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# Comparative Effect of Foliar and Soil Application of FertiGroe Nano N, P and K Fertilizer on the Growth Performance of 'Cavendish' banana [*Musa acuminata* Colla (AAA) 'Cavendish']

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**Abstract**
This study was conducted to compare the effect of foliar and soil application of FertiGroe Nano fertilizer on the growth performance of the Cavendish banana plant. The experiment was laid out in a Completely Randomized Design (CRD) with two treatments (foliar and soil application of FertiGroe). Each treatment was replicated four times with 15 meriplants per treatment and replicate. FertiGroe N, P, and K rate were dissolved in 1 litre of distilled water and stirred thoroughly. The mixture was applied four weeks after transplanting using a hand sprayer as a foliar application while FertiGroe was side dressed at about 2 cm and FertiGroe covered with soil and then irrigated as media application. The research result turned out to show that the media application of FertiGroe Nano fertilizer was more effective in shoot and root growth characteristics compared to foliar application. There was a significant difference between the soil application of FertiGroe Nano fertilizer and foliar application in terms of shoot growth parameters. FertiGroe is a slow-release fertilizer developed primarily for soil application. Hence should be applied as such on Cavendish banana seedlings instead of foliar spraying.

***Keywords: Nano fertilizer, Foliar application, FertiGroe, Meriplants***

## Introduction

Bananas are grown by small-scale and large-scale farmers as one of the world's most important crops, with production in about 130 countries. Banana production employs thousands of people in Southeast Asia, West Africa and Latin America and generates a high income for them as well. (Svanes, and Aronsson, 2013). In the Philippines, banana production for the fourth quarter of 2018 accounted for 2.42 million metric tons of total crop production, 0.6 % higher than the previous year's level of 2.41 million metric tons. The Cavendish variety had the highest share during the period at 51.9 per cent (PSA, 2018). Banana are fast-growing plants which require a continuous supply of nutrients and water for high yield. These nutrients may be partly supplied by the soil and through cycling within banana plantations, but fertilizer application is generally needed to satisfy plant requirements for obtaining profitable production. Bananas require large amounts of macronutrients such as nitrogen, phosphorus and potassium (Nansamba et al., 2020). According to Seenivasan (2017), one ton of banana requires 7 to 8 kg of Nitrogen (N), 0.7 to 1.5 kg of Phosphorous (P) and 17 to 20 kg of Potassium (K).

The most commonly used commercial fertilizers are water-soluble quick-release fertilizers (QRFs) whose nutrients are predictively readily available for plants when properly placed in soil. Controlled-release fertilizers (CRF) are typically coated or encapsulated with inorganic or organic materials that control the rate, pattern, and duration of plant nutrient release. Polymer-coated urea exemplifies CRFs (Loper et al., 2013). Nano fertilizer penetrates plant cells directly through the sieve-like cell wall structures if the particle sizes are smaller than the sizes of cell wall pores (5-20 nm). In effect, nano fertilizer simply dissolves in solution and release the nutrient(s) as soluble ions. Plants take in the soluble nutrient ions as indiscriminately as they take in those from dissolved conventional fertilizers. Considering the nutrient use efficiency of bananas and the loss of fertilizer and nutrients through leaching and other environmental hazards, there is a need to develop smart materials that can systematically release fertilizer to specific parts of the plant which can be beneficial in controlling nutrient deficiency in crop production. Smart delivery systems, such as the use of Nano fertilizer, have increased nutrient uptake and minimized nutrient losses (Naderi and Danesh-Shahraki, 2011). Foliar fertilizer application at the vegetative stage may lead to better growth performance of bananas and higher quality of the fruit produced. The prediction of plant growth is important in fertilizer application decision-making (Mushoddad and Latif, 2018). This experiment was designed to establish a relationship between foliar and media application of Nano N, P and K on the growth performance of Cavendish banana.

