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Assessment of All-in-One Fertilizers and Foliar Spray for Nutrient Management of GCTCV-218 Cavendish Banana Seedlings

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Abstract

With the proliferation of GCTCV-218 in the banana industry due to its promising performance against Fusarium wilt, there is a need to explore and establish an optimum and practical nutrient management, particularly in nursery management. As such, this study was conducted aiming to compare the growth performance of GCTCV-218 seedlings using conventional and all-in-one fertilization programs, evaluate the effect of a foliar spray in combination with fertilizer materials, and assess the profitability of using conventional and all-in-one fertilization programs. A 3 x 2 factorial experiment in a completely randomized design (CRD) was used with four (4) replications with a total of 768 GCTCV-218 seedlings. Results show that GCTCV-218 seedlings had higher plant height grown under the combination of all-in-one fertilizer and foliar spray. Leaf surface area and root length were significantly high in the same treatment, implying a synergistic effect on the growth performance of GCTCV-218 seedlings. Cost analysis also revealed a positive return when using all-in-one and foliar spray since the desired height for planting is attained earlier (15-20 cm) than the recommended eight (8) weeks after planting (WAP). Savings of 31 cents per seedling or equivalent to PHP 580.23 on a hectare basis can be made if seedlings are released at 6 WAP using Haracoat all-in-one and foliar spray than at 8 WAP using the conventional and foliar spray. Therefore, optimal and economical nutrient management can be attained when Haracoat all-in-one fertilizer and foliar spray are applied in GCTCV-218 seedlings under nursery conditions.

Keywords: giant Cavendish tissue culture variant, fertilization, liquid humus, nursery management

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The Philippines, being the number one exporter of Cavendish bananas in Asia and second in the world, has been challenged in the previous years due to the impact of significant productivity problems such as poor plant nutrition and soil fertility, inferior fruit quality, and the outbreak of pest and diseases (Viljoen, 2015). FAO (2014) reported a decline in the country's banana production from 2.04 million tons to 1.59 million tons from 2005 to 2010, respectively. Among these challenges, Fusarium wilt greatly contributed to the reduction of banana production along with other diseases like Sigatoka, Moko, and Bunchy top (UNCTAD, 2016). To address such concerns, they popularized the Cavendish cultivars due to the assured resistance to Panama or Fusarium wilt since it is successfully grown in the same soil planted with the previously affected Gros Michel cultivar (Ploetz & Pegg, 1997). Not until the early 1990s was the vulnerability of Cavendish cultivars highlighted when newly established plantations were decimated in Malaysia and Indonesia. Since then, tropical Race 4 (TR4) has been found in the islands of Borneo, other Indonesian islands, mainland China, Australia, and the Philippines (FAO, 2019).

In the Philippines, the devastation of Cavendish banana farms was vastly experienced in the province of Davao del Norte due to the spread of Fusarium wilt caused by *Fusarium oxysporum* f. sp. *cubense* (Foc) TR4. This incident tremendously affected banana farmers, who mostly rely on the productivity of their farms. Despite many studies and trials to control the disease, no one has succeeded (Hwang & Kho, 2004). Natural calamities like floods exacerbated the spread of the disease in the entire province, not considering other predisposing factors such as poor quarantine measures, stray animals, and poor orientation towards prevention and management approaches. Addressing Fusarium wilt problems is still of utmost priority. Thus, resistant or tolerant varieties are the most practical and economical solutions in Fusarium wilt management (Lee et al., 2011).

