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Propagation and productivity evaluation of Anthurium (*Anthurium andraeanum*) using organic fertilizers in tropical conditions

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Abstract

One of the important cut flowers of the country is the Flamingo Flower (*Anthurium andraeanum*). In tropical countries such as the Philippines, *A. andraeanum* is commonly grown in cooler climatic condition mostly in the uplands, but there are some potential varieties that can also be grown in the lowlands. This study aimed to investigate the growth and yield performance of Anthurium under lowland conditions in response to the application of different organic fertilizers (rice hull compost, goat manure, cow manure, chicken manure, vermicompost), compared to negative control and to inorganic 14-14-14 fertilizer as standard check. Treatments were applied twice a month for three months through localized placement application method. The study was laid in a Randomized Complete Block Design replicated four times. Results revealed that anthurium "flame red var." plants applied with cattle manure produced the tallest plants (19.95 cm) while goat manure and vermicompost-treated anthuriums resulted in the greatest number of developed leaves (2.15). Plants applied with rice hull compost were observed to have the widest spathe (5.89 cm) and chicken manure application resulted in highest number of flowers produced (5.33). Among the organic fertilizers, chicken manure generally resulted in better growth performance, most especially in terms of flower production.

Introduction

Ornamental crops are distinct from food crops in that they are specifically grown for beautifying and decorating, so the most desirable qualities in them are those that enhance their visual appeal, such as flower color, size, fragrance, and longevity, as well as general plant morphology and structure (Saraswathi et al., 2018). Beyond providing aesthetic benefits, certain ornamental plants have demonstrated efficiency in removing toxins in the air, such as formaldehyde, trichloroethane, and benzene (Wolverton et al., 1989).

The Flamingo Flower (*Anthurium andraeanum*) is among the most cultivated cut flowers in the world (Jahan et al., 2009). Anthurium belongs to the family Araceae, and is an evergreen, tropical herbaceous plant. Anthuriums attract a vast majority of growers for its massive effect, elegance, and variety of colors, and consequently, there is a need to standardize the growing techniques (Islam et al., 2013). Under ambient conditions and with waxing of the spadix, the shelf life of *A. andraeanum* can extend up to 20 days or more (Mujaffar & Sankat, 2003), making it an ideal export crop.

Anthurium plants best strive in temperatures ranging from 18 to 26°C (Gao et al., 2002; Higaki et al., 1995), in well-aerated medium with good water retention and drainage characteristics (Higaki et al., 1995). In tropical countries such as the Philippines, *A. andraeanum* is commonly grown in cooler climatic conditions, mostly in the uplands (Arguillas, 2015). Chopped coconut husk is a common planting medium, which can be used in clay pots or plastic bags (Penpillo & Ballano, 2012). Net houses and shading are necessary to provide protection from full sunlight (Higaki et al., 1995).

It is important to consider cultivation techniques that produce high yields with low investment. Anthurium is an export-earning flower. It is necessary to produce good quality anthurium flowers that appeal to both local and international markets.

Commercial growers widely utilize organic amendments such as volcanic cider, organic mulches and manures (Higaki et al., 1995). In addition to these organic practices, chemical fertilizer treatments are also used extensively as part of the conventional fertilization management system (Chang et al., 2010). However, there is a recent push towards the use of organic fertilizers owing to the concern for the sustainability of agricultural systems. Besides being cheap, organic fertilizers can improve soil structure, texture and aeration, increase water retention ability of the soil, and stimulate healthy root development. Organic fertilizers include chicken manure (Indriyati, 2014), cattle manure (Rasool et al., 2013), rice hull (Chang et al., 2010), vermicompost (Singh et al. 2011) and goat manure (Almeida, 2012).

With the exception of rice hull and cattle manure, the other organic fertilizers have not been investigated specifically on *A. andraeanum*. Published literature on the use of organic fertilizers on *A. andraeanum* include the use of seaweed extract (Muraleedharan et al., 2020), or composted organic matter and cow manure (Cuquel et al., 2012). Chang et al. (2010) investigated pea and rice hull compost (PRHC) and cattle dung with tea leaf residue compost (CDTC).

