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# Performance of Anthurium (*Anthurium andraeanum* Lind.) as Influenced by Different Organic Manures and Inorganic Fertilizers

Enrique E. Biñas Jr.[1*], Gilbert V. Lumentac[2] and Amina A. Mocadam[2]

[1]Iloilo State College of Fisheries
[2]Jose Rizal Memorial State University

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*Corresponding author's email: enriquebinas@gmail.com

Abstract

*Anthurium* production has an important contribution to the floriculture or cut flower industry. The integration of organic and inorganic nutrient sources is the best cultivation management for anthurium. The study was conducted to assess the effect of organic manures and inorganic fertilizers as exogenous sources of nutrients on the performance of anthurium. The study was two factor experiment laid out in a 3 × 3 adopting a randomized complete block design (RCBD). Data were analyzed using analysis of variance (ANOVA). Treatment means comparison was done using tukey's significant difference test (HSD). The different factors were as follows: $M_1$: Coconut husk, $M_2$: Coconut husk with chicken dung and $M_3$: Coconut husk with cattle manure for factor A, and $F_0$: No inorganic fertilizer, $F_1$: 90-60-60 (NPK) and $F_2$: 45-30-30 (NPK) for factor B. The results revealed that the chicken and cattle manures as part of the growing media significantly improve the growth of anthurium regardless of the amount of inorganic fertilizer applied. The net income as well as the return on cash expense were negative from all treatments.

**Keywords:** Cut flower production, Marketing potential, Nutrient management, Ornamental crop, Soil media preparation.

## INTRODUCTION

Anthurium (*Anthurium andraeanum* Lind.) is one of the important cut flowers in the market (Pizano, 2003). Anthurium belongs to the largest genus of the Araceae family that encompasses over 1500 species, but it is the most known, leading, and economically significant species which have an attractive and long-lasting inflorescence (Venkat *et al*., 2014; Singh *et al*., 2019). Although, some species have less attractive flowers and are classified under the foliage type of anthurium because their leaves are velvety or leathery, heart-shaped, palmate or ovate, and usually with ivory veins (Rosario and Aurigue, 2009).

The flowering type was introduced in the Philippines in the late 1970s and since then it has become one of the leading ornamental plants grown by local nurserymen. It has less appealing foliage but the flowers are more attractive and vary in color, size, shape, substance, and texture. In anthurium, the so-called flower is composed of the spathe, which is a modified leaf, and the spadix, the structure protruding from the joint of the spathe and the petiole (Rosario and Aurigue, 2009).

Anthurium is a slow-growing, semi-epiphytic perennial plant that requires warm, shady, humid conditions, and a soil-free rooting media which are sufficiently aerated but retain sufficient moisture and provide support to the plant (Collette *et al*., 2004; Penpillo and Ballano, 2013). Anthurium grows best in well-aerated, organic material with good water-holding capacity but with excellent drainage (Penpillo and Ballano, 2013). Locally available raw materials such as coconut husk or cocopeat are a good growing medium for anthurium (Singh *et al*., 2019; Anand *et al*., 2020).

Soilless rooting media are easy to handle and can provide an excellent growing environment for the plants as compared to the soil (Mastouri *et al.,* 2005). The rooting medium has to be amended with organic fertilizer to provide the appropriate physical and chemical properties essential for plant growth (Ganesh and Jawaharlal, 2019). Nutrient supply is one of the key factors affecting the growth and yield of Anthurium cut flowers (Chang *et al*., 2012).

Using coco husk along with the application of animal manure has been a common practice in Anthurium production. The combinations of media and different fertilizers can boost the performance of amthurium (Warigajeshta *et al*., 2021) and thus contributed to the increase of the cut flower production (Salachna, 2022). Moreover, the application of organic sources of nutrients, with no or very little use of inorganic fertilizers, is rapidly gaining favor. However, the nutrient release of animal manure is slow and unpredictable, which restricts its utilization. There is a need to combine the application of animal manure and inorganic fertilizers to be more efficient and sustainable (Zhao *et al*., 2016), hence, this study.

