

Effects of Organic-based Fortified Foliar Fertilizer on the Growth and Yield of 'Lakatan' Banana (*Musa acuminata*)

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Abstract

To determine the effect of Organic-based Fortified Foliar Fertilizer (OFF) on the growth and yield of 'Lakatan' banana, this study was conducted at the University of Southeastern Philippines, Tagum – Mabini Campus, Mabini Unit, Mampising, Mabini, Compostela Valley Province, from December 2015 to March 2016.

The experiment was laid out in Completely Randomized Design (CRD) with six treatments replicated three times. The treatments were: T1- control; T2- Recommended Rate of NPK fertilizer/ha; T3 - ½ RR of NPK/ha; T4 –Organic-based Fortified Foliar fertilizer (OFF) at 100 ml/16 liters of water; T5 - ½ RR of NPK + OFF; and T6 - RR of NPK + OFF.

Results showed that no significant effects were observed in terms of the plant height at 15, 30, 45 days after application (DAA), pseudostem girth at 15, 30, 45 DAA, and number of hands per bunch. However, significant differences were obtained in the number of leaves, number of fingers per bunch, fruit weight (kg) and yield (tons/ha) of 'Lakatan' banana.

The highest number of leaves were obtained in T6 – RR of NPK fertilizer/ha + OFF which is comparable to T5 – ½ RR of NPK fertilizer/ha + OFF. T6 – RR of NPK+ OFF also had the highest number of fingers per hand than the rest of the treatments as much as 21% higher than the control. The fruit weight of T6 – RR of NPK+ OFF has 61% higher than untreated and the yield of 37 tons/ha is higher than the national average yield of 9.4 tons/ha in 'Lakatan' banana.

Keywords: Organic-based, Foliar Fertilizer, Lakatan Banana, Growth and Yield

1. Introduction

Banana (*Musa sapientum*) is considered as the most important crop in the Philippines in terms of hectare and commercial value. It ranks first in production of area planted to fruits. 'Lakatan' banana is a popular dessert banana cultivar in the Philippines not to be confused with the 'cavendish' banana, 'lacatan' also called 'bungulana' which are diploid banana cultivars. It is one of the banana cultivars in the Philippines, along with the 'latundan' and 'saba' banana [1,2,3].

Nowadays, 'Lakatan' is considered as one of the most important banana cultivars in domestic and export market, moreover, it is the leading fruit crops in terms of volume, and area and value of production with the national average yield of 9.4 tons /ha.

In 2011, 926,719 MT of Lakatan banana was produced on an area of 57,032 hectares, higher than the output of the previous year by 0.55%. Highest production with of 223,141 MT was attained in SOCKSARGEN region [4].

It has a great nutritional significance. It consists of eleven vitamins including vitamin A, B and C, although fats and protein are very low, it is rich in some minerals, notably phosphorus, which is essential for bone development. It can be processed in several delicious products that contain ethyl alcohol, flour, dye, floor wax and cork board [5].

Growing food organically is a hot topic across the country. Most of the attention is on avoiding pesticides or using organic and environmentally friendly products to control insects and diseases. However, growing organically also means using organic fertilizers.

The subject invention provides methods for producing homogenous organic based fertilizer for plant nutrition and soil fertility. Also provided by the subject invention are value added fertilizer products for plant nutrition and soil fertility and concentrated liquid formulations or nutrient supplements that provide the value added nutrients to the fertilizer products. Methods according to the invention involve the application of concentrated liquid(s) and/or dry formulation(s) comprising a mixture of one or more plant nutrient(s), one or more additional organic compound(s), one or more penetrant(s), and one or more optional supplement(s) into one or more organic base material(s). These organic-based materials include, and are not limited to, biosolids, activated sludge, municipal compost, animal manures (e.g., horse, cow, chicken, pig, and sheep), and composted organic by products [6].

Foliar application of fertilizer had been highly recommended to be most commonly used to supplement plant nutrient particularly to the growing crops. It provides more rapidly utilization of the plant nutrients for the vigorous plant growth and development and lesser time to utilize than will be required by soil treatment.

Foliar feeding is an effective method for correcting soil deficiencies and overcoming the soil's inability to transfer nutrients to the plant under low moisture conditions.

Hence, this study was conducted to test the efficacy of organic-based foliar fertilizers for optimum production of 'Lakatan' banana.

