Mindanao Journal of Science and Technology Vol. 18 (2) (2020) 108-124

Growth Response of Anonang (*Cordia dichotoma* Forst) Using Different Soil Enhancers

Melody M. Bad-e[1], Shierel F. Vallesteros[2*], Marlon U. Saludarez[2] and Arvin P. Vallesteros[2]
[1]Department of Environment and Natural Resources
Dupax del Norte, Nueva Vizcaya 3706 Philippines

[2]College of Forestry
Nueva Vizcaya State University – Bayombong
Bayombong, Nueva Vizcaya 3700 Philippines
[*]*sfvallesteros@gmail.com*

Date received: November 11, 2019
Revision accepted: August 18, 2020

Abstract

The three-month-old native species of Anonang (Cordia dichotoma Forst) were planted in potting bags in a nursery to determine its growth progress as influenced by different soil enhancers. The study was laid out in a completely randomized design with five treatments and four replications per treatment. Each treatment had 16 plants having a total of 80 plants. Growth parameters used were percent survival, height, stem diameter, leaf number, leaf area, total fresh weight, and total plant biomass. Results and analyses revealed that among treatments, the most suited one was the decomposed rice hay, which obtained the highest survival rate (93.75%), tallest height (39.48 cm), biggest stem diameter (0.61 mm), highest number of leaves (14 counts), largest leaf area (46.62 cm^2), and heaviest shoot (10.94 g), root (1.79 g) and total plant (12.73 g) biomass. Hence, it is recommended to establish tree nurseries for raising Anonang seedlings. Since the duration of the study was only six months, future work should focus on testing the survival of Anonang in the field with a prolonged time of at least one year to achieve more valuable results.

Keywords*:* Anonang (*Cordia dichotoma* Forst) plant, soil enhancers, growth parameters

1. Introduction

The soil is considered a natural medium for plant growth. However, only a few people realize that soil can only supply to a certain extent necessary for the plants to grow. No matter how naturally rich the soil is, if it is continuously used without adding fertilizers, the nutrients will diminish. Additionally, the recurrent problems on soil degradation vis-à-vis soil fertility decline and soil erosion have resulted to low agricultural production and failure of past forest rehabilitation projects (Calubaquib *et al.*, 2016) which include the use of endemic tree species like the Anonang (*Cordia dichotoma* Forst) – an edible plant that is also used as treatment for various ailments (Jamkhande *et al.*, 2013). Maximum growth yield can be achieved if fertilizers are applied properly at the right time using the correct combination (Bumatay, 1978).

Inorganic fertilizers are commonly used even it is more expensive compared with organic fertilizers. To account, using inorganic fertilizers is the problem of leaching. This is because the nutrient components can be washed away easily through overwatering or watering with force. Another disadvantage of inorganic fertilizers is that the essential nutrients required by plants contain certain compounds and salts, which plants cannot absorb and are left behind in the soil. This can render the soil less than ideal for future plantations. Lastly, over usage of inorganic fertilizers can prove to be detrimental to the plants. Too much of them can burn or destroy the plant structures, including the roots, which can hamper the plant's overall development (Yang, 2015).

Despite the negative effects of inorganic fertilizers to the soil, most farmers still opt to use them. However, there are also some growers who use organic fertilizers such as chicken dung, mykovam and other animal manure in their farms as soil nutrient enhancers. These soil nutrient enhancers continue to improve the soil long after the plants have taken the needed nutrients. Hence, the composition and texture of soil would be better when the soil is feed longer with organic fertilizers. While inorganic fertilizer is cheaper in short term, however, it adds less to the soil in the long term (Miller, 2018). In this premise, this study was initiated to determine the responses of Anonang plant to the different soil enhancers which included garden soil, cow manure, coconut coir dust, decomposed rice hay, and carabao manure.

2. Methodology

2.1 Period and Place of the Study

The study was conducted at King's College of the Philippines, Magsaysay Hills, Bambang, Nueva Vizcaya, Philippines (Figure 1). The data collection involved six months observation period (November 2016 to April 2017). The data were recorded, collated and subjected to analysis and interpretation. The survival and early growth of Anonang seedlings were applied with different soil enhancers to boost their survival and growth.