Therefore, based on the above consideration, organic manures and inorganic fertilizers were exploited as an exogenous source of plant nutrients and assessed the effects on the performance of Anthurium.

## MATERIALS AND METHODS

A. Construction of the shade. The shade was constructed from bamboo and a plastic net. The plastic strap was used to strengthen the framework and support the shading materials. Plastic nets and coconut fronds were used as shading.

B. Experimental design and treatments. The study was laid out in a 3 x 3 factorial experiment adopting a Randomized Complete Block Design (RCBD) with three (3) replications. Each replication was composed of nine (9) plots for treatments measuring 1 $m^2$. Each plot had 9 plants (Fig. 1). Each growing media was bordered with bamboo which serves as a treatment

unit. Three growing media was designated as factor A, while three application rates of inorganic fertilizers were as factor B. The treatments were designated as follows:

| **Factor A. Growing media** | **Factor B. Rate of Inorganic Fertilizers** |
|---|---|
| $M_1$- Coconut husk | $F_0$- No inorganic fertilizer |
| $M_2$- Coconut husk + chicken dung | $F_1$- 90-60-60 (NPK) |
| $M_3$- Coconut husk + cattle manure | $F_2$- 45-30-30 (NPK) |

The treatment combinations were as follows:

$T_1$ - ($M_1F_0$) - coconut husk + no inorganic fertilizer;
$T_2$ - ($M_1F_1$) - coconut husk + 90-60-60 N, $P_2O_5$, $K_2O$;
$T_3$ - ($M_1F_2$) - coconut husk + 45-30-30 N, $P_2O_5$, $K_2O$;
$T_4$ - ($M_2F_0$) - coconut husk + chicken dung + no inorganic fertilizer;
$T_5$ - ($M_2F_1$) - coconut husk + chicken dung + 90-60-60 N, $P_2O_5$, $K_2O$;
$T_6$ - ($M_2F_2$) - coconut husk + chicken dung + 45-30-30 N, $P_2O_5$, $K_2O$;
$T_7$ - ($M_3F_0$) - coconut husk + cattle manure + no inorganic fertilizer;
$T_8$ - ($M_3F_1$) - coconut husk + cattle manure + 90-60-60 N, $P_2O_5$, $K_2O$;
$T_9$ - ($M_3F_2$) - coconut husk + cattle manure + 45-30-30 N, $P_2O_5$, $K_2O$.

Note: The recommended rate of the inorganic fertilizer applied in the study was based on the common practice of the farmers in the locality since the researhers were not able to test the soil initially.

C. Acquisition of manure. The cattle manure and chicken dung used in the study was acquired from JRMSU-TC cattle and poultry farm, respectively.

D. Planting. Right after acquiring the planting materials, planting was done late in the afternoon at a distance of 30 cm x 30 cm and the newly planted anthurium was watered immediately and regularly.

E. Fertilizer computation. The recommended application per hectare (in kg) was divided by the fertilizer grade. In the case of ammonium phosphate (16-20-0), the required amount of P was calculated first and the calculated amount was multiplied by the N content (16%) of amophos to obtain the remaining recommended N.

Fig.1. Actual appearance of the experimental area.

The amount of fertilizer per hill was computed as the recommended amount of fertilizer per hectare divided by the number of hills per hectare. To determine the number of fertilizers to be prepared, the amount of fertilizer per hill was multiplied by 81 (3 growing media x 3 replications x 9 representative plants).

F. Application of animal manure and NPK fertilizers. Animal manure was incorporated in the coconut husk at a rate of 3 kg for 9 plants per plot as basal application. The appropriate amount of inorganic fertilizers were applied at the start of the study and at 28 days after planting. The amount and schedule of fertilizers application is shown in table 1.

