Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6928

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (5):** 417-425 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of Varying Levels of Foliar Nutrients on Growth and Yield of *Dendrobium* Orchid Cv. Sonia-17

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Received: 3.07.2018 | Revised: 9.08.2018 | Accepted: 16.08.2018

ABSTRACT

The present investigation was carried out at orchidorium, Regional Horticultural Research and Extension Centre, University of Horticultural Sciences campus, GKVK, Bengaluru during September 2015 to June 2017. The results indicated a significant influence of the treatments on different vegetative and yield parameters. Plant height was recorded maximum in treatment NPK @ 2:6:2 (T_9) followed by 2:6:1 (T_8) (44.08 cm and 44.08 cm respectively) and lowest (30.42 cm) was observed in control (T_1), higher numberof shoots per plant were registered in treatment NPK @ 2:6:2 (T_9) (4.73) and lower number of shoots produced per plant was noticed in control (3.40). Maximum number of leaves per plant was produced in NPK levels 2:6:2 (7.73) and 2:6:1 (7.47). However, control (5.73) recorded minimum number of leaves per plant. Higher number of pseudo bulbs per plant was recorded in 2:6:2 NPK level (T_9) (4.63) and lowest was recorded in (T_1) control (3.82). Maximum leaf area (59.21 cm^2) was observed in NPK level 2:6:2 (T_9) and control recorded minimum leaf area of plant (34.28 cm^2). Significantly higher number of spikes per plant, spikes per square meter and per hectare was registered in treatment (T_9) 2:6:2 NPK level (2.80, 70.00 and 5.60 lakh) followed by treatment T_8 (2:6:1) and lowest was noticed in control at 21 MAT respectively months after treatment. Highest cumulative yield per plant, per square meter and per hectare was noticed in treatment 2:6:2 (T_9) (17.13, 428.00 and 34.27 lakh respectively) and it was on par with 2:6:1 (T_8) (16.27, 406.67 and 32.53 lakh respectively) and lowest cumulative spike yield was observed in (T_1) control (9.20, 230.00 and 18.39 lakh respectively).

Key words: *Foliar nutrient, Dendrobium.*

INTRODUCTION

Orchids are highly valued as cut flowers in commercial floriculture owing to the wide range of colors, shapes, sizes and fragrance they display, with a long vase life being an added advantage. Belonging to the second largest genus of orchids, most *Dendrobium* species are epiphytic and are from subtropical and tropical regions. *Dendrobium* is a popular genus for cut flower production.

Cite this article: Sudeep, H.P., Seetharamu, G.K., Aswath, C., Munikrishnappa, P.M., Sreenivas, K.N., Basavaraj, G. and Gowda, D.M., Effect of Varying Levels of Foliar Nutrients on Growth and Yield of *Dendrobium* Orchid Cv. Sonia-17, *Int. J. Pure App. Biosci.* **6(5):** 417-425 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6928

Many growers in the states of Kerala, TamilNadu, coastal Karnataka and Andhra Pradesh are cultivating *Dendrobiums* on a commercial scale. *Dendrobiums* occupy nearly 90 per cent of the area under orchid cultivation in Kerala due to the easy management practices and plant material availability[10]. In Karnataka, a number of farmers have taken up *Dendrobium* orchid cultivation, under the guidance of Kanflora[4]. Considering the large area under *Dendrobium* cultivation, and the fact that there is a decline in the yield and quality of the spikes during the cooler months of winter, it was found essential to sustain the yield and quality of the flowers round the year for commercial production.

Poole and Sheehan[9] have identified the critical factors affecting orchid mineral nutrition *viz*., the medium, the degree of decomposition of organic materials and the age of the plants. According to Hew and Yong[5] more information pertaining to mineral nutrition of orchid plants at different stages is needed for formulating a practical fertilizer programme for tropical orchid cultivation. The optimum NPK ratio for *Dendrobium Pompadour* has been identified as 1.5:1.5:1[9,5]. This ratio could not however give optimum yield and spike quality over a long period of time in commercial cultivation. Therefore a study was conducted to sustain the growth and yield of the *Dendrobium* orchid through application of different levels of NPK as foliar nutrition.

