}	19.97	19.11	3.00	1.00	3.00	3.12	2.83	0.67
T_{17}	19.77	18.33	3.00	0.33	3.00	3.10	2.50	0.67
Mean	22.02	25.96	5.29	1.75	1.87	3.51	3.40	0.79
SE (d)	0.04	0.32	0.18	0.16	0.30	0.07	0.04	NS
CD (P = 0.05)	0.09	0.68	0.38	0.34	0.63	0.15	0.08	NS

Table 3. Effect of nutrients on floral parameters of *Dendrobium* orchid cv. Sonia 17.

Treatment	Flower bud initiation (days)	Number of spikes/plant	Spike length (cm)	Number of florets/spike	Floret size (cm)	Flower spike longevity (days)	Pedicel length (cm)
T1	172.50	1.00	28.00	5.00	6.50×6.00	43.00	4.00
T2	141.17	1.00	23.17	4.83	6.50×6.00	31.00	3.67
T3	116.67	1.33	45.67	7.67	8.00×7.33	70.67	4.00
T4	141.33	1.00	39.83	6.50	8.00×7.84	51.67	4.33
T5	0.00	0.00	0.00	0.00	0	0.00	0.00
T6	112.83	1.50	57.50	10.50	8.42×8.33	73.17	4.58
T7	0.00	0.00	0.00	0.00	0	0.00	0.00
T8	170.17	1.00	45.50	8.83	7.33×6.83	66.00	4.00
T9	0.00	0.00	0.00	0.00	0	0.00	0.00
Mean	94.96	0.76	26.63	4.81	4.97×4.70	37.28	2.73
SE (d)	0.008	0.014	0.002	0.008	0.004	0.002	0.003
CD (P = 0.05)	0.018	0.032	0.004	0.019	0.011	0.005	0.007

plant (73.17 days) and the longest pedicel length (4.58 cm).

Vase Life

The spikes harvested from the best treatment (T_6) and control (T_1) were kept for vase life study. The maximum vase life, till 50% floret withered (26 days) and total vase life, till last floret withered (33 days) was recorded in the spikes harvested from T_6.

Discussion

In *Dendrobium*, application of NPK nutrients in different ratios along with growth regulators (GA_3 and BA) has been reported to influence growth, yield, and quality. Further, since *Dendrobium* is an epiphytic orchid, it responds well to application of nutrients given through foliar application, rather than uptake by roots.