Table 1. Amount and schedule of fertilizer application.

| Manure/Fertilizer | Recommended rate | Amount (kg plot$^{-1}$) | Schedule of application |
|---|---|---|---|
| Chicken dung | | 3 | Basal/upon planting |
| Cattle dung | | 3 | Basal/upon planting |
| Amophos | 90-60-60 | P-0.03; N-0.00442 | Upon planting and 28 DAP |
| | 45-30-30 | P-0.015; N-0.0021 | Upon planting and 28 DAP |
| Urea | 90-60-60 | 0.0091 | Upon planting and 28 DAP |
| | 45-30-30 | 0.0046 | Upon planting and 28 DAP |
| Muriate of Potash | 90-60-60 | 0.01 | Upon planting and 28 DAP |
| | 45-30-30 | 0.005 | Upon planting and 28 DAP |

G. Care and Management. The area was visited regularly and the plants were watered sufficiently.

H. Data Gathered. The following data was gathered on 56, 70, and 84 days after treatment application (DATA). The methods for gathering the data were shown below.

a. Plant height (cm) per plant - This was determined by measuring the height of the new leaves of each representative plant from the base to the tip of the tallest part of the plant using a meter stick.
b. Increment of the number of leaves per plant - The number of leaves was determined by manually counting the branches in each representative plant. A day before the application of different treatments, initial data on the number of leaves was gathered and subtracted from the data collected at 56, 70, and 84 DAP to obtain the increment in the number of leaves.
c. Number of flowers per plant - This was determined by counting the number of flowers in each representative plant.
d. Number of suckers per plant - This was determined by counting the number of suckers per plant.

I. Statistical Analysis. Analysis of variance was performed for each parameter mentioned above, and means with significant differences were compared using Tukey's Significantly Difference (HSD) Test. Statistical analyses were done using the Statistical Tool for Agricultural Research (STAR Version 2.0.1).

J. Actual itemized expenses. The actual itemized expenses were obtained by adding

all the expenses incurred in each treatment during the conduct of the study which includes the supplies, materials, and labor costs.

K. Cost and return analysis. The gross income in each treatment was obtained by multiplying the weight of marketable flowers by the price based on the current market price per kg of baby's breaths. The net income was then computed as the gross income less the expenses. The percentage return on capital (ROC) was computed by dividing the net income by the total expenses multiplied by 100. The formula below was used.

$$ROC = \frac{\text{Net income}}{\text{Total expenses}} \times 100$$

## RESULTS AND DISCUSSION

The average plant height, number of leaves, number of suckers, and number of flowers of anthurium as influenced by organic and inorganic fertilizers are presented in table 2. Among factor A, the result revealed that the plant height, number of leaves, and number of suckers of anthurium were affected by different organic manures. The plants applied with coconut husk + chicken manure ($M_1$) obtained significantly higher plant height at 56, 70, and 84 DAA with a mean of 22.35 cm, 24.88 cm, and 26.84 cm, respectively, but statistically similar to those plants applied with coconut husk + cattle manure ($M_3$). The highest number of leaves was recorded from those plants applied with coconut husk + cattle manure ($M_3$) with a mean of 1.81 at 84 DAA but statistically similar to those applied with coconut + chicken manure ($M_2$). This could be attributed to the significantly higher number of suckers of anthurium applied with coconut husk + cattle manure ($M_3$) that was recorded at 70 and 84 DAA with a mean of 0.68 and 0.96 which is comparable to those plants applied with coconut husk + chicken manure ($M_1$). This implies that the growth of anthurium can be enhanced by applying them with chicken and cattle manures along the coconut husk. Coconut husk alone cannot suppress the growth of anthurium, this may be due to the lack of nutrients absorbed by the plants since there were no other nutrient sources applied ($M_1$). However, among factor B, the growth of anthurium was not affected by different rates of inorganic fertilizers. The comparable plant height of anthurium applied with different rates of inorganic fertilizer was probably due to the dearth of micronutrients in inorganic fertilizers. Dofour and Guerin (2003) reported that the anthurium applied with different rates of inorganic fertilizer resulted in the same level of performance because this plant performs well when receive even a small amount of inorganic fertilizer. In the case of the comparability with those plants without inorganic fertilizer applied, this may be due to the adequate amount of nutrients taken from animal manure and coconut husk that already satisfied the need of anthurium for its plant height.