MATERIAL AND METHODS

The experiment was conducted to study the effect of varying levels of NPK on growth and yield of *Dendrobium* orchid cv. Sonia-17 under naturally ventilated polyhouse at Regional Horticultural Research and Extension Centre, University of Horticultural Sciences campus, GKVK, Bengaluru during September 2015 to June 2017. The experiment was laid out in a Completely Randomized Design comprising thirteen treatments (three levels of N, two levels of P and two levels of K) replicated thrice. The number of pots per treatment was twenty. Two year-old plants of *Dendrobium* Sonia- 17 in earthen pots were placed on iron benches and 50 per cent shade was provided using green agro shade nets. All the plants were given as foliar spray of 19:19:19 water soluble fertilizer @ 0.2 per cent and additional requirement of nutrient levels were supplement through urea (46 %), orthophosphoric acid (61%) and potassium sulphate (50%). Urea was used as the source of nitrogen, Orthophosphoric acid was used as the source of phosphorous and potassium sulphate used as the source of potassium and were supplied throughout the growth period using water soluble fertilizers at 15 days interval through foliar spray throughout the experiment from September 2015 to May 2017. The treatment comprising of foliar nutrients at various N: P: K levels are as follows.

Nutrients sprayed at different levels					
Treatments	**NPK levels**	**19:19:19**	**N (g)**	**P (ml)**	**K (g)**
T_1	1:1:1(control)	2 g	-	-	-
T_2	1:4:1	2 g	-	1.90	-
T_3	1:4:2	2 g	-	1.90	0.76
T_4	1:6:1	2 g	-	3.15	-
T_5	1:6:2	2 g	-	3.15	0.76
T_6	2:4:1	2 g	0.83	1.90	-
T_7	2:4:2	2 g	0.83	1.90	0.76
T_8	2:6:1	2 g	0.83	3.15	-
T_9	2:6:2	2 g	0.83	3.15	0.76
T_{10}	3:4:1	2 g	1.67	1.90	-
T_{11}	3:4:2	2 g	1.67	1.90	0.76
T_{12}	3:6:1	2 g	1.67	3.15	-
T_{13}	3:6:2	2 g	1.67	3.15	0.76

Five plants were selected at randomly in each treatment of replications for the purpose of recording observations on various parameters of growth and yield. The mean value of the data was worked out for the purpose of statistical computation (analysis).

RESULTS AND DISCUSSION

The experimental results revealed a significant influence of the nutritional treatments on the different vegetative and yield parameters. The data pertaining to the plant height, number of shoots per plant, number of leaves per plant, number of pseudo bulbs per plant and leaf area per plant at different stages of crop growth are presented in tables from 1 to 5. The perusal of results from table 1 revealed that, plant height varied significantly at different stages of crop growth (*viz.*, 3, 6, 9, 12, 15, 18 and 21 months after treatment). Influence of varying nutrient levels on plant height at 3, 6 and 9 MAT, NPK level 2:6:2 (T_9) recorded maximum plant height (19.55, 24.23 and 29.39 cm respectively) and it was on par with 2:6:1 (T_8) and 3:6:2 (T_{13}) (18.83, 22.11, 28.87 cm and 18.71, 21.87, 27.88 cm respectively) which were superior to rest of the treatments studied. However, plant height was minimum in control (13.48, 15.47 and 18.51 cm respectively). On the other hand, significant increase in plant height recorded at 12, 15, 18 and 21 months after treatment, where highest plant height was recorded in NPK level of 2:6:2 (T_9) (33.22, 37.21, 41.46 and 45.66 cm respectively) and it was on par with ratio 2:6:1 (T_8) and 3:6:2 (T_{13}).Whereas, plant height was minimum in (T_1) control (20.88, 23.54, 26.72 and 30.42 cm respectively). Nitrogen is a chief constituent of protoplasm and chlorophyll resulting higher photosynthetic activity in plants, which enables the plant for quick and better upward growth. Phosphorous also encourages energy metabolism which influence on cell division and root growth. The beneficial role of potassium in catalyzing various metabolic activities and maintenance of osmotic potential in the cellular environment to keep translocation process at desirable rate. This might have played a positive role in development of plant height. These results are in conformity with the findings of Kabir *et al.*[6], Gufran *et al.*[3], Ali *et al.*[1], Kumar *et al.*[7] and Anitha and Kannan[2] in *Dendrobium* orchid. Increased level of nitrogen and phosphorus dose resulted in increasing the plant height in *Dendrobium* orchid. Similar variation was observed by Nair *et al.*[8].