The previous studies on the use of organic fertilizers show its potential in promoting growth and flowering characteristics of *A. andraeanum*. Muraleedharan et al. (2020) found that seaweed extract together with Gibberellic Acid or Naphthalene Acetic Acid promotes the growth and flowering characteristics of *A. andraeanum*, respectively. Cuquel et al. (2012) found that wood shavings and organic matter significantly outperformed the traditional growing media (mixture of soil, coal residue and cow manure) in producing the best quality flowers. According to Chang et al. (2010), PRHC can be an alternative to chemical fertilizers and be just as effective in providing nutrients for this flower.

This study addresses a research gap by comparing the effects of various organic fertilizers on the growth and productivity performance of Anthurium in a tropical setting. Specifically, this study investigated vermicompost, rice hull, and various types of animal manure which have been shown to have differential effects on plant growth (Alituha, 2020; Situmeang, 2019) due to the differences in nutritional contents of each treatment. These organic fertilizers commonly used in agriculture contain three basic plant nutrients namely: nitrogen, phosphorus and potassium which are necessary for plant growth.

Unlike previous Anthurium studies, which were predominantly conducted in cooler environments (Chang et al., 2010), this study takes place in a tropical climate where most Anthurium studies were carried out in vitro (Dufour & Guérin, 2003). Because of Anthurium's preference for shade and aversion to direct sunlight (Van Der Leeden, 2001), it is relevant to explore how different fertilizers influence its growth under tropical conditions, thus motivating this investigation.

Methodology

Study Site

The experiment was conducted at the University of Southern Mindanao Research and Development Center, Kabacan, North Cotabato, Philippines (7°7′12″N 124°49″E) from January to December 2022. The area has an elevation of 21 m, and the temperature ranges from 22˚C to 35°C throughout the year.

Planting Material

Healthy and good quality planting materials of about two months old were collected from a farm in Brgy. Kisante, Makilala North Cotabato. Criteria for selection of good quality planting materials are as follows: (1) suckers reached 3 to 4 leaf stage; (2) disease free planting materials; and (3) with 4-5 number of aerial roots with a length of 2 inches.

Experimental Set-up

The potting medium, prepared beforehand with a 1:1 ratio of garden soil and coco coir/stripped coconut husk, was placed in polybags measuring 5″ × 5″ × 10″. Anthurium seedlings were immediately brought to the experimental area and planted in the prepared medium (Figure 1).

Figure 1. Planting of Anthurium in a previously prepared potting medium.

Seven treatments, each comprising 12 sample plants per replicate, were organized in a Randomized Complete Block Design (RCBD) with four replications allocated to each treatment. The treatments were five organic fertilizers from natural and animal materials (chicken manure, carbonized rice hull, cattle manure, vermicompost, goat manure), 14-14-14 NPK fertilizer (as standard check), and the control treatment where no fertilizer was added. Chicken manure and vermicompost were commercially acquired, whereas goat and chicken manure were obtained from the University's available sources. All the manure had undergone composting for a minimum of one year.

In treatments involving fertilizers, the application method was through localized placement application with a rate of 100 g per polybag for organic fertilizers and 10 g per polybag for 14-14-14 NPK. The fertilizers were first applied 7 days after transplanting, and every 15 days for the next three months. Irrigation was maintained at field capacity, and a volume

ranging from 50 to 100 mL was applied three to four times per week, adjusting as needed based on prevailing weather conditions.

Ten Anthurium flowers were randomly selected from each treatment for measurement of growth and flower parameters. Measurements were performed three months after transplanting. Plant height was measured using a meter stick. All other lengths were measured using a ruler (Figures 2 and 3). For the number of newly developed leaves, leaves of the ten randomly selected flowers per treatment were tagged with yellow yarn at the start of the experiment. The new leaves, denoting those not marked with yarn, were counted after three months.