## Methodology

The experiment was conducted at the Fruits Crops Nursery and the Crops Physiology Greenhouse of the Institute of Crop Science (I Crops), College of Agriculture and Food Science, University of the Philippines Los Baños (UPLB), College Laguna, and the Philippines. UPLB is located at $14^0\ 10'$ N and $12^0\ 15'$ E with an elevation of 40 m above sea level, a mean annual temperature of $27^0$ C, and a mean annual rainfall of 2200 mm.

### *Experimental plants*

Meriplants of 'Cavendish' bananas were propagated from the Tissue Culture Laboratory of the Lapanday Food Corporation located in Barangay Callawa, Davao City. The *meriplants* were propagated from explants of Fusarium Wilt-resistant strains of 'Cavendish' bananas. The plants were about 3 cm long with two undeveloped leaves.

### *Plant materials and treatments*

Cavendish banana *meriplants* were planted immediately in 10.16 cm x 10.16 cm x 17.78 cm black polybags filled with garden soil. The newly planted *meriplants* were incubated for four weeks by covering them with transparent plastic cups to maintain favourable relative humidity for immediate recovery of the plantlets. However, these cups are slightly tilted periodically for ventilation. These polybags were placed inside a screen house for the 12 weeks duration of the experiment. The experiment was conducted to test the efficacy of two types of fertilization namely: foliar, and soil application of nanofertilizer on bananas grown in garden soil media.

### *Foliar application of FertiGroe N, P and K*

FertiGroe N, P, and K rate (Table 1) were dissolved in 1 litre of distilled water and stirred thoroughly. The mixture was applied four weeks after transplanting using a hand sprayer. The plants were sprayed uniformly until the leaves were completely wet. At the time of spray, growth media were covered with a plastic sheet to prevent spray drift on media. The FertiGroe sediments were kept, dissolved further in water and sprayed the next day. The remaining sediments were again kept and dissolved in water and applied on the third day. Any FertiGroe sediments remaining was discarded after the third day. This was done because FertiGroe fertilizer, when dissolved in water, releases only 50 per cent N, P, and K (Fernando *et al*., 2017). The fertilizer was sprayed weekly for a period of 8 weeks.

### *Soil application of FertiGroe N, P and K*

The individual N, P and K fertilizers were mixed thoroughly before application. FertiGroe was side dressed at about 2 cm and FertiGroe was covered with soil and then irrigated.

### *Experimental design*

The experiment was laid out in a Completely Randomized Design (CRD) with two treatments (foliar and soil application of FertiGroe). Each treatment was replicated four times with 15 *meriplants* per treatment and replicate.

### *Data collation*

***Morphological Characteristics***:
Shoot characteristics measured included plant height (cm), pseudostem diameter (cm), number of functional leaves, length and width of leaf (cm) and average fresh and dry shoot weight (g). Root characteristics measured included root length (cm), root fresh and dry weight (g) and root diameter (mm). All measurements were performed every two weeks for eight weeks.

***Statistical analysis***: The data collected were analyzed using the analysis of variance (ANOVA) of Completely Randomized Design CRD and the mean difference was determined using LSD at 5 % significance level.

## Results and Discussion

### *Effect of FertiGroe Application on shoot growth parameters*

The average shoot growth parameters as influenced by FertiGroe application methods are shown in Table 2. The results show that the average plant height, number of leaves, pseudostem diameter and leaf area of plantlets fertilized with FertiGroe in the soil was higher than plantlets fertilized by foliar applications. The shoot dry weight of plantlets fertilized with FertiGroe in both foliar and soil applications was statistically different at 5 % significant levels. Foliar application has proven to be the best way of correcting nutrient deficiencies and increasing the yield and quality of plant products (Roemheld and El-Fouly, 1999). It also improves nutrient utilization by reducing the amounts of fertilizers added to the soil (Abou-El-Nour, 2002). However, in the case of FertiGroe, soil application has proven to be better than foliar application. Though leaves allow gas exchange, the cuticle present in the leaves limits the penetration of substances like fertilizer (Pérez-de-Luque, 2017). The higher shoot growth parameters observed in soil application of FertiGroe can be due slow release of nutrients from the fertilizer and decreased leaching (Ramesh and Reddy, 2011). Other experiments have shown that zeolites can become an outstanding plant growth media for providing plant roots with additional vital nutrient cations and anions (Zhou and Huang, 2007). Foliar application of FertiGroe was performed at about 10 am coinciding with the peak of the plant's physiological activity.