Number of shoots per plant recorded at different stages of crop are presented in Table 2.At three months after foliar application of NPK at 2:6:2 (T_9) and 3:6:1(T_{13}) produced highest number of shoots per plant (3.20), which was at par with the treatment 2:6:1(T_8) (3.13). However, lowest number of shoots per plant was observed in control (2.53). Shoots production at 6 and 9 MAT, NPK level 2:6:2 (T_9) produced maximum number of shoots per plant (3.60 and 4.13 respectively) and it was statistically on par with (T_8) 2:6:1 and it was minimum in control (2.67 and 2.80 respectively). At 12, 15, 18 and 21 months after treatment varied significantly among treatments. NPK level 2:6:2 (T_9) produced maximum number of shoots per plant (4.27, 4.47, 4.60 and 4.73 respectively) and it was statistically on par with T_8-2:6:1. However it was minimum in control (2.93, 3.07, 3.20 and 3.40 respectively). The possible reason for this acceleration might be due to higher photosynthetic activities for production of IAA and cytokinin which leads to higher meristematic activities in plant for production of higher number of shoots. This was in accordance with the reports of Kumar *et al.*[7]. Higher level of phosphorus serves as a structural component of cell constitutes like chloroplast and mitochondria, it is a part of sugar phosphates (ATP and ADP), which plays an inevitable role in photosynthesis and respiration, consequently leading to increase in production of more number of shoots per plant. These results were in the agreement of Nair *et al.*[8]. Sufficient supply of nutrients might have shown stimulatory metabolic action promotes for cell division and cell elongation leads to production of higher shoots per plant. Similar findings are in accordance

with earlier reports of Kabir *et al.*[6] and Anitha and Kannan[2] in *Dendrobium* orchid.

The data on leaf production at different stages of growth are furnished in table 3. As the growth stages advanced the leaf production also increases continuously from three months after imposing treatments. At 3, 6 and 9 MAT, leaf production varied significantly among the treatments. Treatment 2:6:2 (T_9) produced higher number of leaves per plant (5.40 5.80 and 6.07 respectively) and it was on par with treatment 2:6:1 (T_8) (5.27, 5.67 and 5.97 respectively). However, it was registered minimum in control (4.47, 4.73 and 5.00 respectively). During 12, 15, 18 and 21 months after treatment, highest number of leaves per plant was observed in NPK level 2:6:2 (T_9) (6.60, 7.13, 7.53 and 7.73 respectively) and it was on par with treatment 2:6:1 (T_8) of 6.53, 6.87, 7.27 and 7.47 respectively. However, the lowest number of leaves per plant was recorded in (T_1) control (5.27, 5.33, 5.60 and 5.73 respectively). This variation in leaf production helps in better synthesis of chlorophyll, amino acids and nucleic acid which are the building blocks of proteins and their utilization for building up of new cells. These results are in agreement with the reports of Kabir *et al.*[6] in *Dendrobium* orchid. Variation in leaf production can be attributed for better availability of nutrients for growth and development of plant especially, nitrogen is essential for all the enzymatic reactions in plant promotes rapid vegetative growth for better synthesis of chlorophyll, nucleic acid, amino acid which inturn form of proteins. Similar trend of variation was observed by Kumar *et al.*[7] and Anitha and Kannan[2] in *Dendrobium* orchid. Further there is increase in number of leaves per plant at higher levels of NPK nutrients supplied through foliar application might have positive correlation with production of increased plant height and number of shoots per plant. Similar variations are in findings of Nair *et al.*[8], Gufran *et al.*[3] and Ali *et al.*[1] in *Dendrobium* orchid.

