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Evaluation of Low Cost Protected Structure for Commercial Cultivation of *Dendrobium* Cv. Sonia under Assam Condition

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ABSTRACT

Background: Dendrobiums are most popular high value cut flowers which require special attention during cultivation. In Assam, *Dendrobium* orchids are normally grown under iron frame shade net houses which are quite vulnerable to cold injury during extreme winter period and heavy rain during monsoon period. Further, the existing structures are very costly which is not affordable by small and marginal farmers of Assam. Keeping in view the current study was aimed to evaluate a suitable low cost protected structure for commercial cultivation of *Dendrobium* cv. Sonia under Assam condition.

Methods: An experiment was conducted in the Horticulture Experimental Farm, Assam Agricultural University, Jorhat, during 2018-2019 which was laid out in factorial completely randomized design with 10 treatment combinations replicated five times. The first factors comprised 5 numbers of low cost protected structures *viz*., G_1, G_2, G_3, G_4 and G_5. The second factors comprised T_1-1 tier and T_2-2 tiers.

Result: The results revealed that among the protected structures, healthy growth and better quality flowers were obtained under G_1 (Bamboo frame structure covered with fixed 200 micron UV film with top ventilated and 50% agro shade net as ceiling) protected structure followed by G_4. Between the tiers, T_2 was found to be superior in respect of the growth characters as well as most of the flower characters. So, this treatment combination is merits consideration for commercial growers of Assam to bring about timely and quality flower production of *Dendrobium* cv. Sonia.

Key words: *Dendrobium* cv. Sonia, Flower characters, Growth characters, Protected structure, Tier.

INTRODUCTION

Dendrobiums are most popular tropical orchid getting fame as cut flowers in India as well as in the world. The total orchid cut flower trade of the world mostly consists of 70-80 per cent *Dendrobium* species (Cheamuangphan and Panmanee, 2013). About 103 species of *Dendrobium* orchids are reported from India (Singh *et al*., 2001). *Dendrobium* cv. Sonia flowered throughout the year with peak flowering during August to October and March to June under North east region. *Dendrobium* grows best at night temperatures between 15-18°C and day temperatures 23-29°C. They can grow both in tropical and subtropical climate with warm bright light (25,000-30,000 lux), 60-80 per cent of relative humidity and good ventilation. Therefore, *Dendrobiums* are grown under different protected condition for both plant sale and cut flowers production. But, in North East India, *Dendrobium* orchids are normally grown under iron frame shade net houses which are quite vulnerable to cold injury during extreme winter period and heavy rain during monsoon period which causes severe impediment in growth and flowering. Further, the existing iron frame structures setup at different parts of the state for growing *Dendrobium* orchids are very costly in nature which is not affordable by small and marginal farmers and also the existing structure do not have provision for proper utilization of the vertical space. Keeping in view the export potential of orchids and the requirement of small farmers as well as the abundance of bamboo in the North Eastern Region, it is necessary to evaluate a suitable low cost orchid growing structure which is capable of providing optimal growing condition for the crop. It gives an added advantage to both small and marginal farmers, who wish to take up orchid industry for more profit.

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MATERIALS AND METHODS

The present investigation entitled “Evaluation of low cost protected structure for commercial cultivation of *Dendrobium* cv. Sonia under Assam condition” was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the period of 2018-2019 for two seasons. The experiment was laid out in factorial completely randomized design with 10 treatment combinations replicated five times. The first factor comprised G_1 (Bamboo frame structure covered with

fixed 200 micron UV film with top ventilated and 50% agro shade net as ceiling), G_2 (Bamboo frame structure with fixed 50% agro shade net as cladding material), G_3 (Bamboo frame structure covered with fixed 200 micron UV film with side removable and 50% agro shade net as ceiling), G_4 (Bamboo frame structure with fixed 50% agro shade net and 200 micron UV film as top covering), G_5 (Bamboo frame structure with 200 micron UV film side removable and fixed 50% agro shade net as covering). The second factor comprised T_1-1 tier (40 cm above the ground level), T_2-2 tiers (40 and 100 cm above the ground level). *Dendrobium* cv. Sonia was raised in 5 low cost growing structures oriented in North-South direction with a size of 4 m length, 4 m width and central height of 3 m. The frame of the house was constructed with bamboo and was covered with 200 micron UV stabilized polythene and Agro Shade net (50 per cent) of green colour. Plantlets were planted in the plastic basket of size 6" depth and 4" diameter and placed on raised platforms (Bench system). The basket was filled laying 1" at the top with a mixture of charcoal, coco husk and coco peat. Potted plants were arranged at the rate of 20 plants on bamboo bench at a size of 1 m breath and 3 m length. Fertilizer mixture NPK-19:19:19 @ 2 g/L was given twice a week as foliar spray. The mineral nutrient treatments - Tracel 20 EC @ 2 g/L was applied as foliar spray at 15 days interval.

