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INFLUENCE OF SHADE ON THE GROWTH ATTRIBUTES AND FLOWER QUALITY IN *DENDROBIUM* ORCHIDS

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Abstract

The present study was undertaken in *Dendrobium* var. *Sonia* Bom Jo and Renappa to assess the influence of different levels of shade on growth parameters, quality flower production, pigment content, nutrient uptake, and post-harvest characters. The present data revealed that the different levels of shade significantly influenced the morphological characters of the plant *i.e.* plant height, shoot production, internodal length, leaf production, and early flowering. Maximum plant height was obtained for fifty per cent double level shading. The length of the internode was maximum for 50 per cent double level shading. Highest leaf production was noticed in 35 per cent double level shading which was statistically at par with 50 per cent double level of shade. Flower quality and production were markedly influenced by shade. Fifty per cent double level of shade was superior for anthocyanin content, vase life, and longevity of spike on the plant.

Introduction

ORCHIDS, A charming group of flowering plants with their flowers exhibiting an incredible range of diversity in size, shape, form, fragrance, colour, and beauty, have significant contribution to traditional trade as cut flowers and potted plants (Thammasiri, 2020). Majority of the orchids known in cultivation are natives of tropical countries (De and Pathak, 2020). Three hotspots of orchids in India are Western Ghats, NorthEastern states, and Himalayas (Prakash and Pathak, 2019, 2020a, 2022).

Dendrobium is the second largest genus in the family Orchidaceae with 1,606 species (POWO, 2023). They are the gem orchids known for their diverse morphological features, beautiful flowers and produce quality flowers in Kerala. The Kerala state is identified as one of the few places in the world where sophisticated infrastructure is not required for orchid cultivation. *Dendrobium* hybrids occupy the major part of orchids under commercial cultivation in Kerala and Andhra Pradesh (Reddy *et al.,* 2022; Sivakumar *et al.,* 2022). The practices being adopted here require slight changes in order to exploit the available agro-climatic conditions (Rajeevan, 1997). The growing conditions and type of nutrients provided influence the growth and quality of flowers (Raja Naik and Ajithkumar, 2014). Controlled polyhouse conditions for commercial purposes under favourable conditions can also assist the growth of insects and pests diseases (Kalaivanan *et al.,* 2022). When the requirement of infrastructure is focused upon, regulation of light is proved to be a key to the successful commercial cultivation of this genus, since they are shade loving orchids. Earlier some studies have been carried out on different aspects of *Dendrobium* spp. including antioxidant and anti-inflammatory potential (Paul *et al.,* 2022; Sanjana *et al.,* 2021), *in vitro* propagation (Anuprabha *et al.,* 2017; Arora *et al.,* 2016; Bhowmik and Rahman, 2020, 2022; Rahamtulla and Khasim, 2022), and effect of NPK on the vegetative growth (Prakash and Pathak, 2020b).

In this context, a study was presently undertaken in *Dendrobium* var. Sonia Bom Jo and Renappa so as to assess the influence of shade on growth parameters, quality flower production, pigment content, nutrient uptake, and post-harvest characters.

Material and Methods

The present study was carried out in the Orchidarium of All India Co-ordinated Floriculture Improvement project in the Department of Floriculture, College of Horticulture, Vellanikkara, KAU (Kerala Agricultural University). Shade house of size 21.00 m x 6.00 m x 3.00 m x 2.70 m was constructed with mist irrigation.

Planting Material

Two popular varieties of *Dendrobium* namely Sonia Bom Jo and Renappa were used for the study. Hardened tissue culture plants of 3-4 cm size were planted in pots of 5.0 cm size using coconut husk, brick pieces, and charcoal bits as growing media. The effect of six levels of shade on *Dendrobium* var. Sonia Bom Jo and Renappa were studied. The treatments were

T_1- 25% one level shading

T_2- 35% one level shading

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T_3- 50% one level shading (control)

T_4- 25% two level shading

T_5- 35% two level shading

T_6- 50% two level shading

The experimental design was split plot in RBD with four replications. Statistical analysis was done using analysis of variance technique (Panse and Sukhatme, 1985). MSTATC and MS-Excel software were used for the computation and analysis.