All the treatments were differed significantly with respect to the number of pseudobulbs per plant during the entire period of experiment and presented in Table 4. Number of pseudobulbs per plant varied significantly, it was higher in 2:6:2 (T_9) and 2:6:1 (T_8) (3.56 and 3.48 respectively) as compared to other treatments. Whereas, it was less (2.54) in control (at 3 MAT). At 6, 9 and 12 months after treatment, significant increase in pseudobulb production was noticed in NPK level T_9 (2:6:2) recorded maximum pseudobulbs per plant (3.88, 4.08 and 4.22 respectively) and it was on par with the treatment T_8 (2:6:1) (3.48, 3.76 and 3.96). However, minimum was observed in control. Pseudobulb production at 15, 18 and 21 MAT, highest number of pseudo bulbs per plant was recorded in 2:6:2 (T_9) (4.35, 4.50 and 4.63 respectively) and it was statistically on par with treatments T_8 and T_{12} (4.29, 4.42, 4.58 and 4.18, 4.35, 4.52 respectively).While, lowest was recorded in control (3.52, 3.65 and 3.82 respectively) (T_1). The possible reason for this acceleration might be due to the influence of nitrogen has chief constituent of chlorophyll and it is essential for the formation of protoplasm which ultimately results to cell division and cell elongation. Phosphorous is a structural component for cell organelles which involved in energy metabolism activity which greatly encourages the pseudobulb production. This might have played a positive role in increasing the pseudobulb production which is considered as store house of nutrients. These results were previously observed by Nair *et al.*[8], Kabir *et al.*[6], Kumar *et al.*[7] and Anitha and Kannan[2] in *Dendrobium* orchid.

Leaf area recorded in *Dendrobium* cv. Sonia-17 at 6, 12 and 18 months after imposing treatments differed significantly throughout the experimental period and presented in Table 5. Leaf area recorded at 6, 12 and 18 MAT showed significant differences among the treatments. The largest leaf area was noticed in treatment (T_9) 2:6:2 of 40.96, 51.56 and 59.21 cm^2 respectively and it was on par with treatment T_8 (2:6:1) (38.21, 48.94 and 56.28 cm^2 respectively). Whereas, leaf area was minimum in control (27.04, 30.18 and 34.28 cm^2 respectively). The increased leaf

area might be due to availability of optimum nutrition for promotion of cell division and cell elongation, which eventually increase in photosynthetic activity in plants resulting to produce larger leaf area. These findings were in accordance with Kumar *et al.*[7]. Increase in leaf area helps in a better way for photosynthesis, there by more transformation of foods to the other plant parts in *Dendrobium* orchid by Anitha and Kannan[2].

Higher availability of nutrients supplied through foliar application might be have positive inter relationship with production of higher plant height, number of shoots per plant, number of leaves per plant and pesudobulb production, which ultimately might have increased the dry matter production per plant. These results are in line with findings of Kabir *et al.*[6] and Anitha and Kannan[2] in *Dendrobium.*

The data on spike yield per plant in *Dendrobium* as influenced by treatments are presented in Table 6. Number of spike per plant recorded at 3, 6 and 9 MAT had found significant effect on different levels of nutrients. Maximum number of spike per plant (1.60, 2.00 and 2.20 respectively) was recorded in T_9- 2:6:2 and it was on par with treatment T_8 - (2:6:1) (1.40, 1.93 and 2.13 respectively). However, it was registered minimum yield of 0.87, 1.20 and 1.07 spikes per plant was noticed in control (T_1). Significantly highest cut flower yield of 2.60, 2.87, 3.07 and 2.80 was recorded in 2:6:2 (T_9) which is at par with the treatment (T_8) 2:6:1 (2.54, 2.80, 2.87 and 2.60 respectively). While, lowest flower yield per plant was recorded in control (T_1) at 12, 15, 18 and 21 months after treatment.

Data on spike yield per square meter during the entire period of experiment as influenced by varied nutrient levels of NPK as presented in Table 7. Spike yield per square meter varied significantly and it was higher in T_9- 2:6:2 NPK ratio (40.00) as compared to rest of the treatments. Whereas, it was lower (21.67) in control (at 3 MAT). At 6, 9 and 12 months after treatment, significant increase in spike yield. Treatment T_9- (2:6:2) recorded maximum cut flower yield (50.00, 55.00 and 65.00 respectively), which was at par with the treatment T_8- 2:6:1 *Viz.*, 48.00, 53.00 and 63.00 respectively. However, minimum flower yield per square meter (30.00, 26.00 and 35.00 respectively) was observed in (T_1) control. On the other hand at 15, 18 and 21 MAT, highest number of cut flower per meter square was recorded in 2:6:2 (T_9) (71.67, 76.00 and 70.00 respectively) and it was statistically on par with T_8 (2:6:1) (70.00, 71.67 and 65.00 respectively). While, lowest number of flowers per spike was recorded in (T_1) control (38.33, 41.67 and 36.67 respectively).