The data were collected on various parameters during vegetative and flowering period from four randomly tagged plants in each replication. All the observations were recorded for two growing season *i.e.* 2018 and 2019 and then pooled over years analysis was done using Fisher's method of analysis of variance in CRD as described by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Growth characters

The data (Table 1 and 2) indicated that the different protected structures and tiers had significant effect on growth characters. Amongst the protected structures, G_1 was the best for increasing the growth characters *viz*., plant height (45.26 cm), leaves per plant (11.65), leaf area per plant (569.61 cm^2) and height of pseudobulb (25.67 cm). Similarly, T_2 was found to be superior in respect of the growth characters *viz*., plant height (42.57 cm), leaves per plant (10.54), leaf area per plant (532.47 cm^2) and height of pseudobulb (24.13 cm). Good vegetative growth indicates better accumulation of photosynthates in plants. Faster growth is essential especially during juvenile stage for better flowering later on. In the present study, G_1 (Bamboo frame structure covered with fixed 200 micron UV film with top ventilated and 50% agro shade net as ceiling) was found to be superior amongst the growing structures. This phenomenon could be attributed to the favorable environmental conditions *viz*., optimum temperature, relative humidity, light intensity and proper air circulation inside the growing system which may drastically influence

Table 1: Effect of different treatments on plant height and leaves per plant.

Treatments	Plant height (cm)								Leaves per plant							
	2018			2019			Pooled		2018			2019			Pooled	
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
G_1	40.90	42.80	41.85	47.54	50.00	48.77	44.21	46.30	45.26	10.60	11.00	10.80	12.00	13.00	12.50	11.30	12.00	11.65
G_2	36.13	36.70	36.42	41.81	42.50	42.16	38.97	39.60	39.29	7.60	8.00	7.80	9.40	9.60	9.50	8.50	8.80	8.65
G_3	37.16	36.60	36.88	44.19	43.50	43.85	40.68	40.00	40.34	9.00	9.40	9.20	11.40	11.00	11.20	10.20	10.20	10.20
G_4	38.18	40.70	39.44	46.20	48.40	47.30	42.19	44.50	43.35	9.20	10.40	9.80	11.60	12.40	12.00	10.40	11.40	10.90
G_5	37.54	39.00	38.27	44.50	45.80	45.15	41.02	42.43	41.73	9.60	10.00	9.80	11.00	12.00	11.50	10.30	10.30	10.30
Mean	37.98	39.16	38.57	44.85	46.04	45.45	41.41	42.57		9.20	9.76	9.48	11.08	11.60	11.34	10.14	10.54	
	S.Ed		$C.D_{0.05}$			S.Ed	$C.D_{0.05}$					S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$	
Year (Y)	0.27		0.44	G × Y		0.59	NS			Year (Y)		0.16	0.27	G × Y		0.36	NS	
Effect of growing structure (G)	0.42		0.70	T × Y		0.38	NS			Effect of growing structure (G)		0.26	0.43	T × Y		0.23	NS	
Effect of tier (T)	0.27		0.44	G × T × Y		0.84	NS			Effect of tier (T)		0.16	0.27	G × T × Y		0.51	NS	
G × T	0.59		0.99							G × T		0.36	NS					

*Significant at 5% probability level; NS non-significant.

Table 2: Effect of different treatments on leaf area per plant and height of pseudobulb.