2. Materials and Methods

2.1 Field Experiment

The experiment was conducted at the research area of the University of Southeastern Philippines, Tagum-Mabini campus, Mabini, Compostela Valley Province from December 2015-March 2016. The study was conducted using Completely Randomized Design (CRD) with six treatments and replicated three times having two plants per treatment. The following treatments were used: T1 – Untreated check (no fertilizer); T2 –Recommended Rate (RR) of NPK fertilizer /ha (based on soil analysis); T3 – $\frac{1}{2}$ RR of NPK/ha; T4 –Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16 liters of water; T5 – $\frac{1}{2}$ RR of NPK fertilizer/ha + OFF; and T6 – RR of NPK fertilizer/ha + OFF.

This was done before the study was conducted. Soil sample was taken randomly from the experimental area following the conventional method of soil sampling at a depth of 30cm. The soil sample gathered was dried for one week and pulverized. This was submitted to the Bureau of Soil Laboratory in Davao city for the analysis, to determine the soil status of the experimental area.

'Lakatan' banana (*Musa acuminata*) at shooting or flowering stage, which are already planted in the production area of the University of Southeastern Philippines, Mabini, ComVal Province were used.

Weeding was done from time to time or whenever necessary to control the weeds that competed with the plants for nutrients and sunlight by ring weeding. The application of fertilizer was done based on the recommendation of the soil analysis: 274 grams urea (46-0-0), 600 grams ammosul (21-0-0-24), 175 grams ammophos (16-20-0) and 300 grams muriate of potash (0-0-60) per mat. Organic-based Fortified Foliar Fertilizer (OFF) was sprayed every ten days using knapsack sprayer at 100 ml per 16 liters of water. Spraying of insecticide and fungicide was done when pest and diseases were observed in the area. Bend leaves were removed occasionally during the study.

Banana fruits were harvested not earlier than 80 hanging days. Harvesting was done by cutting the trunk slowly and partially about one-third from the top to ensure the falling of the bunch. This was done when the plant had six or less functional leaves (turning yellow). This was also done using the following indicators: fruits are full, pulp, round and light green and the angles in the fingers are rounded.

2.2 Data Gathered

The plant height was determined by measuring the two representative samples per treatment per replication. This was measured from the base up to the apical shoot. Measurement was done at 15-days interval using tape measure/meter stick and expressed in centimeters (cm). The increment was computed by subtracting the final height and initial height.

The girth diameter was determined by measuring the two representative samples per treatment per replication at 15-days interval. Measurement was done at the middle point of the stem, from the base. The increment was computed by subtracting the final diameter and initial diameter.

Number of leaves was taken by counting the average number of leaves from two representative samples in every treatment per replication at 15-days interval.

Number of Finger per Hand was collected by counting the number of finger per hand of all experimental plants. This was done right after harvesting.

Number of Hands per Bunch was gathered by counting the number of hands per bunch right after the harvesting.

Fruit Weight (kg) was taken by weighing the hands using weighing scale. This was done right after harvesting and was expressed in kilogram (kg).

The yield (tons/ha) was taken by weighing the two representative sample fruits per treatment per replication right after harvesting. This was computed using the formula:

$$\text{Yield} = \frac{\text{Weight}}{\text{Plot area}} \cdot \frac{10000}{1000}$$

The cost and return analysis of the study was based on the current price. The gross income or total sales of total harvest of banana was subtracted by the total expenses of production to obtain the net income. The net income and return of production cost (RPC) was determined using the formula below:

$$\text{Net Income} = \text{Gross income} - \text{Production cost}$$

$$\text{RPC} = \frac{\text{Net income}}{\text{Production cost}} \cdot 100$$

Statistical Analysis of the data gathered was obtained through Analysis of Variance (ANOVA) following Completely Randomized Design (CRD). The differences among treatments were computed using the Honest Significant Difference (HSD) test by means of Assistat Software.

3. Results and Discussion

3.1 Plant Height

Table 1 shows the plant height increment (cm) of 'Lakatan' banana at 15, 30 and 45 Days after application as affected by Organic-based Fortified Foliar Fertilizer (OFF).

Statistical Analysis showed no significant differences among treatments. The plant height of 'Lakatan' banana ranged from 267cm to 293cm after 45 days of application.

Table 1. Average Plant Height Increment (cm) of 'Lakatan' banana as affected by Organic-based Fortified Foliar Fertilizer.