The data on cut flower yield per hectare differed significantly on *Dendrobium* var. Sonia-17 as influenced by varied nutrient levels of NPK are furnished in Table 8. At 3, 6, 9 and 12 months after treatment, significant increase in spike yield. Treatment T_9 - (2:6:2) NPK level recorded maximum yield of cut flowers (3.20, 4.00, 4.40 and 5.20 lakh respectively) and it was on par with T_8 - (2:6:1) *Viz.*, 2.80, 3.87, 4.27 and 5.07 lakh respectively. However, minimum flower yield per hectare (1.73, 2.40, 2.13 and 2.80 lakh respectively) was observed in (T_1) control. Spike yield at 15, 18 and 21 MAT, highest number of spikes per hectare was recorded in 2:6:2 (T_9) (5.73, 6.13 and 5.60 lakh respectively) and it was statistically on par with 2:6:1 (T_8) (5.60, 5.73 and 5.20 lakh respectively) and lowest flower yield was observed in control.

The increased nutrient availability from phosphorus through phosphobacteria might have increased the various endogenous hormonal levels in the plant tissue, which ultimately increased the number of spikes per plant. The findings were quoted by earlier author Nair *et al.*[8].

The findings of Anitha and Kannan[2] reported that, increase in number of spikes per plant had positive correlation with production of more number of shoots, pseudobulbs, number of leaves and leaf area which helps in production of more photosynthesis resulting in greater accumulation of dry matter which inturn directly or indirectly leads to production

of quality spikes. This variation might be due higher nutrient availability of nitrogen, phosphorus and potassium resulted in accumulation of relatively more photosynthates which were synthesized in the plants for better translocation of assimilates from source to sink which inturn increased the spike yield. These lines are in accordance with Kumar *et al.*[7] in *Dendrobium* orchid.

The data on cumulative spike yield per hectare differed significantly on *Dendrobium* var. Sonia-17 as influenced by varied nutrient levels of NPK are furnished in Table 9. Different nutrient levels were differed significantly with respect to cumulative spike yield per plant, per square meter and per hectare. Highest cumulative yield per plant was recorded in T_9 -2:6:2 nutrient level (17.13, 428.00 and 34.27 lakh) and it was on par with T_8-2:6:1 (16.27, 406.67 and 32.53 lakh) and lowest cumulative spike yield was observed in (T_1) control (9.20, 230.00 and 18.39 lakh). These lines are in accordance with Nair *et al.*[8] and Kumar *et al.*[7] in *Dendrobium* orchid.

It can be concluded from the above study that increasing the levels of phosphorus and potassium in the foliar spray given to *Dendrobium* orchids can result in better growth and higher yield almost throughout the growing season. Treatment T_9-2:6:2 and T_8-2:6:1 NPK ratios which were highly profitable for the farmers for commercial cultivation.

Table 1: Effect of varying nutrient levels on plant height of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Plant height (cm) at different months after treatment							
	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	Mean
T_1: 1:1:1 (Control)	13.48	15.47	18.51	20.88	23.54	26.72	30.42	20.09
T_2- 1:4:1	15.21	18.28	19.32	21.48	24.82	28.28	32.88	21.75
T_3- 1:4:2	15.17	18.52	20.22	23.15	26.48	30.05	33.76	22.55
T_4- 1:6:1	16.38	18.87	22.20	24.84	27.33	30.22	34.29	23.45
T_5- 1:6:2	16.05	19.10	21.76	25.31	28.14	31.16	35.27	23.85
T_6- 2:4:1	18.24	20.18	24.87	26.96	29.26	33.64	37.94	25.68
T_7- 2:4:2	17.71	20.07	25.57	28.05	30.29	35.03	39.40	26.19
T_8- 2:6:1	18.83	22.11	28.87	31.86	35.36	39.18	44.08	29.33
T_9- 2:6:2	19.55	24.23	29.39	33.22	37.21	41.46	45.66	30.69
T_{10}- 3:4:1	16.68	19.51	23.18	25.90	28.55	32.88	36.55	24.64
T_{11}- 3:4:2	17.21	19.99	24.32	28.32	30.98	34.92	39.26	26.23
T_{12}- 3:6:1	18.18	23.21	27.21	29.64	32.26	35.93	40.79	27.66
T_{13}- 3:6:2	18.71	21.87	27.88	30.88	33.54	37.55	41.02	28.21
S.Em ±	0.48	0.44	0.52	0.65	0.61	0.73	0.87	
C.D.@ 5%	1.41	1.29	1.52	1.89	1.77	2.12	2.52	