Figure 2. Length of pedicel of harvested Anthurium cut flowers at three months after transplanting applie with different fertilizers: (a) Control, (b) Vermicompost, (c) Rice hull compost, (d) Cattle manure, (e) Chicken manure; and (f) 14-14-14 NPK fertilizer.

Data Analysis

The experiment was analyzed using one-way ANOVA to compare the effects of various organic fertilizers on growth and productivity of anthurium. The level of significance was set at 5%, and significant differences were analyzed using Tukey's post-hoc test.

Results

Plant Growth Assessment

Table 1 shows various growth parameters of Anthurium applied with different organic fertilizers at three months after transplanting. Significant differences were found in plant

height and number of leaves. In each of these parameters, plants applied with cattle manure had the tallest plant height (19.95 cm) while plants applied with goat manure and vermicompost produced the greatest number of leaves (2.17 and 2.15, respectively). In terms of plant height and number of leaves, Anthurium applied with rice hull compost and chicken manure had comparable values. The result indicates that Anthurium plants applied with cattle manure, goat manure and vermicompost significantly improved growth and development of anthurium in terms of the plant height or number of leaves, compared with those applied with inorganic fertilizer and the negative control. There were no significant differences in the length and width of anthurium leaves applied with different fertilizers.

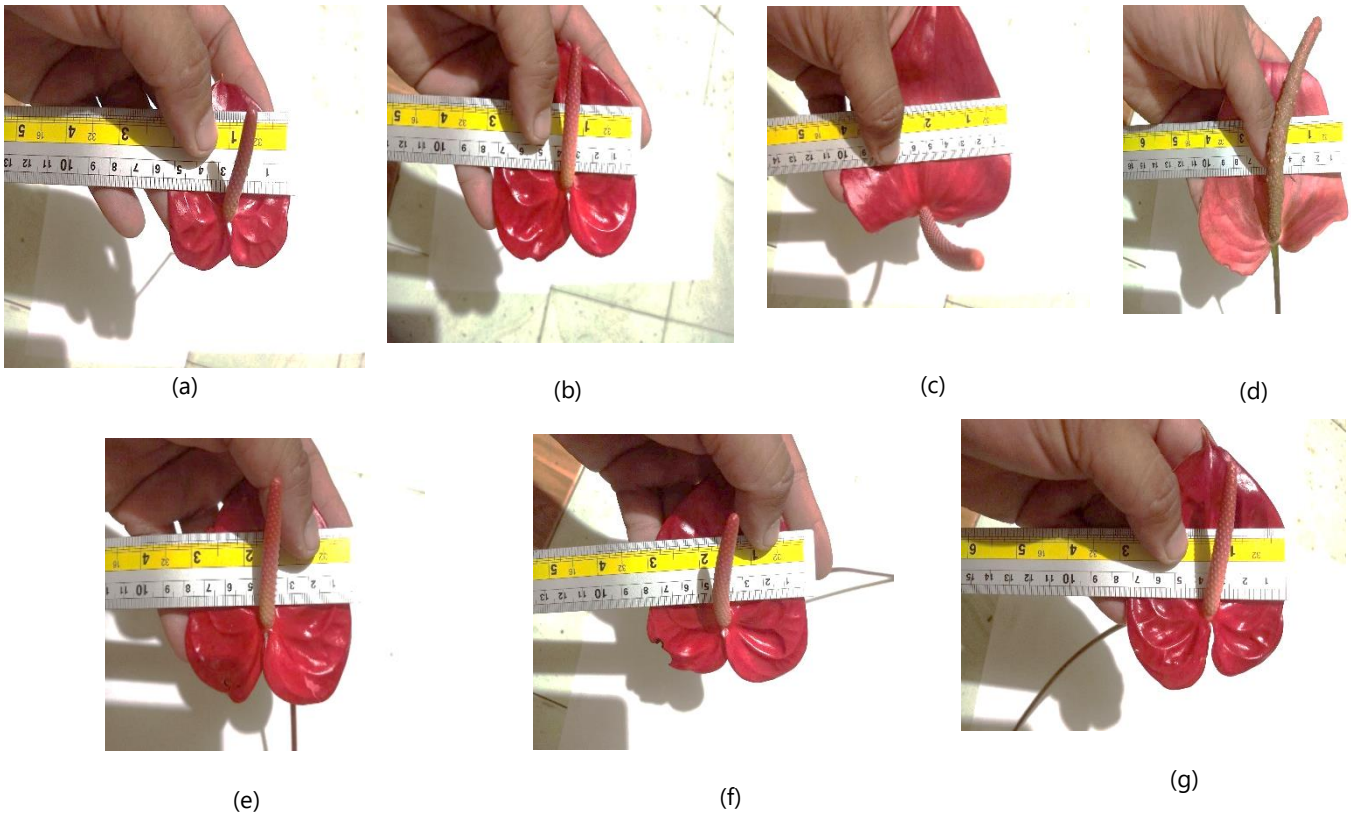

Figure 3. Width of spathe of harvested anthurium cut flowers at three months after transplanting applied with different fertilizers: (a) Control, (b) Vermicompost, (c) Rice hull compost, (d) Cattle Manure, (e) Chicken Manure; and (f) 14-14-14 NPK fertilizer.

Table 1. Mean plant height (cm), length of leaves (cm), width of leaves (cm) and number of newly developed leaves of anthurium plants applied with different organic fertilizers three months after transplanting.