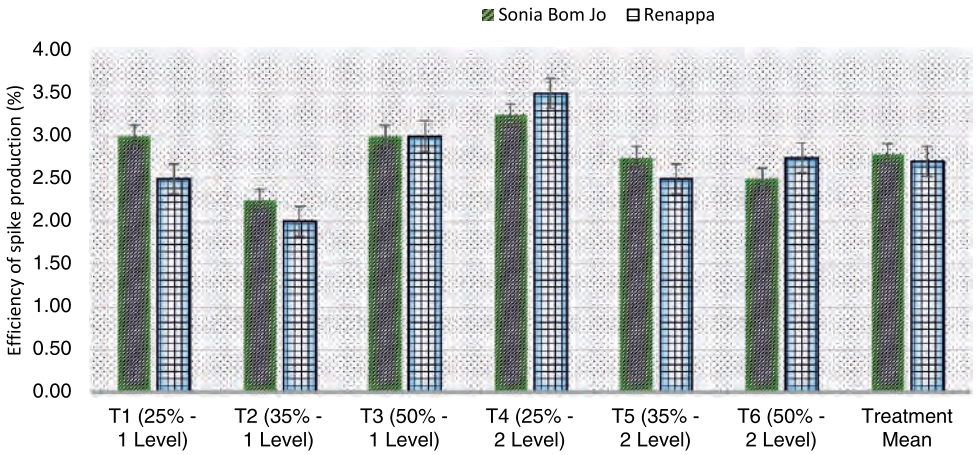

Fig. 1. Efficiency of spike production (%) in *Dendrobium* var. Sonia Bom Jo and Renappa as influenced by different levels of shade.

Anthocyanin content of the flower was extracted using methanolic HCl and determined at maximum absorption of 525 nm (using Spectrometer Spectronic-20).

Results and Discussion

The results obtained from the present study are briefly described and discussed in light of the available literature.

Leaf Production

Mean number of leaves produced was markedly influenced by shade after the seventh month. Treatments imposed with double level shade were found outstanding as compared to single shade levels. Best results were obtained for 35 per cent double level shading (T_5) with a mean value of 2.84. T_6 was superior to T_4, even though all the three were statistically at par with each other. Single level shading showed an appreciable reduction in the number of leaves produced and the least result was obtained for T_1 (2.38) (Table 1).

Plant Height

Influence of shade was not significant during the initial months after planting. During the sixth month after planting, height of the plant reflected an appreciable significant variation. The peak summer showed an influential effect on plant height. Treatments receiving more shade gave substantial increase, for example T_3, T_4, T_5, and T_6 were superior and statistically at par where plant height was maximum for T_4 (8.9 cm). Similar progressive increase was observed in seventh month after planting. Fifty per cent double level shading was distinctly superior with a maximum height of 10.98 cm. During the eighth and ninth month, not much varied significance was noticed in plant height and later on the plant entered to flowering phase (Table 2).

During the initial months, influence of different shade levels on plant height was not much evident which could be due to the time taken for acclimatization. While during the peak summer months, those treatments receiving more shade intensity put forth more height. These

Table 1. Leaf production/plant in *Dendrobium* var. Sonia Bom Jo and Renappa as influenced by different levels of shade.

Treatments	Two months after planting			Four months after planting			Six months after planting		
	Sonia Bom Jo	Renappa	Mean	Sonia Bom Jo	Renappa	Mean	Sonia Bom Jo	Renappa	Mean
T1 (25% - 1 Level)	1.69	1.59	1.64	1.81	1.77	1.79	2.44	2.31	2.38
T2 (35% - 1 Level)	1.81	1.73	1.77	1.75	2.08	1.92	2.38	2.44	2.41
T3 (50% - 1 Level)	1.81	2.06	1.94	1.81	1.56	1.69	2.38	2.52	2.45
T4 (25% - 2 Level)	1.94	2.00	1.97	2.13	1.75	1.94	2.31	2.94	2.63
T5 (35% - 2 Level)	1.69	1.88	1.78	1.88	1.88	1.88	2.56	3.13	2.84
T6 (50% - 2 Level)	1.61	1.69	1.65	1.81	1.81	1.81	2.94	2.50	2.72
Treatment Mean	1.76	1.82	-	1.87	1.81	-	2.5	2.64	-
CD[1] (0.05)	0.225		-	NS		-	0/303		-

