

Full Length Research Paper

Plant performance of *Anthurium andreanum* as affected by shade conditions and different conventional nutrient sources

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Investigation was done on the performance of *Anthurium andreanum* plant as affected by shade conditions as well as the effects of different conventional nutrient sources. Anthuriums were planted on beds containing a media of cocopeat, charcoal and vermicompost. The beds were constructed under two shade conditions, that is, shade house (netlon with 75% shade) and natural tree shade. Different sources of nutrients such as NPK, biofertilizers, cattle manure, pig and poultry manure were supplemented. Better performance in terms of consistent growth as well as taller plant heights were obtained from those grown under shade house. Under shade house, NPK and biofertilizer application resulted in best performance of plant height whereas cattle manure treatment resulted in tallest average plant height under tree shade.

Key words: Anthurium, shade effect, nutrient sources, plant height.

INTRODUCTION

Anthurium andreanum is a member of the Araceae family, which includes more than 100 genera and about 1599 species, chiefly from the tropics (Higaki et al., 1994). In the global market, anthurium is second, only to the orchid, among tropical cut flowers (Galinsky and Laws, 1996). Anthurium plantlet growth begins with a monopodial vegetative period during which no flowers are produced (Dufour and Gue´rin, 2003) and the duration of this period was strongly influenced by fertilization produced (Dufour and Gue´rin, 2005).

The mild climatic condition of Mizoram state, India, permits anthurium cultivation without the use of temperature control facilities. It has been cultivated since the year 2002, with approximately 300 families actively engaged in the cultivation. Cultivation is done usually on shade house, with soilless cultivation. Soilless cultivation systems require expensive equipment, so the yield and quality of the flowers have to be very high (Dufour and Gue´rin, 2003). The present experiment is conducted to

study the performance of plants under natural tree shade, as compared to the conventional shade house being used in Mizoram, so as to understand the plant performance as affected by shading conditions, and also to investigate the effect of different nutrient sources on the plant performance.

MATERIALS AND METHODS

The experiment was conducted at Mizoram University campus, Tanhril, Mizoram, which is situated at 21°58' and 24°35'N latitude and 92°15' and 93°29'E longitude and at an altitude of 750 MSL. The environment is a warm, humid sub-tropical climate, with an annual average temperature of 11 to 21°C in winter and 20 to 30°C in summer, and 250 cm per annum rainfall. The experiment was conducted during 2008 to 2009, and plant height reading was taken from the third month after planting, that is, during September 2008 to August 2009.

Plant materials and cultivation conditions

Tissue cultured plantlets of anthurium cv. Evita (AVO *Anthurium Vogels*, Holland) were planted on the flower beds of 1.2 m², on a media consisting of cocopeat, charcoal, and vermicompost in the ratio 6.5:1:1. The plantlets were each measuring 20 to 25 cm (pots)

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and nine (9) plants were planted on each plot at a distance of 40 cm. Two plots were selected, one under a forest where terrace was constructed, leaving the trees to provide shade to the terraces. The flower beds were made on these terraces with a brick lining. For the other plot, terraces were made on barren land, where shade house was constructed with a netlon that provides 75% shade (Rakshak Agro-shading, White x Black, 75%).

Treatments

The first treatment was that of the cultivation condition, that is, on shade house and under forest trees. Different sources of nutrient were applied as:

- i. Control –no additional nutrient source
- ii. NPK(19:19:19) at 220 kg/ha/year
- iii. Biofertilizers (Azospirillum and Phosphotika) at 500 gm/acr/year.
- iv. Cattle manure at 10 tonnes/ha/year.
- v. Pig manure at 10 tonnes/ha/year.
- vi. Poultry manure at 5 tonnes/ha/year.

Each treatment having three replications under two different conditions, as T_1R_1 , T_1R_2 , T_1R_3 , T_2R_1 ,... $T_{12}R_3$. Among these, T_1 to T_6 represents the plants cultivated under shade house, while T_7 to T_{12} are the plants grown under natural tree shade. Nine plants were planted within each of these treatments.

Plant growth measurements

Three representative plants, out of nine plants, were randomly selected for measurement from each plot. The height of each plant was observed by measuring the plant from base to petiole end of the tallest leaf.