Treatments	Plant height (cm)**	Length of leaves (cm)^{ns}	Width of leaves (cm)^{ns}	Number of newly developed leaves**
Control	15.12^{c}	9.20	6.51	1.16^{b}
Vermicompost	19.45^{ab}	13.25	7.69	2.15^{a}
Rice hull compost	18.99^{ab}	14.58	7.93	1.79^{ab}
Cattle manure	19.95^{a}	13.82	7.79	1.72^{ab}
Chicken manure	19.50^{ab}	15.42	8.50	1.81^{ab}
Goat manure	17.64^{abc}	12.72	7.37	2.17^{a}
(14-14-14) Standard check	16.25^{bc}	11.92	7.25	1.31^{b}

Table 1. Continuation...

C.V. (%)	10.02	11.32	9.24	18.90
SeM	1.54	-	-	0.08
CD	0.43	-	-	0.10

**-significant,
ns-not significant
Means in a column having different superscripts are significantly different (p<0.05) (Tukey's Test)

Flower Parameters Assessment

Table 2 shows various flower data parameters applied with different organic fertilizers. Significant differences were found in width of spathe, number of flowers, and length of flower pedicel. Among the organic fertilizers, plants applied with rice hull compost had the widest spathe (5.89 cm), while plants applied with chicken manure had the greatest number of flowers (5.33). In terms of the length of pedicel, plants applied with chicken manure had the longest pedicel (39.00 cm) followed by plants applied with vermicompost (38.90 cm), comparable with rice hull compost (37.00 cm), cattle manure (35.33 cm), and goat manure (38.20 cm). The results indicate that Anthurium applied with rice hull compost significantly improved the width of spathe, while application of chicken manure significantly improved the development of Anthurium cut flower in terms of the number of flowers and length of pedicel.

Table 2. Mean diameter of spadix (cm), length of spadix (cm), length of spathe (cm), width of spathe (cm), number of flowers and length of pedicel (cm) of anthurium plants applied with different organic fertilizers three months after transplanting.