The Giant Cavendish Tissue Culture Variant 218 (GCTCV-218) was selected by the Taiwan Banana Research Institute (TBRI) for its resistance to Foc TR4 that causes Panama wilt in Cavendish bananas (Arias & Dankers, 2003). The Bureau of Plant Industry (BPI) distributed this cultivar to the banana growers for evaluation, and some selected materials have been successfully planted on a commercial scale. Usually, quality issues are the major concern of new varieties. However, GCTCV-218 showed comparable productivity parameters (e.g., stem weight, hand class, box-to-stem ratio, and quality parameters like sweetness and aroma) to that of the old Gran Naine variety (Tang, 2012). Moreover, GCTCV-218 differs from the old 'Gran Naine' variety due to its recovery potential from Foc TR4 infection. At the younger vegetative stage, the mother plant will recover in not less than 8 weeks, making it capable of developing fruit and can still be harvested (Hwang, 2002). The promising response of GCTCV-218 urged most banana exporting companies to convert their plantation drastically from the old susceptible Gran Naine variety into GCTCV-218. As a result, there is an increasing demand for planting materials, and very limited sources of tissue culture seedlings are available. At present, most companies have adopted cultural practices and fertilization programs for the old Gran Naine variety, and there is a need to evaluate and establish a fertilization program specific to GCTCV-218 seedlings.

The availability of fertilization protocol specific to GCTCV-218 will address nutritional problems such as poor seedling growth, high mortality, and compromised disease resistance. These characteristics are the primary requirements for evaluating seedling vigor (Robinson & Galan, 2009). Seedling vigor is a prerequisite to a high survival rate in the field, and to produce good quality seedlings, an efficient and optimum fertilization protocol is necessary. Application efficiency and fertilizer cost are the key economic issues of seedling production, considering the volume produced to cater to thousands of hectares. Hence, utilization of all-in-one fertilizers is a potential intervention that can be considered. Unlike conventional fertilizers (e.g., diammonium phosphate and muriate of potash), where the application of each nutrient source requires separate labor costs and availability of each material often delays the application, the use of all-in-one fertilizers simplifies the operation since you only need to apply one kind throughout the life cycle of the seedlings in the nursery. The sulfur-coating of the all-in-one fertilizers allows nutrients to be gradually released into the soil and eliminates warehousing problems due to the hygroscopic characteristics of most conventional fertilizers. To address nutrient loss, particularly trace elements, applying liquid humus with potassium humate (18%) suspension and bioactive humic and fulvic acids is seen to have potential. It is a water-soluble, high-quality plant growth stimulant and soil conditioner that can be applied to all agricultural and horticultural plants through soil and foliar application. Among its benefits are increased yield and improved quality of plants, improved soil structure and water retention capacity, increased effectiveness of fertilizers and reduced nutrient leaching, improved root development and increased nutrient uptake, increased germination of seeds, and development of radicles. Humic acids are an effective agent to use as a complement to synthetic or organic fertilizer, for it has the ability to chelate micronutrients, thus increasing their bioavailability (Khaled & Fawy, 2011). Hence, this study was conducted to explore the potential of all-in-one fertilizer and humic acids for nutrient management of GCTCV-218 seedlings and eventually assess the profitability for nursery management.

Materials and Methods

Experimental site

The pot experiment in the greenhouse was conducted at a Biotech Nursery located at Alejal, Carmen, Davao del Norte, from November 2016 to February 2017. The facility has an area of 1.2 hectares with a capacity of 500,000 seedlings and was fully equipped with overhead sprinkler irrigation and active biosecurity measures. All seedlings used in the experiment were sourced from completely disease-indexed materials using Polymerase Chain Reaction (PCR) technology.

All-in-one fertilizers and foliar spray

The all-in-one fertilizer contains the three primary elements in varying formulations depending on crop and soil requirements. It may also contain trace elements to suffice the deficiency of most common micronutrients like zinc, boron, and sulfur. In this experiment, Subete and Haracoat are used. Subete all-in-one fertilizer was originally developed for Cavendish bananas; farmers prefer this blend as it contains macro and microelements. Subete is a Japanese term that means "all." It is odorless, granular in form, and blue-green in color. It contains 13% nitrogen, 7% phosphorus, 26% potassium, 1.2% magnesium, 1.6% zinc, and 0.26% boron. Like other all-in-one blend fertilizers, Haracoat contains the major elements N, P, and K and some trace elements needed for plant growth. It has a pale yellow and brown color and is odorless. The fertilizer grade is as follows: 13% nitrogen, 6% phosphorus, 26% potassium, 2% magnesium, 1.5% zinc and 1% boron.