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

Table 2: Effect of varying nutrient levels on number of shoots per plant of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Number of shoots per plant at different months after treatment							
	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	Mean
T_1: 1:1:1 (Control)	2.53	2.67	2.80	2.93	3.07	3.20	3.40	2.87
T_2- 1:4:1	2.60	2.80	2.93	3.20	3.40	3.53	3.73	3.09
T_3- 1:4:2	2.60	2.93	3.13	3.27	3.47	3.67	3.93	3.17
T_4- 1:6:1	2.73	3.07	3.20	3.40	3.53	3.80	4.00	3.29
T_5- 1:6:2	2.80	3.13	3.27	3.47	3.67	3.87	4.07	3.35
T_6- 2:4:1	2.93	3.20	3.60	3.73	3.87	4.07	4.20	3.52
T_7- 2:4:2	3.00	3.33	3.80	3.93	4.13	4.27	4.40	3.68
T_8- 2:6:1	3.13	3.53	4.00	4.13	4.33	4.47	4.60	3.86
T_9- 2:6:2	3.20	3.60	4.13	4.27	4.47	4.60	4.73	3.95
T_{10}- 3:4:1	2.87	3.13	3.40	3.53	3.73	3.93	4.07	3.39
T_{11}- 3:4:2	2.93	3.20	3.33	3.67	3.87	4.13	4.27	3.50
T_{12}- 3:6:1	3.00	3.40	3.87	4.00	4.20	4.27	4.40	3.72
T_{13}- 3:6:2	3.20	3.47	3.93	4.07	4.27	4.40	4.53	3.81
S.Em ±	0.14	0.20	0.29	0.32	0.20	0.24	0.22	
C.D.@ 5%	0.39	0.57	0.85	0.93	0.59	0.68	0.64	

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

Table 3: Effect of varying nutrient levels on number of leaves per plant of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Number of leaves per plant at different months after treatment							
	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	Mean
T_1: 1:1:1 (Control)	4.47	4.73	5.00	5.27	5.33	5.60	5.73	5.04
T_2- 1:4:1	4.60	4.87	5.13	5.47	5.60	5.80	6.00	5.19
T_3- 1:4:2	4.73	5.07	5.27	5.60	5.80	6.00	6.20	5.37
T_4- 1:6:1	4.60	5.00	5.20	5.47	5.73	6.00	6.20	5.30
T_5- 1:6:2	4.80	5.20	5.33	5.67	5.87	6.20	6.40	5.45
T_6- 2:4:1	4.87	5.33	5.47	5.73	6.07	6.33	6.53	5.55
T_7- 2:4:2	4.93	5.40	5.47	5.87	6.20	6.47	6.67	5.65
T_8- 2:6:1	5.27	5.67	5.97	6.53	6.87	7.27	7.47	6.17
T_9- 2:6:2	5.40	5.80	6.07	6.60	7.13	7.53	7.73	6.32
T_{10}- 3:4:1	4.93	5.47	5.60	5.93	6.13	6.47	6.67	5.67
T_{11}- 3:4:2	5.00	5.47	5.67	6.07	6.27	6.67	6.87	5.79
T_{12}- 3:6:1	5.20	5.53	5.73	6.20	6.53	6.80	7.00	5.89
T_{13}- 3:6:2	5.27	5.60	5.87	6.33	6.73	7.13	7.33	6.05
S.Em ±	0.20	0.16	0.18	0.20	0.28	0.34	0.42	
C.D.@ 5%	0.58	0.46	0.52	0.57	0.82	0.99	1.22	