Statistical analysis

To analyze if there was a systematic difference between different treatments being applied in the experiment on the growth performances of plant height during the twelve month period, the method of 2-way ANOVA with m (that is, 3) observations per cell was adopted to each of the shade house and tree shade separately. Using this method, three possible effects, namely, treatment, durations (month) and interaction were examined. In addition, an attempt had been made to examine if there is significant difference between the two types of experimental plots, that is, shade house and tree shade, using 3-way ANOVA with m (that is, 3) observations per cell.

RESULTS AND DISCUSSION

As it is presented in Tables 6 and 7, all the effects of treatment and duration are found to be significant under shade house and tree shade; while interaction is not significant. That is, the growth performances of plant height have shown significantly different behaviour from one treatment to another and duration (months) has also played a significant role in the growth performance of plant height. Meanwhile, Table 8 revealed that, whereas the shade effect is significant, its interaction with treatment is found to be indeterminate. However, the result

being observed in the overall performances is that there are significant differences in the overall treatment averages between shade house and tree shade, with shade house showing a better performance throughout.

Among the different treatments, T_2 recorded the most number of tallest plant height (that is, five times) followed by T_3 (four times) during the twelve months recorded period. Also, plant heights of both T_2 and T_3 are significantly at par with the tallest recorded plant height in most of the readings (ten times and eleven times respectively). We can thus conclude that treatment with NPK (T_2) and biofertilizer (T_3) resulted in the best performance in terms of plant height, under shade house condition (Table 1).

From the observations taken from the plants grown under natural tree shade (Table 2) among the different treatments, T_{10} recorded the most number of tallest plant height (seven times) during the twelve month recorded period. Also, the record of T_{10} on third month was the tallest plant height record of all the treatments. Besides, plant height record of T_{10} was significantly at par with the tallest record in all the months except for the second month. Thus, we can conclude that treatment with Cattle manure (T_{10}) recorded best performance in terms of plant height during the twelve month recorded period under natural Tree shade conditions. Also the performance of plant height was fairly good with treatments of Pig manure (T_{11}) and NPK (T_8).

The average plant height under shade house increases up to the third month (November, 2008), which lowers down in the following months, rises again after the ninth month up to the tenth month (May to June, 2009) and then falls down. However, the plant height under natural tree shade rises initially up to the third month, which falls from the fifth month and continues to lower. This fluctuation in the pattern of plant height is attributed to the adverse climatic condition especially water stress during the winter seasons (December to February, that is, fourth to sixth months), and also pruning of the oldest leaves during the peak growth season to avoid overcrowding of the plantation. However, Agasimani et al. (2011) revealed that different varieties of anthurium performed well in winter from September to December compared to rainy season, that is, May to August with respect to foliage and floral characters. The plants under shade house recovers from the adverse climatic conditions once favourable climatic conditions prevails in the ninth and tenth month, whereas the plants exposed to natural conditions, even under the shade of trees, do not recover as well as those grown under shade house.

Under shade house (Table 3), among the different treatments, T_2 (NPK) have the tallest average plant height during twelve month observation, followed by T_3 (biofertilizer treatment) whereas T_5 (pig manure treatment) shows lowest average plant height. Again, under natural tree shade, treatment with cattle manure (T_{10}) recorded tallest average plant height, whereas poultry manure treatment (T_{12}) shows lowest average plant height (Table 4

Table 1. Growth performance of plant height with different nutrient sources during 12 months (shade house).

		Month																					
		1	2	3	4	5	6	7	8	9	10	11	12										
T ₃	38.60	T ₆	37.33	T ₄	44.00	T ₂	42.83	T ₃	43.67	T ₄	42.33	T ₂	40.33	T ₃	38.50	T ₃	41.33	T ₂	44.67	T ₂	38.67	T ₂	41.67
T ₁	35.73	T ₂	37.00	T ₅	42.67	T ₆	42.50	T ₆	43.33	T ₂	41.67	T ₃	39.03	T ₁	37.67	T ₆	40.67	T ₃	44.33	T ₄	36.33	T ₄	39.67
T ₅	34.80	T ₄	37.00	T ₆	42.67	T ₃	41.50	T ₂	42.33	T ₃	39.33	T ₆	37.50	T ₂	37.67	T ₂	40.17	T ₁	43.67	T ₁	36.00	T ₄	39.00
T ₄	34.27	T ₅	36.33	T ₃	42.33	T ₁	40.00	T ₅	41.33	T ₅	39.33	T ₁	36.67	T ₅	37.67	T ₅	38.50	T ₅	41.33	T ₆	36.00	T ₆	38.00
T ₆	33.67	T ₃	35.67	T ₁	41.67	T ₅	39.00	T ₁	41.00	T ₆	39.33	T ₅	36.17	T ₆	37.60	T ₁	38.00	T ₄	41.00	T ₃	35.33	T ₅	36.67
T ₂	33.50	T ₁	35.00	T ₂	39.67	T ₄	38.83	T ₄	39.33	T ₁	37.33	T ₄	35.67	T ₄	34.33	T ₄	37.50	T ₆	39.67	T ₅	34.67	T ₁	36.00
Average	35.09		36.39		42.17		40.78		41.83		39.89		37.56		37.24		39.36		42.44		36.17		38.50