Among the treatment combinations, the result revealed that the plants were not affected by the treatments except for the plant height at 70 and 84 DAA and the number of leaves at 84 DAA. The highest plant height at 70 and 84 DAA was obtained from those applied with coconut husk + chicken dung + 45-30-30 N, $P_2O_5$, $K_2O$ ($T_6$) with a mean of 26.24 cm and 28.86 cm, respectively which is not significantly different from those applied with coconut husk + cattle manure + 90-60-60 N, $P_2O_5$, $K_2O$ ($T_8$) with a mean of 26.21 cm and 28.61 cm, respectively. However, statistical analysis indicated that these are comparable to other treatments except for $T_2$ (coconut husk + 90-60-60 N, $P_2O_5$, $K_2O$). It implies that the majority of the height of anthurium plants does not vary regardless of the fertilizers applied as long as there is coco husk as their main growing medium.

Moreover, the number of leaves was statistically highest on plants applied with manure as part of the growing media and lowest in coconut husk alone at 84 days after treatment application. This simply suggests that manure application improved the development of new leaves in anthurium plants.

In addition to the above result, the number of suckers was also considerably lowest in coconut husk alone but highest in coconut husk with cattle manure. The possible reason for this result is the same as the plant height.

The number of flowers was considerably analogous. The very plausible reason for this is the short duration of the study because during the conduct up to the termination of the study, the plants were not able to produce the maximum number of flowers or they haven't reached the peak of production. The study was done for only three months which is not yet favorable for the flower production. The best period for the production of flower is 3 to 6 months (https://anthuriuminfo.com/en/faq/). The result implies that even the combination of coconut husk + different manures + inorganic fertilizers cannot give an assurance for anthurium to produce flowers for the period of 3 months.

Likewise, the highest number of leaves was recorded from those plants applied with cattle manure + 90-60-60 N, $P_2O_5$, $K_2O$ ($T_8$) with a mean of 2.15 which is significantly different from those applied with + 90-60-60 N, $P_2O_5$, $K_2O$ ($T_2$) with a mean of 0.85. The result implies that the anthurium produces more leaves especially when they are applied with manures.

The results of the study conformed to the findings of Muraleedharan *et al*. (2019) in a similar experiment on the response of anthurium to different growing media and nutrients. They also found that coconut husk with seaweed extract has maximum plant height, plant spread, number of flowers per plant, flower stalk length, spathe length, and spathe breadth. The number of days taken for flower bud appearance was also faster in this treatment.

Moreover, the result of the study of Basheer and George (2012) on the vegetative growth of anthurium in different growing media and organic nutrient dosage suggested that among the media treatments, sand and coir pith compost produced the maximum plant height, leaf area, and petiole length at the fourth week after emergence and shortest phyllochron, highest fresh and dry weight of leaves at 225 days after application. Vegetative growth enhancement was also obtained with 4 g $l^{-1}$ and 6 g $l^{-1}$ fresh cow dung extract.

Furthermore, Cuquel *et al*. (2012) conducted a study on the yield and flower quality of anthurium plants grown in different growing media and fertilization. Four fertigation solutions were applied weekly for eleven months as compared with monthly fertilization done locally with slow-releasing solid fertilizer. The study found out that the growing media prepared with wood shavings + organic compost with all fertilization tested produced the best quality anthurium cut flowers.

## Cost and return analysis

The cost and return analysis is presented in table 3. The production of anthurium using growing media regardless of sources and applied with inorganic fertilizers is unprofitable for it resulted in a negative net income and return on cash expense. This can be attributed to the high cost of inputs but low price of assumed flowers and suckers based on the local flower shop. Furthermore, the duration of the study was not enough to determine the performance of anthurium as influenced by the growing media and inorganic fertilizer.