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

Table 4: Effect of varying nutrient levels on number of leaves per plant of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Number of pseudobulbs per plant at different months after treatment							
	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	Mean
T_1: 1:1:1 (Control)	2.54	2.98	3.08	3.30	3.52	3.65	3.82	3.16
T_2- 1:4:1	2.62	3.04	3.21	3.41	3.61	3.78	3.90	3.26
T_3- 1:4:2	2.83	3.08	3.28	3.48	3.68	3.86	4.02	3.34
T_4- 1:6:1	2.96	3.12	3.25	3.42	3.62	3.84	3.97	3.35
T_5- 1:6:2	3.04	3.20	3.46	3.54	3.74	3.94	4.08	3.45
T_6- 2:4:1	3.02	3.28	3.48	3.66	3.80	3.98	4.15	3.49
T_7- 2:4:2	3.33	3.58	3.71	3.85	4.05	4.22	4.43	3.73
T_8- 2:6:1	3.48	3.76	3.96	4.16	4.29	4.42	4.58	3.91
T_9- 2:6:2	3.56	3.88	4.08	4.22	4.35	4.50	4.63	3.99
T_{10}- 3:4:1	3.22	3.45	3.58	3.72	3.84	4.02	4.22	3.61
T_{11}- 3:4:2	3.30	3.53	3.66	3.80	3.93	4.13	4.30	3.69
T_{12}- 3:6:1	3.41	3.62	3.84	4.04	4.18	4.35	4.52	3.85
T_{13}- 3:6:2	3.27	3.69	3.83	3.98	4.12	4.29	4.46	3.80
S.Em ±	0.20	0.17	0.16	0.15	0.15	0.11	0.09	
C.D.@ 5%	0.57	0.48	0.47	0.44	0.43	0.33	0.26	

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

Table 5: Effect of varying nutrient levels on leaf area per plant of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Leaf area (cm^2)at different months after treatment			
	6 MAT	12 MAT	18 MAT	Mean
T_1: 1:1:1 (Control)	27.04	30.18	34.28	28.41
T_2- 1:4:1	28.11	33.19	36.85	30.98
T_3- 1:4:2	30.64	35.60	39.60	32.78
T_4- 1:6:1	31.12	36.84	40.11	32.62
T_5- 1:6:2	32.96	38.92	42.62	34.78
T_6- 2:4:1	34.54	40.43	45.43	37.07
T_7- 2:4:2	37.74	42.44	48.10	39.67
T_8- 2:6:1	38.21	48.94	56.28	42.19
T_9- 2:6:2	40.96	51.56	59.21	44.89
T_{10}- 3:4:1	31.35	38.95	43.62	36.19
T_{11}- 3:4:2	33.86	41.02	46.69	37.63
T_{12}- 3:6:1	33.45	42.63	48.90	37.77
T_{13}- 3:6:2	33.23	45.20	52.54	39.88
S.Em±	1.24	1.46	1.18	
C.D.@ 5%	3.61	4.24	3.43	

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

Table 6: Effect of varying nutrient levels on number of spike yield per plant of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Spike yield per plant at different months after treatment							
	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	Mean
T_1: 1:1:1 (Control)	0.87	1.20	1.07	1.40	1.53	1.67	1.47	**1.31**
T_2- 1:4:1	0.93	1.33	1.60	1.73	1.93	2.00	1.80	1.61
T_3- 1:4:2	1.13	1.53	1.67	1.87	1.73	1.87	1.67	1.63
T_4- 1:6:1	1.27	1.73	1.81	2.34	2.41	2.54	2.00	2.01
T_5- 1:6:2	1.40	1.80	1.93	2.00	2.07	2.33	2.13	1.95
T_6- 2:4:1	1.20	1.53	1.73	1.87	2.07	2.13	2.00	1.79
T_7- 2:4:2	1.07	1.67	1.67	1.93	2.27	2.27	2.13	1.85
T_8- 2:6:1	1.40	1.93	2.13	2.54	2.80	2.87	2.60	**2.32**
T_9- 2:6:2	1.60	2.00	2.20	2.60	2.87	3.07	2.80	**2.44**
T_{10}- 3:4:1	1.20	1.60	1.67	2.00	2.00	2.20	1.73	1.77
T_{11}- 3:4:2	1.27	1.67	1.73	2.07	2.27	2.07	1.87	1.85
T_{12}- 3:6:1	1.47	1.80	2.00	2.40	2.60	2.73	2.47	2.21
T_{13}- 3:6:2	1.47	1.87	2.07	2.47	2.73	2.87	2.53	2.28
S.Em ±	0.10	0.13	0.15	0.17	0.22	0.10	0.23	
C.D.@ 5%	0.31	0.38	0.45	0.49	0.63	0.30	0.66	