5% level critical difference for treatment means = 3.33.

Table 2. Growth performance of plant height with different nutrient sources during 12 months (tree shade).

		Month																					
		1	2	3	4	5	6	7	8	9	10	11	12										
T ₇	37.13	T ₁₁	41.67	T ₁₀	45.67	T ₁₀	42.83	T ₁₂	42.33	T ₈	38.00	T ₈	39.67	T ₁₀	40.83	T ₁₀	41.37	T ₁₀	38.00	T ₁₀	39.67	T ₁₀	38.67
T ₈	36.83	T ₈	40.00	T ₇	42.67	T ₈	41.67	T ₁₀	42.00	T ₁₁	38.00	T ₁₁	39.67	T ₁₁	40.43	T ₈	38.80	T ₁₁	36.33	T ₁₁	38.67	T ₁₁	37.67
T ₁₀	36.53	T ₁₂	39.00	T ₈	42.33	T ₁₁	41.03	T ₁₁	42.00	T ₁₀	36.67	T ₇	38.33	T ₈	39.33	T ₁₁	37.77	T ₉	35.67	T ₈	35.67	T ₇	33.67
T ₉	36.47	T ₇	38.67	T ₉	42.00	T ₇	40.67	T ₈	41.00	T ₁₂	36.00	T ₁₀	38.00	T ₉	37.33	T ₉	34.67	T ₈	35.00	T ₉	35.00	T ₉	33.67
T ₁₁	35.83	T ₉	38.00	T ₁₁	42.00	T ₉	40.00	T ₉	40.00	T ₉	35.50	T ₉	33.07	T ₇	36.00	T ₇	34.43	T ₇	33.00	T ₇	34.67	T ₈	32.00
T ₁₂	35.40	T ₁₀	37.50	T ₁₂	39.67	T ₁₂	38.83	T ₇	39.67	T ₇	35.00	T ₁₂	33.00	T ₁₂	31.67	T ₁₂	33.43	T ₁₂	32.00	T ₁₂	30.00	T ₁₂	27.67
Average	36.37		39.14		42.39		40.84		41.17		36.53		36.96		37.60		37.10		35.00		35.61		33.89

5% level critical difference for treatment means = 4.20.

Table 3. Growth of plant height (cm) during 12 months (shade house).

		Treatment									
Months	T ₁	Months	T ₂	Months	T ₃	Months	T ₄	Months	T ₅	Months	T ₆
10th	43.67	10th	44.67	10th	44.33	3rd	44.00	3rd	42.67	5th	43.33
3rd	41.67	4th	42.83	5th	43.67	6th	42.33	5th	41.33	3rd	42.67
5th	41.00	5th	42.33	3rd	42.33	10th	41.00	10th	41.33	4th	42.50
4th	40.00	6th	41.67	4th	41.50	5th	39.33	6th	39.33	9th	40.67
9th	38.00	12th	41.67	9th	41.33	12th	39.00	4th	39.00	10th	39.67
8th	37.67	7th	40.33	12th	39.67	4th	38.83	9th	38.50	6th	39.33
6th	37.33	9th	40.17	6th	39.33	9th	37.50	8th	37.67	12th	38.00

Table 3. Contd.

7th	36.67	3rd	39.67	7th	39.03	2nd	37.00	12th	36.67	8th	37.60
11th	36.00	11th	38.67	1st	38.60	11th	36.33	2nd	36.33	7th	37.50
12th	36.00	8th	37.67	8th	38.50	7th	35.67	7th	36.17	2nd	37.33
1st	35.73	2nd	37.00	2nd	35.67	8th	34.33	1st	34.80	11th	36.00
2nd	35.00	1st	33.50	11th	35.33	1st	34.27	11th	34.67	1st	33.67
Average	38.23		40.01		39.94		38.30		38.21		39.02

5% level critical difference for duration means = 2.35

Table 4. Growth of plant height (cm) during 12 months (tree shade).