Treatment	Plant Height Increment (cm) Days After Application			
	Initial	15 ^{ns}	30 ^{ns}	45 ^{ns}
T1 – Untreated check (no fertilizer)	288.00	2.83	4.83	4.83
T2 – Recommended Rate of NPK fertilizer/ha	255.16	7.00	12.16	12.16
T3 – ½ RR of NPK fertilizer/ha	283.00	8.50	10.16	10.16
T4 – Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16liters of water	278.66	3.00	8.00	8.00
T5 – ½ RR of NPK fertilizer/ha + OFF	267.66	8.33	13.50	13.50
T6 – RR of NPK fertilizer/ha + OFF	274.00	4.83	11.16	11.16
CV%		64.78	34.81	34.81
ns= not significant				

3.2 Stem Girth

The stem girth increment (cm) of 'Lakatan' banana was not also significantly affected by Organic-based Fortified Foliar Fertilizer at 15, 30, 45 Days after application (Table 2). Girth of 'Lakatan' banana ranged from 53 to 74 cm after 45 days of application.

Result showed that plant height is not influenced by the application of Organic-based Fortified Foliar Fertilizer (OFF). According to Brady (1974) [7], organic matters applied were not absorbed quickly by the plant. Moreover, the effect of frequency of foliar fertilizer application was not significantly noticed in the growth and development of mother plant [8].

Agronomic growths of 'Lakatan' banana such as plant height and pseudostem girth were not enhanced by basal and foliar application of fertilizer. As the plant becomes more mature, the development of stem diameter was slow or gradually declined [9].

3.3 Number of Leaves

The number of leaves of 'Lakatan' banana at 15, 30 and 45 Days after Application (DAA) was significantly affected by Organic-based Fortified Foliar Fertilizer (Table 3). The number of leaves of 'Lakatan' banana in T6 – RR of NPK fertilizer/ha + OFF at 15 Days after application have the most number of leaves than the rest of the treatments which are comparable to each other.

Table 2. Average Pseudostem Girth Increment (cm) of ‘Lakatan’ banana as affected by Organic-based Fortified Foliar Fertilizer.

Treatment	Pseudostem Girth Increment (cm) Days After Applying			
	Initial	15 ^{ns}	30 ^{ns}	45 ^{ns}
T1 – Untreated check (no fertilizer)	49.16	1.50	2.33	4.33
T2 – Recommended Rate of NPK fertilizer/ha	67.33	2.66	2.50	5.33
T3 – ½ RR of NPK/ha	70.33	1.50	1.83	4.33
T4 – Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16liters of water	68.83	0.50	0.66	2.50
T5 – ½ RR of NPK fertilizer/ha + OFF	67.16	1.16	2.5	2.66
T6 – RR of NPK fertilizer/ha + OFF	70.00	0.83	1.5	3.36
CV%		76.66	96.37	61.17

ns= not significant

Table 3. Average Number of Leaves of ‘Lakatan’ banana as affected by Organic-based Fortified Foliar Fertilizer.

Treatment	Number of Leaves Days After Application		
	15**	30*	45**
T1 – Untreated check (no fertilizer)	5.00 ^b	5.00 ^b	3.00 ^c
T2 – Recommended Rate of NPK fertilizer/ha	6.33 ^{ab}	5.66 ^{ab}	4.66 ^{ab}
T3 – ½ RR of NPK fertilizer/ha	5.33 ^{ab}	5.33 ^b	3.00 ^c
T4 – Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16liters of water	5.33 ^{ab}	5.00 ^b	4.00 ^b
T5 – ½ RR of NPK fertilizer/ha + OFF	6.00 ^{ab}	6.00 ^{ab}	5.00 ^a
T6 – RR of NPK fertilizer/ha + OFF	6.66 ^a	6.66 ^a	5.00 ^a
CV%	7.66	6.12	5.73

** = highly significant

* = significant

Means in column with the same letter superscript are not significantly different at 1% level using HSD.

At 30 DAA, T6 – RR of NPK fertilizer/ha + OFF, had more leaves which is comparable to T5 – ½ RR of NPK fertilizer/ha + OFF and T2 - RR of NPK fertilizer/ha, While T3 – ½ RR of NPK fertilizer/ha, T4 – OFF at 100 ml/16 liters of water and T1 – Untreated check (no fertilizer) have similarly lower leaves. Still, at 45 DAA, the leaves of T5 – ½ RR of NPK fertilizer/ha + OFF (T3+T4) and T6 – RR of NPK fertilizer/ha remained higher than the rest of the treatments.

Moreover, basal and foliar combination enhanced leaves of ‘Lakatan’ banana. Nutrients could also be absorbed through the leaves [10]. Application of fertilizer by spraying them on leaves is particularly effective with some elements and micronutrient deficiencies are corrected faster as if the elements are supplied through the foliage probably because lesser factors are limiting the uptake of element applied on leaves than through the soil.