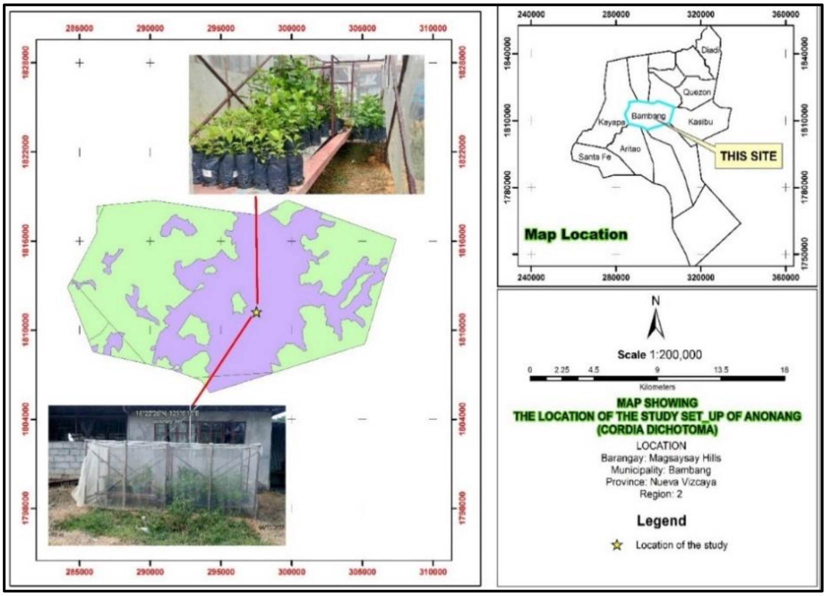

Figure 1. Location of the study area

2.2 Soil and Different Treatments Collection and Analysis

Soil samples were collected in the area where Anonang seeds gathered by digging six holes having 20 cm depth around the mother tree. Around 1 kg of soil was collected from each hole, placed in a sack and then mixed. Out of the mixture, 3/4 kg of soil was placed in a container and crushed using a hammer. A 0.5-kg pulverized soil was placed in a labelled transparent plastic (Ziploc). Different treatments such as coconut coir dust, cow manure, carabao manure and decomposed rice hays including garden soil were collected, pulverized and refined by passing through a 2-mm wire mesh. All refined samples were prepared and brought to the Department of Agriculture Soil Laboratory, Ilagan, Isabela for analysis. Based on the result of the soil analysis (Table 1), it showed the Anonang plant can thrive in soil having 7.2 pH implying that it can grow in non-acidic soil with high phosphorus and potassium content.

Table 1. Chemical analysis of the soil

	pH	Nitrogen (%)	Phosphorus (%) (ppm Olsen's Mtd)	Potassium (ppm)
Soil	7.20	2.30	105.00	575.00
Garden Soil	6.40	4.00	46.89	426.00

It can be observed that in Table 2, there are no results on the chemical analysis of Nitrogen content among the four treatments. Likewise, the pH and moisture content analyses of the decomposed rice hay and coconut coir were missing due to the unavailability of the needed equipment.

Table 2. Chemical analysis of soil enhancers

Treatments	pH	%Moisture Content	Phosphorus (%)	Potassium (%)
Cow Manure	8.19	4.29	0.52	0.89
Decomposed Rice Hay			0.46	0.19
Coconut Coir			0.49	0.43
Carabao Manure	7.45	8.09	0.75	0.66

2.3 Collection and Preparation of Potting Media

The garden soil served as a control group. The garden soil and coconut coir dust were bought from the nearest flower garden in Bambang, Nueva Vizcaya. Soil enhancers, namely cow manure, carabao manure, and 95% decomposed rice hay were collected within the farm situated at Palabotan, Dupax del Sur, Nueva Vizcaya. The debris was separated using the 2-mm wire mesh. Thereafter, the garden soil was mixed with the soil enhancers following the proportion of 3:1 (Table 3).

Table 3. Treatments used in the study

Treatments	Specific Treatment Used
Treatment 1(T1)	Garden soil/control
Treatment 2 (T2)	3 parts soil, 1 part cow manure
Treatment 3 (T3)	3 parts soil, 1 part coconut coir dust
Treatment 4 (T4)	3 parts soil, 1 part 95% decomposed rice hay
Treatment 5 (T5)	3 parts soil, 1 part carabao manure

*Treatment 1 – control (T1), treatment 2 – cow manure (T2), treatment 3 – coconut coir dust (T3), treatment 4 – decomposed rice hay (T4), and treatment 5 – carabao manure (T5)