Treatments	Leaf area per plant (cm^2)								Height of pseudobulb (cm)							
	2018			2019			Pooled		2018			2019			Pooled	
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	T_1	T_2	Mean
G_1	537.98	575.44	556.71	577.36	587.66	582.51	557.67	581.55	569.61	24.30	24.90	24.60	26.54	26.92	26.73	25.42	25.91	25.67
G_2	403.06	424.96	414.01	430.60	444.00	437.30	416.83	434.48	425.66	20.68	20.94	20.81	23.62	24.02	23.82	22.15	22.48	22.32
G_3	522.10	537.78	529.94	526.08	534.70	530.39	524.09	536.24	530.17	21.40	22.24	21.82	24.82	25.06	24.94	23.11	23.65	23.38
G_4	532.16	558.92	545.54	551.80	563.46	557.63	541.98	561.11	551.55	23.04	23.12	23.08	26.38	26.41	26.40	24.71	24.77	24.74
G_5	528.68	544.32	536.50	537.66	553.60	545.63	533.17	548.96	541.07	22.12	22.28	22.20	25.04	25.39	25.21	23.58	23.83	23.71
Mean	504.80	528.28	516.54	524.70	536.68	530.69	514.75	532.47		22.31	22.70	22.50	25.28	25.56	25.42	23.79	24.13	
		S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$					S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$	
Year (Y)		7.05	11.73		G × Y	15.76	NS			Year (Y)		0.23	0.38		G × Y	0.51	NS	
Effect of growing structure (G)		11.14	18.54		T × Y	9.97	NS			Effect of growing structure (G)		0.36	0.60		T × Y	0.33	NS	
Effect of tier (T)		7.05	11.73		G × T × Y	22.29	NS			Effect of tier (T)		0.23	0.38		G × T × Y	0.73	NS	
G × T		15.76	NS							G × T		0.51	NS					

*Significant at 5% probability level; NS: non-significant.

the growth of the plants. Because, natural ventilation affects both the air temperature and humidity which directly affect crop transpiration and carbon di oxide concentration that affects the photosynthesis process of crop (Hanan, 1998). Again, 50% shading and better air circulation in G_1 which has a positive effect on plant physiology by preventing a down regulation of photosynthesis during periods of high radiation. These findings are in confirmatory with the findings of Naik and Kumar (2015) who reported that top ventilated poly house had the maximum influence on plant height (25.50 cm). Similar observations of increasing the leaf area due to better light and shading were made by Pires *et al.* (2012) in an experiment on epiphytic orchid *Miltonia spectabilis* var. Moreliana. Zou and Liu (2010) observed that during the pseudo bulb thickening phase, the *Dendrobium nobile* should be grown in full sun with good air circulation to produce strong pseudobulbs.

Flower characters

The data pooled over years of flower characters were tabulated in (Table 3, 4, 5 and 6). The different protected structures and tiers had significant effect on the flower characters of *Dendrobium* cv. Sonia. Amongst the growing structures G_1 exhibited minimum days for bud visibility to opening of first floret (19.00 days), days for opening of first floret to full bloom (15.80 days) as well as the highest value for spikes per plant (4.40), spike length (38.17 cm), florets per spike (9.50), floret diameter (9.28 cm), self life of spike (44.60 days) and vase life of spike (30.35 days). Between the tiers, T_2 took minimum days for bud visibility to opening of first floret (21.82 days), days for opening of first floret to full bloom (18.99 days) as well as the highest value for florets per spike (7.60). Results revealed that minimum duration for first floret open and full bloom were recorded in G_1 compared to others. This treatment resulted earliness in flowering which recorded 8 days reduction to first floret open compared to the G_2. This might be due to the fact that to utilization of shade nets as a ceiling corroborating with ventilation on G_1 may be create a favorable temperature range both in dry and wet conditions during flowering time of *Dendrobium* cv. Sonia. G_1 might have increased number of flowers had positive and significant correlation with shoots and pseudobulbs production. Thus, the increased number of leaves, leaf area on plant growth helped in better way to synthesis of carbohydrates and their utilization to give up extra growth, thereby increasing the production of spikes as compare to others. Moreover, this might be due to favorable microclimate helps in accumulating more amount of assimilates which are needed for improvement of spike. Similar trend of report was made by Sugapriya *et al*. (2012).

Plants were placed on T_2 (40 cm and 100 cm above the ground) showed superior performance for most of the flower and growth characters compared to T_1. The possible reason for the reduction of temperature with increase in height of the greenhouse is due to the fact

Table 3: Effect of different treatments on days taken from bud visibility to opening of first floret and days taken from opening of first floret to full bloom.