Table 2. Summary of the plant height (cm), number of leaves, number of suckers, and number of flowers of anthurium as influenced by different organic manures and inorganic fertilizers.

| Treatment | Plant height (cm) | | | Number of leaves | | | Number of suckers | | | Number of flowers | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days after application | | | | | | | | | | | |
| | 56 | 70 | 84 | 56 | 70 | 84 | 56 | 70 | 84 | 56 | 70 | 84 |
| **Factor A** | | | | | | | | | | | | |
| $M_1$ | 19.18$^{b}$ | 20.86$^{b}$ | 22.27$^{b}$ | 0.59 | 0.98 | 1.28$^{b}$ | 0.19 | 0.36$^{b}$ | 0.49$^{b}$ | 0.10 | 0.14 | 0.17 |
| $M_2$ | 22.35$^{a}$ | 24.88$^{a}$ | 26.84$^{a}$ | 0.43 | 1.17 | 1.72$^{a}$ | 0.23 | 0.57$^{ab}$ | 0.72$^{ab}$ | 0.05 | 0.05 | 0.16 |
| $M_3$ | 22.05$^{a}$ | 24.87$^{a}$ | 27.05$^{a}$ | 0.44 | 1.16 | 1.81$^{a}$ | 0.19 | 0.68$^{a}$ | 0.96$^{a}$ | 0.05 | 0.12 | 0.14 |
| P-Value | 0.0187* | 0.0041** | 0.0009** | 0.3847$^{ns}$ | 0.3821$^{ns}$ | 0.0281* | 0.8672$^{ns}$ | 0.0177* | 0.0079** | 0.5150$^{ns}$ | 0.2016$^{ns}$ | 0.9086$^{ns}$ |
| **Factor B** | | | | | | | | | | | | |
| $F_0$ | 31.70 | 35.33 | 37.59 | 1.00 | 1.87 | 2.69 | 0.31 | 0.91 | 1.06 | 0.06 | 0.13 | 0.24 |
| $F_1$ | 30.94 | 34.50 | 38.18 | 0.65 | 1.61 | 2.35 | 0.31 | 0.78 | 1.13 | 0.13 | 0.17 | 0.19 |
| $F_2$ | 32.72 | 36.08 | 38.48 | 0.56 | 1.48 | 2.19 | 0.28 | 0.72 | 1.07 | 0.11 | 0.17 | 0.28 |
| **p-value** | 0.5644$^{ns}$ | 0.6725$^{ns}$ | 0.8702$^{ns}$ | 0.0724$^{ns}$ | 0.2627$^{ns}$ | 0.2273$^{ns}$ | 0.9648$^{ns}$ | 0.4695$^{ns}$ | 0.9237$^{ns}$ | 0.5808$^{ns}$ | 0.8494$^{ns}$ | 0.7730$^{ns}$ |