2.4 Transplanting and Maintenance of Seedlings

Anonang seedlings in different seed pre-germination treatments were utilized. The three-month-old seedlings from the highest survival rate of seedlings were uprooted and transplanted in the properly labelled 3" x 7" polyethylene bags with prepared substrates. The study was laid out in a completely randomized design (CRD) with five treatments and four replications per treatment. Each treatment had 16 plants totaling to 80 plants. Watering of sown seedlings was done every day depending on the weather condition. Seed boxes were placed inside the established structure covered with a screen to lessen an attack of insects and other harmful organisms. Weeding was also undertaken. The selected experimental seedlings were applied with different soil enhancers to boost their survival and growth. The responses of Anonang seedlings were laid in this investigation. The growth response of the plants included stem diameter, height, number of leaves, leaf area, oven-dry root weight, and oven-dry shoot weight. Furthermore, animal manures and decomposed materials like rice hay were used as source of nutrients for the seedlings.

2.5 Parameters Measured

2.5.1 Percent Plant Survival

The percent plant survival was determined after six months. Plants were considered dead when all the aboveground organs were dried-up. The number of dead seedlings was recorded and the percent survival was determined using the following Formula 1.

$$PS = \frac{TNS - NDS}{Total\ Number\ of\ Seedlings} \times 100 \qquad (1)$$

where:

PS = percent survival
TNS = total number of seedlings
NDS = number of dead seedlings

2.5.2 Plant Height and Diameter

The height (cm) and diameter (mm) of each seedling was measured from the plant's base to the tip of the highest bud using a foot ruler, and measured every month from the base of the plant using a caliper, respectively.

2.5.3 Number of Leaves and Leaf Area

The total number of fully expanded leaves counted every month within the six-month study period. Leaf area of the second matured leaf from the top of each seedling was obtained using Formula 2 (Pandey and Singh, 2011). Ten pieces of paper having a dimension of 5 x 5 cm were weighed to get the average weight; each leaf outline was clipped from the paper. The ratio of leaf area (g) and the paper area (25 cm^2) was equivalent to the ratio of weight of the clipped paper and the average weight of the 25 cm^2 paper.

$$Leaf\ area = \frac{Paper\ area \times weight\ of\ clipped\ paper}{Average\ weight\ of\ ten\ 25\ cm^2\ papers} \quad (2)$$

2.5.4 Fresh Weight and Total Plant Biomass

The fresh weight was taken using a digital analytical balance right after the harvesting. The harvested plants were oven-dried at 70 °C in an oven for 48 h until a constant weight is attained. The oven-dry weight was taken using a digital weighing balance.

2.6 Data Analysis

The data gathered were tabulated and analyzed using the measures of central tendency which included frequency, and mean percentages in testing the effect of soil enhancers on the early growth of Anonang seedling. The growth parameters covered the height (cm), stem diameter (mm), leaf number, leaf area (cm^2), fresh weight (g) and total plant biomass (g). One-way analysis of variance (ANOVA) was used. The Tukey post-hoc test was employed to test the specific significant differences among treatment means.

3. Results and Discussion

3.1 Percent Survival

After six months of observation, the survival rate of Anonang seedlings gradually decreased. Seedlings treated with decomposed rice hay gave the highest percent survival (93.75%) followed by cow manure, coconut coir dust and carabao manure (87.50%) and garden soil (control) (81.25%). Insects and disease attacks may be the immediate cause or contributor to the inability of plants to recover. Some grasshoppers and worms were observed from the Anonang leaves. Diseases such as yellowing of the leaves were also seen two months after transplanting. Figure 2 shows the percent survival of transplanted Anonang seedlings applied with different treatments.