Vegetative Growth Parameters

In the present investigation, it has been observed that the plant height was significantly promoted by the application of different nutrient sources. The maximum plant height was observed with the application of 0.2% of NPK (20:10:10). The reason for increased growth with this treatment might be the influence of balanced nutritional supplements to the plant. Nitrogen is a chief constituent of proteins for the formation of protoplasm, providing metabolic energy to cell division and cell enlargement. It is also an important constituent of amino acids and co-enzymes which are of considerable importance for the growth and development. The results of the present study are in conformity with the earlier studies (Ramya, 2007; Swapna, 2000) in *Dendrobium* hybrid cv. Sonia 17. However, the increase in nitrogen concentration beyond 0.2 per cent did not produce any improvement on plant height. This might be due to the fact that increase in nitrogen above the required level sustains the auxin metabolism which could induce only fleshy growth of very soft shoots (White, 1990). The results of the present study indicated that increased leaf area was expressed in the treatment T_6 with 0.2% of NPK (20:10:10), at 270 DAP. This indicates that the higher carbohydrate accumulation in leaves, facilitated by favourable nutrients has led to higher photosynthetic activities, resulting in an increased leaf area. These findings are in conformity with those by Sobhana and Rajeevan (1995) in *Cymbidium tracyanum*. The higher number of shoots per plant and also maximum number of pseudobulbs per plant was recorded with 0.2% of NPK (20:10:10) was attributed due to the activation of better N nutrition leading to lateral buds and production of new lateral shoots. As an invariable component of proteins, and therefore of protoplasm, nitrogen promotes the lateral growth. Similar results were observed in *Cymbidium* 'Pharoah Pathfinder' by Nichols (1982), wherein the author obtained increased number of shoots with increase in nitrogen supply. Similar observation was reported by Nair (2001) in *Dendrobium* cv. Sonia 17. The number of leafless backbulbs was less in the treatment with 0.2% of NPK (10:20:10) applied at 270 DAP. Lesser numbers of leafless backbulbs were produced at the higher dosages of P. Contradictory observations were documented by Bichsel *et al.* (2008) in *Dendrobium* cv. Red Emperor 'Prince', where NPK ratio with higher N and K content was found to enhance leaves. A larger diameter of the shoot and internodal length per shoot was noticed when NPK nutrients given at 0.2% of NPK (20:10:10). In orchids, a good correlation has been observed between shoot girth and flower production as reported by White (1990). Nitrogen might be responsible for enhancing the translocation of metabolites and thereby increasing the growth. The diameter of pseudobulbs was reported to increase with increase in nitrogen supplied in *Phalaenopsis* hybrids Sylba, Nopsya and Abylos (Amberger Ochsenbauer, 1996). Application of inorganic nutrients and growth regulators exhibited significant influence on the number of keikis per plant. The number of keikis per plant was the highest in the treatment of 0.2% of NPK (20:10:10) + GA_3 (200 ppm) + BA (400 ppm). Similar observations were reported by Stewart and Button (1977) in *Paphiopedilum* and Dale *et al*., (1996) in day neutral strawberries. In the present study, application of nutrients along with the growth regulators GA_3 (200 ppm) and BA (400 ppm), however, resulted in reduced growth and development and gave a negative effect as compared to control. However, application of GA_3 (200 ppm) and BA (400 ppm) resulted in production of higher number of backbulbs and keikis per plant, which can be used as a propagating material. BA sprayed plants were healthier compared to GA_3 sprayed plants. Since BA reduces the production of ethylene. Hence, indicating that BA is having an influence on reduction in leaf senescence and shedding (Pileuk *et al.,* 1992). The defoliation in GA_3 sprayed plants might be due to the epiphytic nature of the crop which receives more photosynthates for the maintenance of plant biomass through foliage. However, the foliar spray of GA_3 might have antagonistic effect which is triggering the ABA metabolism in leaves hindering the sufficient supply of nitrogen to the foliage, causing yellowing and defoliation. Similar reports were obtained by Matsumoto (2006) wherein foliar damage in *Miltoniopsis* and Bivins (1968) indicated that effect of gibberellins, however, effectively defoliated the plants at 250 or 500 ppm concentration, speeded up the senescence of leaves and delayed new growth at higher concentration.

Floral Parameters

The potential of exogenous application of nutrients is

to cause physiological and biochemical changes, influencing all reproductive characters have been reported by many earlier workers. A balanced supply of nitrogen might have promoted the translocation of phytohormones to the shoot which probably induced flower bud initiation. This confirms the earlier findings of Binisha (2003) in *Phalaenopsis*. In the present work, application of nutrients 0.2% of NPK in the ratio of 20:10:10 had significantly promoted number of spikes per plant and also increased the spike length. The result is supported by Yoneda *et al.* (1999) who observed that low N rates resulted in shorter and thinner stalks and fewer flowers in *Odontoglossum* and Wang and Gregg (1994) in *Phalaenopsis*. In the present work, application of nutrient 0.2% of NPK (20:10:10) had significantly resulted in more number of florets per spike, increased floret size and pedicel length. This indicated the vigorous photosynthetic activities of the leaf due to the application of inorganic nutrients which might have led to the efficient partitioning of photosynthates towards sink. This is in line with the observation by Bhattacharjee (1982) in *Aerides multiflora*. The treatment of 0.2% of NPK 20:10:10 resulted in highest spike longevity on the plant. It depends on the number of florets per spike, number of days taken for opening of the successive flowers (Wang and Lee, 1994). The treatment of 0.2% of NPK (20:10:10) also resulted in the longest vase life. Similar results were obtained in *Dendrobium* orchid at Kahikuchi and in *Cymbidium* orchid at Kalimpong (Anonymous, 2010-11a and 2010-11b). The results of the present study have indicated that foliar application of 0.2% of NPK in the ratio of 20:10:10 at weekly intervals led to improved vegetative growth and development which in turn lead to early flower bud initiation (112.83 days) and increased flower yield (1.50 spikes per plant). Application of NPK nutrients along with GA_3 (200 ppm) and BA (400 ppm) lead to defoliation and reversal towards vegetative growth of *Dendrobium* orchid cv. Sonia 17. Hence, the growth regulators GA_3 (200 ppm) and (BA 400 ppm) can be applied to *Dendrobium* plants which are required to produce more of propagating materials namely keikis and backbulbs. The cost economic analysis revealed that the best treatment T_6 (0.2% of NPK 20:10:10) registered the highest gross income, net returns and benefit cost ratio (0.15) whereas benefit cost ratio was 0.08 for control T_1 (0.1% of NPK 10:10:10).

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