Treatments	Days taken from bud visibility to opening of first floret (days)									Days taken from opening of first floret to full bloom (days)								
	2018			2019			Pooled			2018			2019			Pooled		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
G_1	19.80	17.60	18.70	20.20	18.40	19.30	20.00	18.00	19.00	16.00	15.60	15.80	16.60	15.00	15.80	16.30	15.30	15.80
G_2	27.40	25.40	26.40	28.60	26.80	27.70	28.00	26.10	27.05	23.40	22.80	23.10	24.00	22.60	23.30	23.70	22.70	23.20
G_3	26.00	24.00	25.00	26.60	25.00	25.80	26.30	24.50	25.40	21.60	20.80	21.20	20.80	19.20	20.00	21.20	20.00	20.60
G_4	21.20	19.00	20.10	22.40	20.40	21.40	21.80	19.70	20.75	18.60	17.80	18.20	19.20	18.20	18.70	18.90	18.00	18.45
G_5	22.60	20.20	21.40	23.20	21.40	22.30	22.90	20.80	21.85	20.00	18.80	19.40	20.40	19.06	19.73	20.20	18.93	19.57
Mean	23.40	21.24	22.32	24.20	22.40	23.30	23.80	21.82		19.92	19.16	19.54	20.20	18.81	19.51	20.06	18.99	
		S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$					S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$	
Year (Y)		0.34	0.57	G × Y		0.77	NS			Year (Y)		0.36	NS	G × Y		0.80	NS	
Effect of growing structure (G)		0.54	0.90	T × Y		0.48	NS			Effect of growing structure (G)		0.57	0.95	T × Y		0.51	NS	
Effect of tier (T)		0.34	0.57	G × T × Y		1.08	NS			Effect of tier (T)		0.36	0.60	G × T × Y		1.14	NS	
G × T		0.77	NS							G × T		0.80	NS					

*Significant at 5% probability level; NS non-significant.

Table 4: Effect of different treatments on spikes per plant and spike length.

Treatments	Spike per plant									Spike length (cm)								
	2018			2019			Pooled			2018			2019			Pooled		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
G_1	4.20	4.40	4.30	4.40	4.60	4.50	4.30	4.50	4.40	37.20	37.86	37.53	38.68	38.92	38.80	37.94	38.39	38.17
G_2	2.00	2.40	2.20	2.40	2.60	2.50	2.20	2.50	2.35	31.58	32.74	32.16	33.14	33.98	33.56	32.36	33.36	32.86
G_3	3.00	2.60	2.80	3.00	2.80	2.90	3.00	2.70	2.85	33.15	34.14	33.64	34.20	35.40	34.80	33.67	34.77	34.22
G_4	4.00	4.00	4.00	4.00	4.20	4.10	4.00	4.10	4.05	36.54	37.06	36.80	37.75	38.04	37.90	37.15	37.55	37.35
G_5	3.60	3.80	3.70	3.80	3.80	3.80	3.70	3.80	3.75	34.72	35.96	35.34	35.39	36.83	36.11	35.05	36.40	35.73
Mean	3.36	3.44	3.40	3.52	3.60	3.56	3.44	3.52		34.64	35.55	35.09	35.83	36.64	36.23	35.24	36.09	
		S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$					S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$	
Year (Y)		0.11	NS	G × Y		0.25	NS			Year (Y)		0.38	0.64	G × Y		0.86	NS	
Effect of growing structure (G)		0.17	0.29	T × Y		0.16	NS			Effect of growing structure (G)		0.60	1.01	T × Y		0.54	NS	
Effect of tier (T)		0.11	NS	G × T × Y		0.35	NS			Effect of tier (T)		0.38	NS	G × T × Y		1.21	NS	
G × T		0.25	NS							G × T		0.86	NS					

*Significant at 5% probability level; NS non-significant.

Table 5: Effect of different treatments on florets per spike and floret diameter.