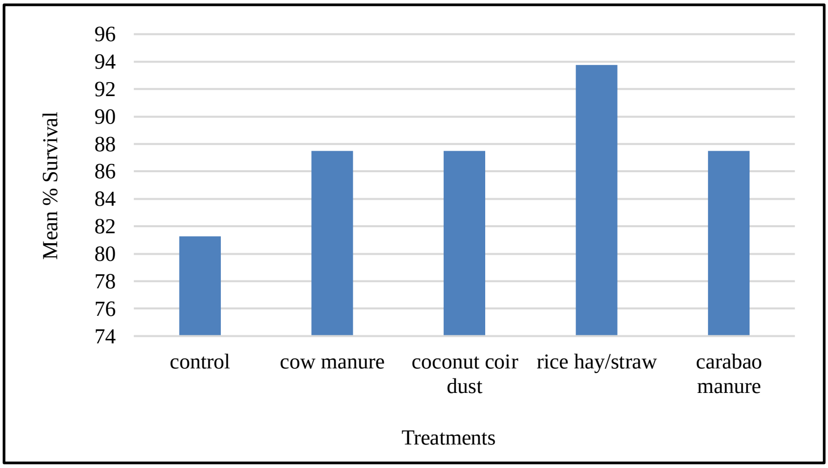

Figure 2. Mean percent survival of Anonang in different treatments

3.2 Growth Performance of Anonang

3.2.1 Diameter

Table 4 shows that the 180-day-old Anonang seedlings with decomposed rice hay had gained the highest diameter measurement over the other treatments with a mean of 0.61 mm (SD = 0.04), followed by the garden soil (control group) with a mean diameter of 0.50 mm. The lowest measured diameter was the 180-day-old Anonang in coconut coir dust with a mean diameter of 0.36 mm (SD = 0.05). Moreover, Figure 3 shows the observed differences in the diameter of the plant across the different treatments.

Table 4. Growth response of 180 days old Anonang applied with different treatments in terms of diameter

Treatment	Seedling Replicates	Mean	SD
Garden Soil (T1)	4	0.50^{bc}	0.02
Cow Manure (T2)	4	0.48^{abc}	0.11
Coconut Coir Dust (T3)	4	0.36^{d}	0.05
Decomposed Rice Hay (T4)	4	0.61^{a}	0.04
Carabao Manure (T5)	4	0.41^{ab}	0.04
Total	20	0.47	0.10

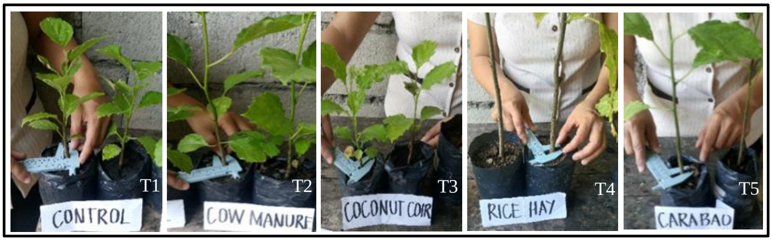

Figure 3. Measuring of the diameter of the 180-day-old Anonang seedlings with different treatments

Table 4 reveals that there was a significant difference in the recorded stem diameters (p = 0.001). The Anonang plant with decomposed rice hay dominated the four other treatments in terms of diameter. Table 5 shows the specific differences in the diameter of the Anonang in different treatments.

Table 5. Results of significant differences on the diameter of the Anonang with different treatments

Tukey HSD Dependent Variable	(I) treatment	(J) treatment	Mean Difference (I-J)	Std. Error	Sig.
	Garden Soil	Coconut Coir Dust	.014*	0.04	0.036
	Coconut Coir Dust	Decomposed Rice Hay	-0.25*	0.04	0.000
	Decomposed Rice Hay	Carabao Manure	0.20*	0.04	0.003

Anonang plant with garden soil produced bigger stem diameter when compared with the one with coconut coir dust. The plant with coconut coir dust had smaller diameter when compared with the one with decomposed rice hay. The Anonang plant with decomposed rice hay was found to have bigger stem diameter when compared with the plant with carabao manure. In the present study, there were significant differences in stem diameter due to the effect of potassium according to Rap (2017). In the soil enhancers analysis, it was found out that the Anonang with cow manure had the highest potassium content (0.89%). However, the decomposed rice hay resulted in a larger diameter over the others. This scenario maybe attributed to the decomposition of organic matter by the soil microorganisms that convert organic nitrogen into ammonia (NH4) and nitrate (NO3) to form nitrogen utilized by plants (Rap, 2017).

3.2.2 Height Growth

The Anonang plant with decomposed rice hay had the highest recorded height measurement with a mean of 39.48 cm (SD = 4.07) described as the tallest one compared with the other experimental and control groups. The coconut coir dust had the least height measurement with a mean height of 7.59 cm (SD = 0.64). Hence, it was noted to be the shortest among the groups (Table 6).