CD [1] (0.05) - For comparison of treatments

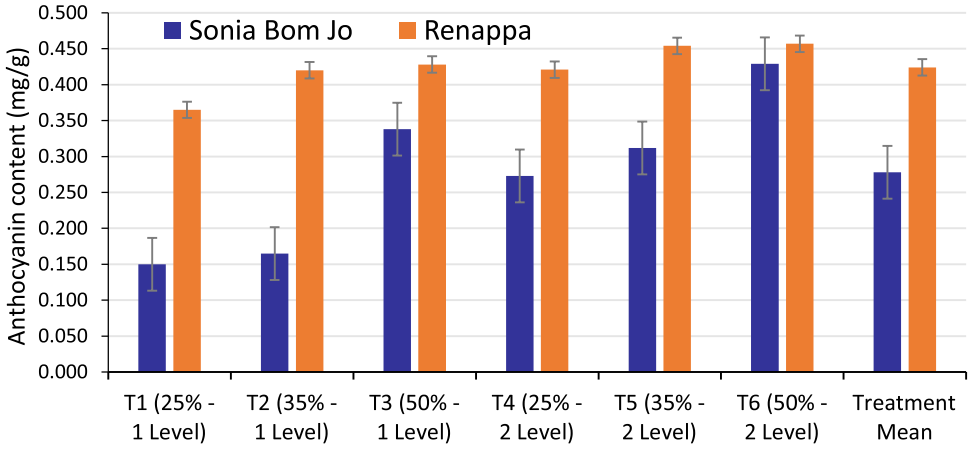

Fig. 2. Anthocyanin content (mg g^{-1}) in *Dendrobium* var. Sonia Bom Jo and Renappa as influenced by different levels of shade.

growth is inversely related to the Pfr/Pr ratio (phytochrome) maintained. Higher light intensities inhibit cell extension by promoting cell maturation.

Higher leaf production was noticed in double level shading mainly under 35 per cent and 50 per cent shade levels. Temperature and relative humidity fluctuations were not prominent in double shade levels of 35 and 50 per cent which reduced the leaf fall in these treatments. These results agree to the findings of Rajeevan (1997) made in dendrobiums under Kerala condition. The auxin concentration at full direct sunlight results are in conformity with the earlier reports of Stamps (1995) and Thekkayam (1996).

Table 2. Plant height in *Dendrobium* var. Sonia Bom Jo and Renappa as influenced by different levels of shade.

Treatments	Six months after planting			Seven months after planting			Eight months after planting		
	Sonia Bom Jo	Renappa	Mean	Sonia Bom Jo	Renappa	Mean	Sonia Bom Jo	Renappa	Mean
T1 (25% - 1 Level)	8.70	6.20	7.46	10.02	7.32	8.67	10.86	8.75	9.85
T2 (35% - 1 Level)	7.35	7.20	7.26	9.00	6.05	7.52	9.75	10.52	10.14
T3 (50% - 1 Level)	9.36	8.10	8.75	11.5	8.98	10.24	12.87	10.11	11.49
T4 (25% - 2 Level)	9.67	8.10	8.90	9.89	9.33	9.61	11.51	9.78	10.64
T5 (35% - 2 Level)	9.75	7.80	8.79	10.39	9.78	10.09	11.39	10.78	11.09
T6 (50% - 2 Level)	9.60	7.70	8.66	11.43	10.52	10.98	10.80	12.54	11.67
Treatment Mean	9.07	7.53	-	10.37	8.66	-	11.20	10.41	-
CD[1] (0.05)	1.25			1.75			NS		

CD [1] (0.05) - For comparison of treatments

Plants may exhibit basically two types of responses to shade. The "shade avoiders" generally tend to redirect their development in shade such that the internode extension is favoured at the expense of leaf development, thereby allowing the young leaves to be kept out of shade. Reduced light levels might have caused increased stem extensions as a shade avoidance reaction, as in other plants. These findings can be well explained based on the report of Kendrick and Frankland (1976) who found that the extension decreases because of photo oxidation. High temperature,