Treatments	Florets per spike									Floret diameter (cm)								
	2018			2019			Pooled			2018			2019			Pooled		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
G_1	9.00	9.40	9.20	9.20	9.60	9.40	9.10	9.50	9.50	9.16	9.29	9.22	9.42	9.24	9.33	9.19	9.35	9.28
G_2	5.60	5.80	5.70	5.80	6.00	5.90	5.70	5.90	5.80	6.18	6.30	6.24	6.78	6.82	6.80	6.50	6.54	6.52
G_3	6.20	6.60	6.40	6.00	6.20	6.10	6.10	6.40	6.25	7.04	7.12	7.08	7.84	7.59	7.72	7.32	7.48	7.31
G_4	8.40	8.80	8.60	8.20	8.60	8.40	8.30	8.70	8.50	8.42	8.44	8.43	8.37	8.45	8.41	8.44	8.40	8.42
G_5	7.00	7.40	7.20	7.40	7.80	7.60	7.20	7.60	7.40	7.50	7.74	7.62	7.90	7.99	7.95	7.75	7.82	7.78
Mean	7.24	7.60	7.42	7.32	7.64	7.48	7.30	7.60		7.66	7.78	7.72	8.06	8.02	8.04	7.84	7.92	
		S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$					S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$	
Year (Y)		0.13	NS	G × Y		0.30	NS			Year (Y)		0.12	0.20	G × Y		0.27	NS	
Effect of growing structure (G)		0.21	0.35	T × Y		0.19	NS			Effect of growing structure (G)		0.19	0.32	T × Y		0.17	NS	
Effect of tier (T)		0.13	0.22	G × T × Y		0.42	NS			Effect of tier (T)		0.12	NS	G × T × Y		0.38	NS	
G × T		0.30	NS							G × T		0.27	NS					

*Significant at 5% probability level; NS non-significant.

Table 6: Effect of different treatments on self life of spike and vase life of spike.

Treatments	Self life of spike (days)									Vase life of spike (days)								
	2018			2019			Pooled			2018			2019			Pooled		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
G_1	45.40	45.00	45.20	44.20	43.80	44.00	44.80	44.40	44.60	30.80	30.20	30.50	30.40	30.00	30.20	30.60	30.10	30.35
G_2	44.60	44.20	44.40	43.60	42.80	43.20	44.10	43.50	43.80	29.80	29.20	29.50	29.20	29.00	29.10	29.50	29.10	29.30
G_3	41.00	40.00	40.50	41.60	40.80	41.20	41.30	40.40	40.85	26.60	25.80	26.20	27.60	26.20	26.90	27.10	26.00	26.55
G_4	43.20	43.00	43.10	42.80	42.40	42.60	43.00	42.70	42.85	28.40	28.20	28.30	28.60	28.40	28.50	28.50	28.30	28.40
G_5	40.40	40.00	40.20	40.20	39.60	39.90	40.30	39.80	40.05	24.64	23.70	24.17	24.80	23.80	24.30	24.72	23.75	24.24
Mean	42.92	42.44	42.68	42.48	41.88	42.18	42.70	42.16		28.05	27.42	27.73	28.12	27.48	27.80	28.08	27.45	
		S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$					S.Ed	$C.D_{0.05}$			S.Ed	$C.D_{0.05}$	
Year (Y)		0.39	NS	G × Y		0.87	NS			Year (Y)		0.35	NS	G × Y		0.79	NS	
Effect of growing structure (G)		0.61	1.02	T × Y		0.55	NS			Effect of growing structure (G)		0.56	0.93	T × Y		0.50	NS	
Effect of tier (T)		0.39	NS	G × T × Y		1.23	NS			Effect of tier (T)		0.35	NS	G × T × Y		1.12	NS	
G × T		0.87	NS							G × T		0.79	NS					

*Significant at 5% probability level; NS non-significant.

that the inside temperature will decrease with increase of ventilation rate.

CONCLUSION

It can be concluded from the above study that G_1 (Bamboo frame structure covered with fixed 200 micron UV film with top ventilated and 50% agro shade net as ceiling) and G_4 (Bamboo frame structure with fixed 50% agro shade net and 200 micron UV film as top covering) are comparatively suitable for healthy growth and flowering of *Dendrobium* cv. Sonia under Assam condition due to utilization of 200 micron UV film causes privations of damage from cold and heavy rain. Moreover, combinations of shade net and top ventilation were maintained the optimum temperature and relative humidity during the winter months (January to February) as well as during the summer months (March to May). Similarly, T_2 (2 tiers-40 and 100 cm above the ground level) showing better performance as compared to T_1 for proper utilization of vertical space. So, this treatment combination is merits consideration for commercial growers of Assam to bring about timely and quality flower production of *Dendrobium* cv. Sonia.

Conflict of interest

All authors declare that they have no conflict of interest.

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