Treatment											
Months	T ₇	Months	T ₈	Months	T ₉	Months	T ₁₀	Months	T ₁₁	Months	T ₁₂
3rd	42.67	3rd	42.33	3rd	42.00	3rd	45.67	3rd	42.00	5th	42.33
4th	40.67	4th	41.67	4th	40.00	4th	42.83	5th	42.00	3rd	39.67
5th	39.67	5th	41.00	5th	40.00	5th	42.00	2nd	41.67	2nd	39.00
2nd	38.67	2nd	40.00	2nd	38.00	9th	41.37	4th	41.03	4th	38.83
7th	38.33	7th	39.67	8th	37.33	8th	40.83	8th	40.43	6th	36.00
1st	37.13	8th	39.33	1st	36.47	11th	39.67	7th	39.67	1st	35.40
8th	36.00	9th	38.80	10th	35.67	12th	38.67	11th	38.67	9th	33.43
6th	35.00	6th	38.00	6th	35.50	7th	38.00	6th	38.00	7th	33.00
11th	34.67	1st	36.83	11th	35.00	10th	38.00	9th	37.77	10th	32.00
9th	34.43	11th	35.67	9th	34.67	2nd	37.50	12th	37.67	8th	31.67
12th	33.67	10th	35.00	12th	33.67	6th	36.67	10th	36.33	11th	30.00
10th	33.00	12th	32.00	7th	33.07	1st	36.53	1st	35.83	12th	27.67
Average	36.99		38.36		36.78		39.81		39.26		34.92

5% level Critical difference for duration means = 2.97.

Table 5. Five percent critical limit of plant height w.r.t treatment during 12 months.

Treatment	Shade house		Tree shade	
	Mean ± t _(.025)	SE (mean)	Mean ± t _(.025)	SE (mean)
Control	38.23 ± 1.26		36.99 ± 1.64	
NPK	40.01 ± 1.30		38.36 ± 1.40	
Biofertilizer	39.94 ± 1.19		36.78 ± 1.33	
Cattle manure	38.30 ± 1.28		39.81 ± 1.49	
Pig manure	38.21 ± 1.26		39.26 ± 1.23	
Poultry manure	39.02 ± 1.32		34.92 ± 1.72	

The average plant height was taller under shade house as compared to tree shade with different treatments except with cattle manure and pig manure treatments (Table 5). Also, the plant height readings show better consistency under shade house in all the cases except for pig manure treatment, which have slight difference in the SE values with that under tree shade. This shows that plants grown under shade house showed good consistency in their growth during twelve month observation, whereas those under tree shade shows highly variable

growth rate.

Thus, we can conclude that anthuriums grown under shade house results in better consistent growth as compared to those grown under natural tree shade in Mizoram. Also, the average plant heights under different nutrient sources were relatively taller under shade house as compared to natural tree shade. Under shade house, NPK and biofertilizer application results in best performance in terms of plant height, while under natural tree shade, cattle manure treatment show tallest average

Table 6. Two-way ANOVA for plant height during 12 month period (shade house).

Source	SS	df	MS	F	Prob > F
Treatment	130.28	5	26.06	3.00	0.01
Month	1250.89	11	113.72	13.11	0.00
Interaction	375.09	55	6.82	0.79	0.84
Residual	1249.00	144	8.67		
Total	3005.26	215	13.98		

Table 7. Two-way ANOVA for plant height during 12 months period (tree shade).

Source	Partial SS	df	MS	F	Prob > F
Treatment	590.50	5	118.10	8.54	0.00
Month	1381.16	11	125.56	9.08	0.00
Interaction	528.81	55	9.61	0.7	0.94
Residual	1990.39	144	13.82		
Total	4490.87	215	20.89		

Table 8. Three-way ANOVA with 3 observation per cell for plant height.

Source	Partial SS	df	MS	F	Prob > F
Shade effect	303.40	1	303.40	26.97	0.00
treatment	720.78	10	72.08	6.41	0.00
month	1857.41	11	168.86	15.01	0.00
Shade effect*treatment	0.00	0			
Shade effect*month	221.10	11	20.10	1.79	0.06
Treatment*month	903.90	110	8.22	0.73	0.97
Residual	3239.39	288	11.25		
Total	7669.28	431	17.79		

plant height.

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