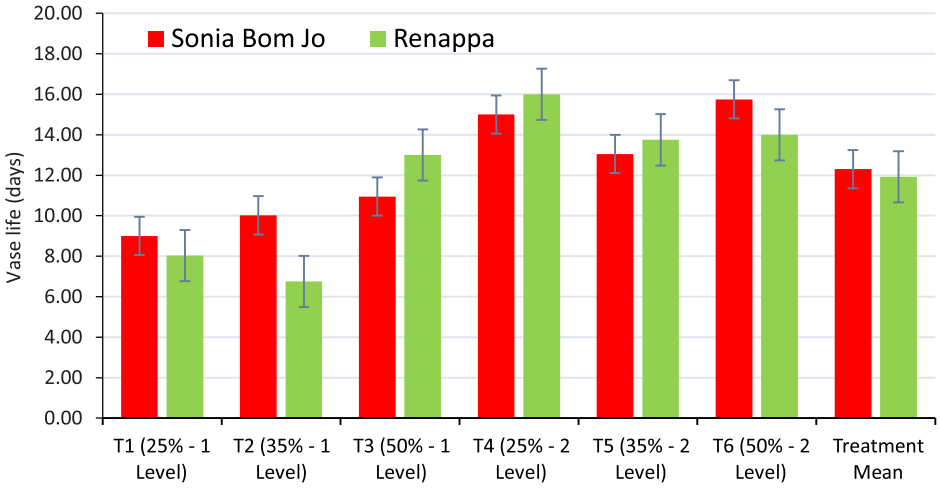

Fig. 3. Vase life (days) of *Dendrobium* var. Sonia Bom Jo and Renappa as influenced by different levels of shade.

Table 3. Efficiency of spike production (%) in *Dendrobium* var. Sonia Bom Jo and Renappa as influenced by different levels of shade.

Treatments	Sonia Bom Jo	Renappa	Mean
T1 (25% - 1 Level)	3.00	2.50	2.75
T2 (35% - 1 Level)	2.25	2.00	2.13
T3 (50% - 1 Level)	3.00	3.00	3.00
T4 (25% - 2 Level)	3.25	3.50	3.38
T5 (35% - 2 Level)	2.75	2.50	2.63
T6 (50% - 2 Level)	2.50	2.75	2.63
Treatment Mean	2.79	2.71	-
CD^1 (0.05)	0.739		
CD^2 (0.05)	NS		

CD^1 (0.05), for comparison of treatments; CD^2 (0.05), for comparison of treatments within varieties.

high light intensity, and low relative humidity influenced the growth attributes of *Dendrobium* (Naik, 2014).

Efficiency of Spike Production

The total number of inflorescences produced in a plot was recorded and expressed as the efficiency. Efficiency of spike production revealed that 25 per cent, two level shading, 25 per cent, and 50 per cent single level shading were significantly superior than others with efficiencies of 3.38, 3.00, and 2.75, respectively. While 35 per cent single level shading recorded the lowest value and was statistically at par with 35 per cent and 50 per cent two level shading (Table 3; Fig.1). Mean values of observations on flowering for eight months are presented.

Table 4. Anthocyanin content (mg g^{-1}) in *Dendrobium* var. Sonia Bom Jo and Renappa as influenced by different levels of shade.

Treatments	Sonia Bom Jo	Renappa	Mean
T1 (25% - 1 Level)	0.15	0.37	0.26
T2 (35% - 1 Level)	0.16	0.42	0.29
T3 (50% - 1 Level)	0.34	0.43	0.38
T4 (25% - 2 Level)	0.27	0.42	0.34
T5 (35% - 2 Level)	0.31	0.45	0.38
T6 (50% - 2 Level)	0.43	0.46	0.44
Treatment Mean	0.28	0.42	
CD^1 (0.05)	0.003		
CD^2 (0.05)	0.003		

CD^1 (0.05), for comparison of treatments; CD^2 (0.05), for comparison of treatments within varieties.

The different treatments used, significantly affected the time taken for emergence of first spike. Early flowering was observed for those treatments receiving more light conditions. Twenty five per cent single level and two-level shading, (T_1, T_4) as well as 35 per cent single level and double level shading (T_2, T_5) were statistically at par, however, 25 per cent single level shading T_1 was the earliest to flower (148.13 days). While the days to first flowering were prolonged in treatments receiving more shade *i.e.* 50 per cent single level (176.75 days) and 50 per cent two level shading (177.38 days). The varieties responded similarly to the character, irrespective of the shade levels.

The flowering response observed during the present study is in line with earlier beneficial effect reported by Goh and Arditti (1981), under higher light intensities on the flowering of tropical species.