However, the high temperature in the screen house could have promoted the evaporation of water from the FertiGroe solution fast enough before the N, P and K nutrients from the surface of zeolites and released into the solution could have diffused into the leaves. Besides, FertiGroe being slow to release fertilizer was developed primarily for soil application. This could explain the poor performance of Cavendish banana seedlings sprayed with FertiGroe. Furthermore, FertiGroe being slowly released must keep the nutrients available for a longer period of time. This cannot be achieved in foliar sprays. Thus, if nutrients will be released on demand by the plant, such nutrients cannot be released because the solution has already dried up and nutrients can no longer diffuse into the leaf tissues.

***Effects of FertiGroe application methods on root growth parameters***

The longest root and largest root diameter were significantly different in plantlets fertilized through soil media compared to foliar application. However, the number of roots and root dry weight were comparable in both foliar and soil application of FertiGroe (Table 3). The application of nutrients through media is the most common practice, but it has limitations in terms of availability for plant use. FertiGroe applied in the soil as insoluble forms could have been exposed to leaching by irrigation water (Alshaal and El-Ramady, 2017). However, the application regime of water to the plantlets could have controlled leaching hence maximum utilization of the nutrients by the plantlets compared to the foliar application of FertiGroe. Besides, FertiGroe being a nano fertilizer was designed for soil application. The release of nutrients on demand by the plant from the nano fertilizer could be affected because the moment the nutrient solution dries up after application, no nutrients can be released even if the plants have a higher demand for them. As such nutrients from the nano fertilizer cannot be released. This explains the better performance of plants in soil applied FertiGroe than foliar sprays.

**Conclusion**

The hypothesis that foliar spray of FertiGroe nano N, P, and K will provide a quick path for nutrients to be easily absorbed by the plant and enhance plant growth was not shown in the results. The research result turned out to show that soil application of FertiGroe nano fertilizer was more effective in shoot and root growth characteristics compared to foliar application.

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**Table 1: FertiGroe application rates for banana seedlings**

| Week | Amount of FertiGroe applied per plant (g) | | |
|---|---|---|---|
| | **Nano N** | **Nano P** | **Nano K** |
| 1 | 1.0 | 3.5 | 0.68 |
| 2 | 3.8 | - | - |
| 3 | 2.5 | 8.75 | 1.71 |
| 4 | 8.2 | - | - |
| 5 | 3.8 | - | - |
| 6 | 2.5 | 8.75 | 1.71 |
| 7 | 8.2 | - | - |
| 8 | 3.8 | - | - |

**Table 2: Average shoot growth performance of 12-week-old Cavendish banana plantlets as influenced by FertiGroe application methods**

| **Shoot growth parameter** | **Foliar application** | **Soil application** |
|---|---|---|
| Plant height (cm) | 9.43[b] | 17.62[a] |
| Number of leaves | 4.9[b] | 7.75[a] |
| Pseudostem diameter (mm) | 11.04[b] | 15.57[a] |
| Leaf area ($m^2$) | 0.12[b] | 0.29[a] |
| Shoot dry weight (g) | 1.63[a] | 2.52[a] |

**Means within rows with the same letters are not significantly different at 5%LSD**

**Table 3: Average root growth parameters of 12-week-old 'Cavendish' banana plantlets as influenced by FertiGroe application methods**

| **Root growth parameters** | **Foliar application** | **Soil application** |
|---|---|---|
| Number of roots | 10.75[a] | 13.00[a] |
| Root length (cm) | 18.14[b] | 26.21[a] |
| Root diameter (mm) | 3.21[a] | 4.73[a] |
| Root dry weight (g) | 0.37[a] | 0.42[a] |

**Means within the row with the same letters are not significantly different at 5%LSD**