3.4 Number of Fingers per Hand

Table 4 shows that the number of fingers per hand of ‘Lakatan’ banana was significantly affected by Organic-based Fortified Foliar Fertilizer. Figure 1 shows the harvested banana at the area. Results indicate that T6 – RR of NPK fertilizer/ha + OFF had the highest number of fingers per hand than the rest of the treatments as much as 21% higher than the control. This is followed by T5 – ½ RR of NPK fertilizer/ha + OFF, T4 – OFF 100 ml/16 liters of water, T3 – ½ RR of NPK fertilizer/ha, T2 – RR of NPK fertilizer/ha and T1– Untreated check (no fertilizer) with the lowest fingers per hand.

Results point out that T6 – RR of NPK fertilizer/ha + OFF had the highest number of fingers per hand than the rest of the treatments as much as 21% higher than the control. Foliar fertilizer has great effects into the plant and will ensure plant growth and development [11]. Fernandez and Tipay [12] also reported that foliar application banana peel increased the number of fruits and yield of pummelo.

Table 4. Average Number Finger per Hand of ‘Lakatan’ banana as affected by Organic-based Fortified Foliar Fertilizer.

Treatment	Number of Finger per Hand**
T1 – Untreated check (no fertilizer)	14 ^d
T2 – Recommended Rate of NPK fertilizer/ha	15 ^c
T3 – ½ RR NPK fertilizer/ha	16 ^b
T4 – Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16liters of water	16 ^b
T5 – ½ RR of NPK fertilizer/ha + OFF	16 ^b
T6 – RR of NPK fertilizer/ha + OFF	17 ^a
CV%	0

** = highly significant

Means in column with the same letter superscript are not significantly different at 1% level using HSD.

3.5 Number of Hands per Bunch

The number of hands per bunch of 'Lakatan' banana was not significantly affected by Organic-based Fortified Foliar Fertilizer (Table 5). Result showed that the hands per bunch of 'Lakatan' banana which ranged from 4–5 hands per bunch were not increased by the application of both and foliar fertilizer applications.

Data on the hands per bunch of 'Lakatan' banana which ranged from 4–5 hands per bunch were not increased by the application of both and foliar fertilizer applications. This implies that Organic-based Fortified Foliar Fertilizer has no influence on the hands per bunch of 'Lakatan' banana.

Table 5. Average Number of Hands per Bunch of 'Lakatan' banana as affected by Organic-based Fortified Foliar Fertilizer.

Treatment	Number of Hands per Bunch ^{ns}
T1 – Untreated check (no fertilizer)	4.00
T2 – Recommended Rate (RR) of NPK fertilizer/ha	4.33
T3 – ½ RR of NPK fertilizer/ha	4.66
T4 – Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16liters of water	4.66
T5 – ½ RR of NPK fertilizer/ha + OFF	4.33
T6 – RR of NPK fertilizer/ha + OFF	5.00
CV%	9.90

ns = not significant

3.6 Fruit Weight

Table 6 shows the fruit weight of 'Lakatan' banana as affected by Organic-based fortified foliar Fertilizer. There were significant differences among treatments. Result indicate that T6 – RR of NPK fertilizer/ha + OFF also got the highest fruit weight as much as 61% higher than untreated. It was followed by T4 –Organic-based Fortified Foliar Fertilizer (OFF) and the rest of the treatments.

Result also confirms that T6 – RR of NPK fertilizer/ha + OFF got the highest fruit weight as much as 61% higher than untreated. Foliar spray supplement significantly increased yield [13].

Table 6. Average Fruit Weight (kg) of ‘Lakatan’ banana as affected by Organic-based Fortified Foliar Fertilizer.

Treatment	Fruit Weight
	kg/plot*
T1 – Untreated check (no fertilizer)	6.90 ^d
T2 – Recommended Rate (RR) of NPK fertilizer/ha	8.15 ^c
T3 – ½ RR of NPK/ha	8.33 ^c
T4 – Organic-based fortified Foliar Fertilizer (OFF) at 100 ml/16liters of water	9.86 ^b
T5 – ½ RR of NPK fertilizer/ha + OFF	8.56 ^c
T6 – RR of NPK fertilizer/ha + OFF	11.13 ^a
CV%	3.84

* = significant

Mean in column with the same letter are not significantly different at 5% level using HSD.

3.7 Yield

Table 7 shows that the yield of ‘Lakatan’ banana was significantly affected by Organic-based Fortified Foliar Fertilizer. Result showed that T6 – RR of NPK fertilizer/ha + OFF had the highest yield by 60% higher than T1 – Control (Figure 1). It was followed by T4 –Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16 liters of water and the rest of the treatments.