One of the most beneficial effects of light was observed in the form of early commencement of flowering. Flowering was earlier in the treatment receiving highest light condition, *i.e.* 25 per cent single level shading with a mean value of 148.13 days. A progressive delay in spike emergence was observed in the other treatments where the maximum delay was noticed in 50 per cent double level shading (177.38 days). This corroborates with the earlier reports of Salvi (1997) and Wardlaw (1990). Information on the assimilate partitioning showed that under source limiting conditions, flowers are the poor competitors for the assimilates. This may be probable reason for less spike production and delay in spike production, under 50 per cent double level shading. The total bloom count is a critical factor in the commercial cultivation of orchids. Here light intensity acts as a key factor in regulating the efficiency of spike production. Efficient spike production was observed under 25 per cent double level as well as under 25 per cent and 50 per cent single level shading.

Anthocyanin Content

The major floral pigment anthocyanin gave conclusive results for the effect of shade. Anthocyanin content gave significant variation with different treatments, as well as for treatments within varieties (Table 4; Fig. 2).

Within treatments, 50 per cent double level shading gave highly superior values (0.443) and confirmed that it was statistically superior to others. Subsequent fall in anthocyanin content was observed with reduction in shade intensity. Treatments T_3 and T_5 were statistically at par (0.383). When treatment comparison was done within a variety, a similar trend was also observed with distinctly superior values for T_6 (0.429). In the case of Renappa, both T_5 and T_6 were statistically outstanding

even though T_6 was superior betweeen the two. T_1 gave the lowest value. The results obtained are in conformity with the report of Griesbach (1983), who opined that environmental factors like light intensity and temperature had a great influence on flower colour. High light intensity and high temperature may cause the breakdown of anthocyanin leading to fading of flowers.

Influence of Shade on Vase Life of Orchid Spike

The longevity of the orchid bloom can be noted in terms of the days taken for wilting of the first floret (Table 5; Fig. 3). Vase life was recorded as the days from harvest to wilting of the first floret. Considerable variations were observed between treatments, with significantly superior results in 25 per cent (15.00 days) and 50 per cent (15.75 days), two level shading. Reduced longevity of spike was noted in 25 per cent and 35 per cent single level shading. Thirty five per cent double level shading (13.4 days) was superior to 50 per cent single level shading, taking intermediate values with much significant variation. According to Halery and Mayak (1981), one of the most important pre-harvest factors influencing the post-harvest life of a cut flower is light, the effect of which is largely related to the accumulation of respirable substrates, mainly carbohydrates. Amylase is involved in the hydrolysis of carbohydrates on perception of light. Light mediated amylase production could thus be an important step in the formation of an active sink to draw materials from the rest of the plant. Longevity of the spike on the plant reflects that, treatments with minimum shade retained the flowers for the least period *i.e.* 25 per cent single level shading (43.5 days) which was statistically at par with 35 per cent single and 25 per cent double levels of shade. Longevity was more in 50 per cent single (59.75 days) and double levels (59.85 days) of shade.

Table 5. Vaselife (days) of *Dendrobium* var. Sonia Bom Jo and Renappa as influenced by different levels of shade.

Treatments	Sonia Bom Jo	Renappa	Mean
T1 (25% - 1 Level)	9.00	8.03	8.51
T2 (35% - 1 Level)	10.02	6.75	8.38
T3 (50% - 1 Level)	10.95	13.00	11.96
T4 (25% - 2 Level)	15.00	16.00	15.50
T5 (35% - 2 Level)	13.05	13.75	13.40
T6 (50% - 2 Level)	15.75	14.00	14.87
Treatment Mean	12.30	11.92	-

During studies on the responses of the leaves and flowers to high light and temperature on CAM *Dendrobium* cv. Sonia, He *et al.* (1998) observed that severe damage occurred in flowers at 38°C than at 28°C under a higher PFD of 1500. Increased ethylene production in strong light was noticed by Gregg (1984). High temperature would increase fatty acid metabolism which may lead to subsequent increase in respiration rate and an ultimate increase in ethylene production. Ethylene shortens the life of orchid flowers under strong light condition in field.

Conclusion

The present results revealed that the different levels of shade significantly influenced the morphological characters of the plant *i.e.* plant height, shoot production, internodal length, and leaf production. Maximum plant height was obtained for 50 per cent double level shading. Highest leaf production was noticed in 35 per cent double level shading which was statistically at par with 50 per cent double level of shade. Flower quality and production were markedly influenced by shade. Fifty per cent double level of shade was superior for anthocyanin content, vase life, and longevity of spike on the plant.

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