Treatments	Diameter of spadix (cm)^{ns}	Length of spadix (cm)^{ns}	Length of spathe (cm)^{ns}	Width of spathe (cm)**	Number of flowers**	Length of pedicel (cm)**
Control	1.03	3.94	5.12	4.25^{b}	2.63^{b}	32.43^{b}
Vermicompost	1.04	5.45	5.35	5.11^{ab}	3.33^{ab}	38.90^{ab}
Rice hull compost	1.10	4.50	5.74	5.89^{a}	4.00^{ab}	37.00^{ab}
Cattle manure	1.05	4.42	5.26	4.32^{b}	4.00^{ab}	35.33^{ab}
Chicken manure	1.04	4.36	5.92	4.82^{ab}	5.33^{a}	39.00^{a}
Goat manure	1.03	4.50	6.17	4.46^{b}	3.50^{ab}	38.20^{ab}
(14-14-14) Standard check	1.03	4.08	6.54	4.33^{b}	3.00^{b}	37.67^{ab}
C.V. (%)	3.90	14.67	6.85	10.22	19.01	6.17
SeM	-	-	-	-	0.49	5.20
CD	-	-	-	-	0.25	0.81

**-significant
ns-not significant
Means in a column having different superscripts are significantly different (p<0.05) (Tukey's Test)

Discussion

This study has shown that organic fertilizer, regardless of type, had comparable effects on plant height, number of leaves, width of spade, number of flowers, and length of pedicel, but it was only goat manure, vermicompost, rice hull, and chicken manure that led to significantly better performance compared to the control and the inorganic standard check in at least one growth parameter. In particular, chicken manure produced significantly longer pedicels than inorganic fertilizer and control, rice hull resulted in wider spathes, and goat manure and vermicompost significantly outperformed the control and inorganic standard check in producing significantly more new leaves.

These results may be due to how farmyard manure can improve soil fertility and soil structure, increase soil organic matter, and enhance microbial activity (Rehman et al., 2010) and nutrients. Based on prior studies, chicken manure has been shown to have high nitrogen content (Alituha, 2020; Sarido, 2013), which is responsible for the production of key enzymes and components (Galembeck et al., 2019), resulting in increased yield (Eleduma et al., 2020; Pujiastuti et al., 2018). Chicken manure, especially at higher concentrations (20 $t{\cdot}ha^{-1}$) significantly influenced the vegetative growth of corn (Eleduma et al., 2020). In kale, the application of chicken manure was favorable for its growth (Pujiastuti et al., 2018), which the authors attribute to the significant increases in nitrogen and phosphorus, the higher concentration of macronutrients, and improved cation exchange capacity of the soil brought about by increased exchangeable calcium in the soil (Dikinya et al., 2010).

Similarly, prior studies have established the high NPK contents of goat manure-based vermicompost (Gichaba et al., 2020). Goat manure has been shown to have high potassium content (Alituha, 2020; Sarido, 2013), which helps regulate plants' responses to abiotic stress (Galembeck et al., 2019). Because the temperature in the experimental site is higher than ideal temperatures for growing Anthurium (Gao et al., 2002; Higaki et al., 1995), potassium may have played a key role in producing significantly more leaves.

Vermicompost produced significantly more leaves as compared to control and standard check. The results may be explained by how vermicompost can increase soil fertility as well as quantity and quality of crops (Rehman et al., 2023).

The results of the study also show that rice hull produced significantly wider spathe compared to the control, standard check, and cattle and goat manure. These are consistent with the findings of Malik et al. (2014) in which the application of composted rice hull with addition of rhizobium and rhizobacterium could significantly induce flowering and improve the vegetative and reproductive parameters of black gram plant.

Conclusion and Recommendation

This study investigated the effects of various organic fertilizers on the growth and flowering performance of anthurium plants. Organic fertilizers were comparable in most growth or flowering parameters, and led to significantly better results than control and standard check. In particular, chicken manure significantly improved the development of Anthurium cut flower in terms of the number of flowers and length of pedicel. Moreover, chicken manure was found to be on par with the best-performing treatments in each of the other assessed parameters. Based on these results, among the organic fertilizers evaluated, application of chicken manure is recommended since it generally resulted in better growth performance, most especially in terms of the flower production.

Disclosure Statement

No potential conflict of interest was declared by the authors.

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