The study further showed that T6 – RR of NPK fertilizer/ha + OFF had the highest yield by 60% higher than T1 – Control. The yield of 37 tons/ha in T6 – RR of NPK fertilizer/ha + OFF was also much higher than the national average yield of 9.4 tons/ha in ‘Lakatan’ banana. The application of organic fertilizer is important in maintaining stable high crop yield [14, 15].

3.8 Economic Analysis

Table 8 presents the economic analysis of ‘Lakatan’ banana as affected by Organic-Based Fortified Foliar Fertilizer (OFF). This shows that the highest return on investment ROI was obtained by T4 –Organic-based Fortified Foliar Fertilizer (OFF) at 100ml/16 liters of water with the ROI of 133.64% followed by T3 – ½ RR of NPK fertilizer/ha, T2 – Recommended Rate of NPK fertilizer/ha and T1 – Control. While T6 – RR of NPK fertilizer/ha + OFF and T5 – ½ RR of NPK fertilizer/ha + OFF had the lowest ROI with 61.69%.

Economic analysis implies that T4-Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16 liters of water enhanced the income of ‘Lakatan’ banana.

Table 7. Average Yield (tons/ha) of ‘Lakatan’ banana as affected by Organic-based Fortified Foliar Fertilizer.

Treatment	Yield
	tons/ha*
T1 – Untreated check (no fertilizer)	23.00 ^d
T2 – Recommended Rate (RR) of NPK fertilizer/ha	27.16 ^c
T3 – ½ RR of NPK fertilizer/ha	27.76 ^c
T4 – Organic-based fortified Foliar Fertilizer (OFF) at 100 ml/16liters of water	32.86 ^b
T5 – ½ RR of NPK fertilizer/ha + OFF	28.53 ^c
T6 – RR of NPK fertilizer/ha+ OFF	37.10 ^a
CV%	0

* = significant

Mean in column with the same letter are not significantly different at 5% level using HSD

Table 8. Economic Analysis of ‘Lakatan’ banana as affected by Organic-based Fortified Foliar Fertilizer.

Treatment	Gross Income	Total Expenses	Net Income	ROI(%)
T1 – Untreated check (no fertilizer)	1,076.40	479	597.4	124.72
T2 – Recommended Rate (RR) of NPK fertilizer/ha	1,271.40	564.4	707	125.27
T3 – ½ RR of NPK fertilizer/ha	1,299.48	564.4	735.08	130.24
T4 – Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16liters of water	1,539.72	659	880.72	133.64
T5 – ½ RR of NPK fertilizer/ha + OFF	1,341.60	829.73	511.87	61.69
T6 – RR of NPK fertilizer/ha + OFF	1,789.32	829.73	959.59	115.65



T1 – Untreated check (no fertilizer)



T2 – RR of NPK Fertilizer/ha



T3 – ½ RR of NPK Fertilizer/ha



T4 – Organic- based Fortified Foliar Fertilizer (OFF)



T5 – ½ RR of NPK Fertilizer/ha + OFF



T6 – RR of NPK Fertilizer/ha + OFF

Figure 1. The harvested 'Lakatan' banana as affected by Organic-based Fortified Foliar Fertilizer (OFF).

4. Conclusion

The result showed that the highest number of leaves were obtained in T6 – RR of NPK fertilizer/ha + OFF which is comparable to T5 – ½ RR of NPK fertilizer/ha + OFF. T6 – RR of NPK fertilizer/ha + OFF also had the highest number of fingers per hand than the rest of the treatments as much as 21% higher than the control. The fruit weight of T6 – RR of NPK fertilizer/ha + OFF has 61% higher than untreated and the yield of 37 tons/ha is higher than the national average yield of 9.4 tons/ha in ‘Lakatan’ banana.

Economic analysis revealed that T4 – Organic-based Fortified Foliar Fertilizer (OFF) 100 ml/16 liters of water had the highest ROI. Hence, T6 – RR of NPK fertilizer/ha + OFF significantly increased the leaves, the number of fingers and yield of ‘Lakatan’ banana. While T4-Organic-based Fortified Foliar Fertilizer (OFF) at 100 ml/16 liters of water increased the income of ‘Lakatan’ banana.

The use of basal and foliar fertilizer combination or Organic-based Fortified Foliar Fertilizer (OFF) alone are highly recommended for the optimum production of ‘Lakatan’ banana. Further study on the effects of Organic-based Fortified Foliar Fertilizer (OFF) on the postharvest quality and attribute is also recommended.

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6. Competing Interests

“Authors have declared that no competing interests exist.”.

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