Table 6. Growth response of Anonang applied with different treatments in terms of height

Treatment	Seedling Replicates	Mean	SD
Garden Soil (T1)	4	13.09^{bc}	0.79
Cow Manure (T2)	4	20.53^{b}	6.48
Coconut Coir Dust (T3)	4	7.59^{c}	0.64
Decomposed Rice Hay (T4)	4	39.48^{a}	4.07
Carabao Manure (T5)	4	14.98^{ab}	0.45
Total	20	19.13	11.68

It is shown in Table 7 that there were significant differences in terms of the height of the Anonang across the different soil enhancer treatments and the garden soil as the control group since the computed P-value is less than 0.01, $p = .000$. Anonang plants with garden soil were shorter in terms of height when compared with the ones with decomposed rice hay. Anonang plant with cow manure was taller when compared with the plant with coconut coir dust. Likewise, Anonang with decomposed rice hay was taller when compared with the one with coconut coir dust and carabao manure.

Table 7. Results of significant differences on the height of the Anonang with different treatments

Tukey HSD Dependent Variable	(I) treatment	(J) treatment	Mean Difference (I-J)	SE	Sig.
Height	Garden Soil	Decomposed Rice Hay	-26.39^{*}	2.45	0.000
	Cow Manure	Coconut Coir Dust	12.94^{*}	2.45	0.001
	Coconut Coir Dust	Decomposed Rice Hay	-31.89^{*}	2.45	0.000
	Decomposed Rice Hay	Carabao Manure	24.50^{*}	2.45	0.000

The findings of the study were in agreement to the results of the study conducted by Polthanee *et al.* (2011), which determined the growth and yield of organic rice as affected by rice straw and organic fertilizer. It was found that the application of different types of organic fertilizer combined with rice straw had a significant effect on plant height. The 180-day-old Anonang plant with decomposed rice hay had the highest mean height recorded (Figure 4). This indicates that the used of decomposed rice hay as soil enhancer could induce greater height of the Anonang seedlings.

Figure 4. The height differences of Anonang using different treatments

3.2.3 Number of Leaves

Table 8 discloses that the 180-day-old Anonang plant with decomposed rice hay had the highest number of leaves with a mean of 14.44 (SD = 1.01), followed by the plant with cow manure with a mean number of leaves of 12.04 (SD = 2.76). The lowest recorded measurement was the Anonang plant with coconut coir dust with a mean number of 8.91 (SD = 1.38). This indicates that the increase in height of the seedlings contributed to the degree of branching or nodes resulting in the production of leaves.

Table 8. Growth response of Anonang applied with different treatments in terms of number of leaves after 180-day observation

Treatment	Seedling Replicates	Mean	SD
Garden Soil (T1)	4	11.96^{ab}	1.82
Cow Manure (T2)	4	12.04^{ab}	2.76
Coconut Coir Dust (T3)	4	8.91^{b}	1.38
Decomposed Rice Hay (T4)	4	14.44^{a}	1.01
Carabao Manure (T5)	4	9.93^{b}	1.06
Total	20	11.45	2.49

Table 9 shows the specific differences in the number of leaves across the treatments using the Tukey post-hoc test. The 180-day-old Anonang plant with decomposed rice hay had more leaves than the coconut coir dust (mean difference = -5.53*, *p* = .003) and carabao manure (mean difference 4.51*, *p* = .016). It was noted that when the seedling is taller, there are more leaves basing from the plant height and number of leaves means. Such is the case of Anonang seedlings with decomposed rice hay which obtained the highest mean height with more leaves. Prado (2013) obtained similar findings which stated that the height of the plant is incongruent with the number of leaves. As the plant height increases, the plant produces more leaves.

Table 9. Results of significant differences in the leaf area of the Anonang with different treatments

Treatment	Seedling Replicates	Mean (cm^2)	SD
Garden Soil (T1)	4	21.64[d]	0.02
Cow Manure (T2)	4	51.59[a]	1.77
Coconut Coir Dust (T3)	4	15.85[e]	0.29
Decomposed Rice Hay (T4)	4	46.62[b]	2.16
Carabao Manure (T5)	4	29.94[c]	1.85
Total	20	33.13	14.31

3.2.4 Leaf Area

Table 10 shows that the 180-day-old Anonang plant with cow manure had the largest leaf area measured with a mean of 51.59 cm^2 (SD = 1.77), followed by the decomposed rice hay with a mean area of 46.62 cm^2 (SD = 2.16). The smallest leaf area measured was the Anonang with coconut coir dust with a mean leaf area of 15.85 cm^2 (SD = 0.29). The present study and previous of work of Wijayawardhana *et al.* (2016) share similar results highlighting that both rice varieties showed a significantly large leaf area with cattle manure.