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

Table 7: Effect of varying nutrient levels on spike yield per square meter of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Spike yield per square meter at different months after treatment							
	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	Mean
T_1: 1:1:1 (Control)	21.67	30.00	26.67	35.00	38.33	41.67	36.67	32.85
T_2- 1:4:1	23.33	33.33	40.00	43.33	48.33	50.00	45.00	40.47
T_3- 1:4:2	28.33	38.33	41.67	46.67	43.33	46.67	41.67	40.95
T_4- 1:6:1	31.67	43.33	45.00	58.33	60.00	63.33	50.00	50.23
T_5- 1:6:2	35.00	45.00	48.33	50.00	51.67	58.33	53.33	48.80
T_6- 2:4:1	30.00	38.33	43.33	46.67	51.67	53.33	50.00	44.76
T_7- 2:4:2	26.67	41.67	41.67	48.33	56.67	56.67	53.33	46.43
T_8- 2:6:1	35.00	48.33	53.33	63.33	70.00	71.67	65.00	58.09
T_9- 2:6:2	40.00	50.00	55.00	65.00	71.67	76.67	70.00	61.19
T_{10}- 3:4:1	30.00	40.00	41.67	50.00	50.00	55.00	43.33	44.28
T_{11}- 3:4:2	31.67	41.67	43.33	51.67	56.67	51.67	46.67	46.19
T_{12}- 3:6:1	36.67	45.00	50.00	60.00	65.00	68.33	61.67	55.23
T_{13}- 3:6:2	36.67	46.67	51.67	61.67	68.33	71.67	63.33	57.14
S.Em ±	2.96	3.27	3.84	4.21	5.37	2.61	5.64	
C.D.@ 5%	8.60	9.50	11.16	12.24	15.61	7.60	16.40	

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

Table 8: Effect of varying nutrient levels on spike yield per ha (lakh) of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Spike yield per ha (lakhs) at different months after treatment							
	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	Mean
T_1: 1:1:1 (Control)	1.73	2.40	2.13	2.80	3.07	3.33	2.93	2.62
T_2- 1:4:1	1.87	2.67	3.20	3.47	3.87	4.00	3.60	3.24
T_3- 1:4:2	2.27	3.07	3.33	3.73	3.47	3.73	3.33	3.27
T_4- 1:6:1	2.53	3.47	3.60	4.67	4.80	5.07	4.00	4.02
T_5- 1:6:2	2.80	3.60	3.87	4.00	4.13	4.67	4.27	3.90
T_6- 2:4:1	2.40	3.07	3.47	3.73	4.13	4.27	4.00	3.58
T_7- 2:4:2	2.13	3.33	3.33	3.87	4.53	4.53	4.27	3.71
T_8- 2:6:1	2.80	3.87	4.27	5.07	5.60	5.73	5.20	4.64
T_9- 2:6:2	3.20	4.00	4.40	5.20	5.73	6.13	5.60	4.89
T_{10}- 3:4:1	2.40	3.20	3.33	4.00	4.00	4.40	3.47	3.54
T_{11}- 3:4:2	2.53	3.33	3.47	4.13	4.53	4.13	3.73	3.69
T_{12}- 3:6:1	2.93	3.60	4.00	4.80	5.20	5.47	4.93	4.41
T_{13}- 3:6:2	2.93	3.73	4.13	4.93	5.47	5.73	5.07	4.57
S.Em ±	0.24	0.26	0.31	0.34	0.43	0.21	0.45	
C.D.@ 5%	0.69	0.76	0.89	0.98	1.25	0.61	1.31	

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

Table 9: Effect of varying nutrient levels on cumulative spike yield of *Dendrobium* orchid cv. Sonia-17

Treatments NPK levels	Cumulative spike yield		
	Number of spikes per plant	Number of spikes per square meter	Number of spikes per hectare (lakh)
T_1: 1:1:1	**9.20**	**230.00**	**18.39**
T_2- 1:4:1	11.33	283.33	22.67
T_3- 1:4:2	11.47	286.67	22.93
T_4- 1:6:1	14.00	352.00	28.13
T_5- 1:6:2	13.67	341.67	27.33
T_6- 2:4:1	12.53	313.33	25.07
T_7- 2:4:2	13.00	325.00	26.00
T_8- 2:6:1	**16.27**	**406.67**	**32.53**
T_9- 2:6:2	**17.13**	**428.33**	**34.27**
T_{10}- 3:4:1	12.40	310.00	24.80
T_{11}- 3:4:2	12.93	323.33	25.87
T_{12}- 3:6:1	15.40	386.67	30.93
T_{13}- 3:6:2	16.00	400.00	32.00
S. Em±	1.75	14.91	2.51
CD @ 5%	5.10	43.35	7.29

Control (19:19:19 @ 2gm/L 1:1:1) MAT-months after treatment

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