| Treatment | Plant height (cm) | | | Number of leaves | | | Number of suckers | | | Number of flowers | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days after application | | | | | | | | | | | |
| | 56 | 70 | 84 | 56 | 70 | 84 | 56 | 70 | 84 | 56 | 70 | 84 |
| $T_1$ | 20.85 | 22.37$^{ab}$ | 23.53$^{ab}$ | 0.96 | 1.33 | 1.63$^{ab}$ | 0.30 | 0.52 | 0.63 | 0.07 | 0.19 | 0.19 |
| $T_2$ | 16.39 | 18.02$^{b}$ | 21.13$^{b}$ | 0.44 | 0.67 | 0.85$^{b}$ | 0.07 | 0.19 | 0.26 | 0.19 | 0.19 | 0.22 |
| $T_3$ | 20.30 | 22.19$^{ab}$ | 22.16$^{ab}$ | 0.37 | 0.93 | 1.37$^{ab}$ | 0.19 | 0.37 | 0.59 | 0.04 | 0.04 | 0.11 |
| $T_4$ | 21.21 | 23.64$^{ab}$ | 25.04$^{ab}$ | 0.70 | 1.44 | 1.81$^{ab}$ | 0.19 | 0.59 | 0.63 | 0.00 | 0.00 | 0.22 |
| $T_5$ | 22.36 | 24.77$^{ab}$ | 26.62$^{ab}$ | 0.22 | 1.04 | 1.70$^{ab}$ | 0.33 | 0.52 | 0.81 | 0.04 | 0.04 | 0.04 |
| $T_6$ | 23.48 | 26.24$^{a}$ | 28.86$^{a}$ | 0.37 | 1.04 | 1.63$^{ab}$ | 0.19 | 0.59 | 0.70 | 0.11 | 0.11 | 0.22 |
| $T_7$ | 21.34 | 24.66$^{ab}$ | 26.60$^{ab}$ | 0.33 | 0.96 | 1.93$^{ab}$ | 0.15 | 0.70 | 0.85 | 0.04 | 0.07 | 0.07 |
| $T_8$ | 23.14 | 26.21$^{a}$ | 28.61$^{a}$ | 0.63 | 1.52 | 2.15$^{a}$ | 0.22 | 0.85 | 1.19 | 0.04 | 0.11 | 0.11 |
| $T_9$ | 21.66 | 23.73$^{ab}$ | 25.94$^{ab}$ | 0.37 | 1.00 | 1.37$^{ab}$ | 0.19 | 0.48 | 0.85 | 0.07 | 0.19 | 0.22 |
| **P-Value** | 0.0625$^{ns}$ | 0.0254* | 0.0122* | 0.0782$^{ns}$ | 0.1004$^{ns}$ | 0.0451* | 0.9312$^{ns}$ | 0.0671$^{ns}$ | 0.0535$^{ns}$ | 0.5718$^{ns}$ | 0.2806$^{ns}$ | 0.8481$^{ns}$ |
| **A x B p-value** | 0.1466$^{ns}$ | 0.1315$^{ns}$ | 0.1897 | 0.0841$^{ns}$ | 0.0526$^{ns}$ | 0.1085$^{ns}$ | 0.666$^{ns}$ | 0.1934$^{ns}$ | 0.1952$^{ns}$ | 0.3986$^{ns}$ | 0.1836$^{ns}$ | 0.5435$^{ns}$ |

*In each column, means with similar letter(s) are not significantly different and *, ** and ns: Significant at P < 0.05, P < 0.01 and insignificant based on the tukey's test, respectively.

Table 3. Cost and return analysis of anthurium as influenced by different organic manures and inorganic fertilizers.

| Treatments | Number of flowers | Number of suckers | Gross income (Php)* | Total production cost (PHP) | Net income (PHP) | ROC (%) |
|---|---|---|---|---|---|---|
| $T_1$ | 5 | 17 | 285.00 | 470.77 | (185.77) | (39.46) |
| $T_2$ | 6 | 7 | 141.00 | 578.80 | (437.80) | (75.64) |
| $T_3$ | 3 | 16 | 258.00 | 549.79 | (291.79) | (53.07) |
| $T_4$ | 6 | 17 | 291.00 | 588.27 | (297.27) | (50.53) |
| $T_5$ | 1 | 22 | 336.00 | 696.30 | (360.30) | (51.74) |
| $T_6$ | 6 | 19 | 321.00 | 667.29 | (346.29) | (51.89) |
| $T_7$ | 2 | 23 | 357.00 | 588.27 | (231.27) | (39.31) |
| $T_8$ | 3 | 32 | 498.00 | 696.30 | (198.30) | (28.48) |
| $T_9$ | 6 | 23 | 381.00 | 667.29 | (286.29) | (42.90) |
| Total | 38 | 176 | 2868 | 5503.07 | (2635.08) | (433.04) |

*Assumed price of the flower is Php 6.00 each.

*Assumed price of the sucker is Php 15.00 each.

## CONCLUSIONS

Based on the result of the study, the application of manure as part of the growing media would significantly improve the growth performance of anthurium regardless of the amount of inorganic fertilizer applied. However, in terms of yield and monetary returns, it is recommended to take a longer duration until the anthurium reached the peak of its production since it was found that for three months this cut flower cannot yet perform its profitability regardless of the growing media and the inorganic fertilizer applied.

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