Table 10 further exhibits significant differences between the Anonang plant with garden soil and coconut coir dust (*p* = .001). Anonang plants with garden soil when compared with the one with cow manure (mean difference = -29.96*), decomposed rice hay (mean difference = -24.98*), and carabao manure mean difference = -8.31*) showed a smaller leaf area measured than the other groups. Likewise, Anonang plants with cow manure was found to have a larger leaf area when compared with coconut coir dust (mean difference = 35.74*), decomposed rice hay (mean difference = 4.97), and carabao manure (mean difference = 21.65*). Seemingly, the Anonang plant with coconut coir dust had a larger leaf area compared with carabao manure. Finally, the

Anonang plant with decomposed rice hay showed larger leaf area when compared with coconut coir dust (mean difference = 30.77*, p = .000), and carabao manure with a mean difference of 16.68*, p =.000.

Table 10. Growth response of Anonang applied with different treatments in terms of leaf area

Tukey HSD Dependent Variable	(I) treatment	(J) treatment	Mean Difference (I-J)	SE	Sig.
Leaf Area	Garden Soil	Cow Manure	-29.96*	1.06	0.000
		Coconut Coir Dust	5.79*	1.06	0.001
		Decomposed Rice Hay	-24.98*	1.06	0.000
		Carabao Manure	-8.31*	1.06	0.000
	Cow Manure	Coconut Coir Dust	35.74*	1.06	0.000
		Decomposed Rice Hay	4.97*	1.06	0.002
		Carabao Manure	21.65*	1.06	0.000
	Coconut Coir Dust	Carabao Manure	-14.09*	1.06	0.000
	Decomposed Rice Hay	Coconut Coir Dust	30.77*	1.06	0.000
		Carabao Manure	16.68*	1.06	0.000

3.2.5 Shoot Biomass

In terms of shoot biomass, the Anonang plant with decomposed rice hay has the highest root biomass with a mean of 10.94 g (SD = 0.00) and the lowest root biomass was the plant with coconut coir dust having a mean of 0.66 g (SD = 0.00). Table 11 shows significant differences in the shoot biomass of Anonang (p = 0.000).

Table 11. Growth response of Anonang applied with different treatments in terms of shoot biomass

Treatment	Seedling Replicates	Mean (g)	SD
Garden Soil (T1)	4	1.99[c]	0.00
Cow Manure (T2)	4	4.42[b]	0.00
Coconut Coir Dust (T3)	4	0.66[e]	0.00
Decomposed Rice Hay (T4)	4	10.94[a]	0.00
Carabao Manure (T5)	4	1.63[d]	0.00
Total	20	3.93	3.81

Tukey post-hoc test revealed that the Anonang plant with garden soil had heavier shoot biomass compared with the plant treated with coconut coir dust (mean difference = 1.33*, p = 0.000) and the plant with carabao manure (mean difference = 0.36*, p = 0.000). However, they had lighter shoots when compared with cow manure (mean difference = -2.43*) and decomposed rice hay (mean difference = -8.95*).

Table 12. Results of significant differences on shoot biomass of the Anonang in different treatments

Tukey HSD Dependent Variable	(I) treatment	(J) treatment	Mean Difference (I-J)	SE	Sig.
Shoot biomass	Garden Soil	Cow Manure	-2.43*	0.000	0.000
		Coconut Coir Dust	1.33*	0.000	0.000
		Decomposed Rice Hay	-8.95*	0.000	0.000
		Carabao Manure	.36*	0.000	0.000
	Cow Manure	Coconut Coir Dust	3.75*	0.000	0.000
		Decomposed Rice Hay	-6.52*	0.000	0.000
	Coconut Coir Dust	Decomposed Rice Hay	-10.27*	0.000	0.000
		Carabao Manure	-.96*	0.000	0.000
	Decomposed Rice Hay	Carabao Manure	9.31*	0.000	0.000

The post-hoc test as shown in Table 12 revealed that the Anonang plant with decomposed rice hay had the heaviest shoot biomass measured after six months. Figure 5 showed that decomposed rice hay (T4) had bulky leaves compared with other treatments.

Figure 5. The oven-dried leaves of Anonang in different treatments

3.2.6 Root Biomass

In terms of root biomass, the Anonang plant with decomposed rice hay had the highest root biomass with a mean of 1.79 g (SD = 0.00) and the lowest was the plant with coconut coir dust with a mean of 0.43 g (SD = 0.00). The result of the study corroborates with the study of Alshankitt and Gill (2016) on using compost fertilizer (decomposed rice straw) and biochar on maize (*Zea mays* L.) wherein it was found out that there was an increase in root and shoot biomass.

Table 13. Growth response of Anonang applied with different treatments in terms of root biomass

Treatment	Seedling Replicates	Mean (g)	Std. Deviation
Garden Soil (T1)	4	0.84[c]	0.00
Cow Manure (T2)	4	0.97[b]	0.00
Coconut Coir Dust (T3)	4	0.43[de]	0.00
Decomposed Rice Hay (T4)	4	1.79[a]	0.00
Carabao Manure (T5)	4	0.47[d]	0.00
Total	20	0.90	0.50

The Tukey post-hoc test revealed significant differences in the effect of the different treatments. The Anonang with garden soil had lighter roots (mean difference = -0.14*) when compared with cow manure and decomposed rice hay (mean difference = -0.95*). Also, it was found out that the Anonang with garden soil had heavier roots compared with the plant having coconut coir dust (mean difference = 0.40*) and carabao manure (mean difference =0.37*). Using one-way ANOVA, Anonang treated with cow manure had heavier root biomass compared with the one with coconut coir dust (mean difference = 0.54*) and carabao manure (mean difference = 0.51*). However, between Anonang with decomposed rice hay and the one with cow manure, it was noted that the latter had lighter root biomass with a mean difference of -0.81*. Also, Table 14 shows that the Anonang produced heavier roots compared with the plant with coconut coir dust (mean difference = 1.32*). Additionally, Anonang with carabao manure had heavier root biomass than the one with coconut coir dust with a mean difference of 0.03*.

In the study of Chinthapalli *et al.* (2015), it was found out that the application of cow dung at 15 t/ha showed significant growth over the inorganic fertilizer urea and potassium chloride in terms of root length as well as the number of leaves in the legume plants. Interestingly, in the present study, it was found out that the decomposed rice hay had induced longer roots. Anonang having the highest root length contributed to the fast growth since roots are responsible for the absorption of nutrients needed for plant growth (Figure 6). This claim is supported by Combalicer *et al*. (2010), who reported that *Erythrina variegata* L. had better growth performance owing to its long primary and secondary roots.

Table 14. Significant differences on root biomass of the Anonang with different treatments

Tukey HSD Dependent Variable	(I) treatment	(J) treatment	Mean Difference (I-J)	SE	Sig.
Root Biomass	Garden Soil	Cow Manure	-.14*	0.000	0.000
		Coconut Coir Dust	.40*	0.000	0.000
		Decomposed Rice Hay	-.95*	0.000	0.000
		Carabao Manure	.37*	0.000	0.000
	Cow Manure	Coconut Coir Dust	.54*	0.000	0.000
		Decomposed Rice Hay	-.81*	0.000	0.000
		Carabao Manure	.51*	0.000	0.000
	Coconut Coir Dust	Decomposed Rice Hay	-1.35*	0.000	0.000
	Decomposed Rice Hay	Carabao Manure	1.32*	0.000	0.000
	Carabao Manure	Coconut Coir Dust	.03*	0.000	0.000

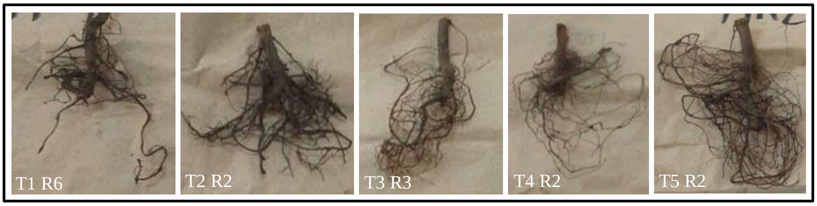

Figure 6. Photo showing the oven-dried roots of Anonang in different treatments

3.2.7 Total Plant Biomass

The total biomass of Anonang had significant differences among the different treatments. This means that oven-dried plant biomass was affected by the application of different soil enhancers on the potting media. Table 15 shows that T4 (decomposed rice hay) had the highest total biomass and the lowest was T3 (coconut coir dust).

Table 15. Significant differences in the total biomass of the in different treatments

Treatment	Total Plant Biomass (g)
T1- Control	2.83^{c}
T2- Cow manure	5.39^{b}
T3- Coconut Coir Dust	1.09^{e}
T4- Decomposed Rice Hay	12.73^{a}
T5-Carabao manure	2.10^{d}
$F_{computed}$	40365.78*

*There is significant difference.

4. Conclusion and Recommendation

The early growth of Anonang (*C. dichotoma* Forst) seedlings using different soil enhancers showed that the decomposed rice hay was the most suited enhancer which achieved the fastest growth throughout the study. Hence, it is recommended to establish tree nurseries for raising Anonang seedlings. Since the duration of the study was only six months, further study should be conducted to test the survival of the plant in the field with a more prolonged time – at least one year to come up with more valuable results.

5. Acknowledgement

The authors would like to acknowledge the Department of Environment and Natural Resources, Dupax del Norte, Nueva Vizcaya; King's College of the Philippines, Magsaysay Hills, Bambang, Nueva Vizcaya; and the College of Forestry, Nueva Vizcaya State University, Bayombong Campus, Bayombong, Nueva Vizcaya for the provision of necessary equipment and instruments needed in the study.

6. References

Alshankitt, A., & Gill, S. (2016). Integrated plant nutrient management for sandy soil using chemical fertilizers, compost, biochar, and biofertilizers – A case study in UAE. Journal of Arid Land Studies, 26(3), 101-106. https://doi.org/10.14976/jals.26.3_101

Bumatay, E.C. (1978). Effects of fertilization on the growth and survival of Agoho (*Casuarina equisetifolia*, Forst) and Giant Ipil-ipil Hawaiian variety (*Leucaena leucocephala*, Lam.) seedlings of planted in a grassland (Thesis). University of the Philippines, Los Baños, College, Laguna, Philippines.

Calubaquib, M., Navarrete, I., & Sanchez, P. (2016). Properties and nutrient status of degraded soils in Luzon, Philippines. Philippine Journal of Science, 145(3), 249-258.

Chinthapalli, B., Dibar, D., Chitra, D., & Leta, M. (2015). A comparative study on the effect of organic and inorganic fertilizers on agronomic performance of Faba Bean (*Vicia faba* L.) and Pea (*Pisum sativum* L.). Agriculture, Forestry and Fisheries, 4(6), 263-268. https://doi.org/10.11648/j.aff.20150406.15

Combalicer, M., Lee, D., Woo, S., Lee, Y., & Jang, Y. (2010). Early growth and physiological characteristics of planted seedlings in La Mesa Dam Watershed, Philippines. Retrieved from http://www.istf-bethesda.org/specialreports/Combalicer/Combalicer.pdf

Jamkhande, P., Barde, S., Patwekar, S., & Tidke, P. (2013). Plant profile, phytochemistry, and pharmacology of *Cordia dichotoma* (Indian cherry): A review. Asian Pacific Journal of Biomedicine, 3(12), 1009-1012. https://dx.doi.org/10.1016%2FS2221-1691(13)60194-X

Miller, R. (2018). Inorganic fertilizer vs. organic fertilizer. Retrieved from https://homeguides.sfgate.com/inorganic-fertilizer-vs-organic-fertilizer-39528.html#:~:text=Organic%20fertilizers%20continue%20to%20improve,soil%20in%20the%20long%20term.

Pandey, S., & Singh, H. (2011). A simple, cost-effective method for leaf area estimation. Journal of Botany, 1-6. https://doi.org/10.1155/2011/658240

Polthanee, A., Promkhambut, A., & S. Kaewrahan. (2011). Growth and yield of organic rice as affected by rice straw and organic fertilizer. International Journal of Environmental and Rural Development, 2(1), 93-99.

Prado, A.J. (2013). Effect of organic fertilizer on the growth performance of *Brassica rapa* under La Union, Philippines. International Scientific Research Journal, 5(4), 1-6.

Rap, S. (2017). Effects of different manure treatment on the growth of Eucalyptus saligna seedlings. Retrieved from http://www.academia.edu/8143726/Effects_of_different_manure_treatment_on_the_growth_of_eucalyptus_saligna_seedlings.

Wijayawardhana, D., Weerasinghe, A., & Herath, V. (2016). Effect of organic matter application on growth of rice (*Oryza sativa* L.) in cadmium contaminated sand. International Journal of Chemical, Environmental & Biological Sciences, 4(1), 74-77.

Yang, T. (2015). Inorganic fertilizers: Advantages and disadvantages. Internet article. Retrieved from http://www.terrabetter.net/html_news/Inorganic-Fertilizers--Advantages-and-Disadvantages-69.html.