Meanwhile, the foliar spray has potassium humate (18%) suspension with bioactive humic and fulvic acids. It is obtained through alkaline extraction from German Leonardite (highly oxidized lignite). It arises from the chemical and biological humification of plants and other organic matter by biological activity and geological processes. Leonardite provides high amounts of humic and fulvic acids and natural, biologically active trace elements.

Greenhouse experiment

A 3 x 2 factorial experiment was laid out in a Completely Randomized Design (CRD) having four (4) replications. There were two (2) factors considered in the experiment: (A) the type of fertilizers: conventional using diammonium phosphate (18-46-0) and muriate of potash (0-0-60), and two all-in-one fertilizers (subete, 13-7-26 and haracoat, 13-6-26) and (B) with and without liquid humus. Thirty-two (32) GCTCV-218 seedlings were used per replication, and there were a total of 768 seedlings. Fertilizer as a factor is coded as A: A1 for Conventional (Diammonium phosphate + Muriate of potash), A2 for Subete All-in-one, and A3 for Haracoat All-in-one and liquid humus foliar spray as a factor is coded as B: B1 for without liquid humus and B2 for with liquid humus.

Application of Treatments

All treatment application schedules were done simultaneously in all treatments, between 6 to 8 a.m., right after watering. Fertilizer materials were applied directly on the media, avoiding spillage on the leaves with a distance of 2 in from the base of the seedling. For conventional fertilizer, DAP was applied 1 week after planting and weekly thereafter at the rate of 1 g per seedling. MOP was applied at 4, 6, and 8 weeks after planting at the rate of 1 g per seedling. All-in-one fertilizers (Subete and Haracoat) were applied 1 week after planting and weekly after that at the rate of 1.4 g per seedling. A calibrated scoop was used for every fertilizer type to ensure a uniform fertilizer rate was applied in every seedling. Liquid humus foliar spray was applied one 1week after planting and weekly thereafter using a calibrated knapsack sprayer at the spray to run-off point. This was done right after fertilizer application using the recommended mixing rate of 5 ml of chemical for every liter of water.

Nursery Management

GCTCV-218 seedlings were planted using 8 x 8 in polyethylene bags on a commercial bagging media. All treatments used a uniformly blended mixture of cocopeat, gypsum, and borax as bagging media. Nutrient analysis of cocopeat as bagging media shows 0.51% Nitrogen, 0.08% Phosphorus, 1.87% Potassium, 0.15% Calcium, 0.10% Magnesium, 0.07% Sulfur, 37 ppm Iron, 9.79 ppm Manganese, 18.12 ppm Boron, 15.99 ppm Copper and 9.03 ppm Zinc.

During planting, four layers of net were installed to provide 80% light penetration and 20% shading. A week later, one layer of net was removed. Until the third week after planting, three layers of the net were removed. In the fourth week after planting, hardening was started, leaving only one layer of net until the experiment was terminated. Application of insecticide and fungicide using the recommended rate was done across all treatments every weeks for insect and fungal disease control. Sprinkler irrigation was done daily.

Data Gathered

Ten sample plants per replication were used to collect the following data at 2, 4, 6, and 8 weeks after planting (WAP):

Percent survival. This was recorded and computed using the formula Percent (%) Survival = (Number of seedlings alive/Total number of seedlings) x 100.

Plant Height. Using a standard ruler, plant height (expressed in cm) was measured from the base to the cogollo of the seedling. Cogollo is where the leaf stalk of the two youngest leaves usually meets at the end of the pseudostem.

Number of leaves. This was counted, excluding the two initial leaves at planting.

Pseudostem Circumference. The girth, or the circumference of the pseudostem, was determined using a digital Vernier caliper to initially get the diameter and convert it to the circumference.

Leaf surface area. This was taken from the third youngest leaf at 8 WAP. The entire leaf lamina was carefully traced along its leaf margin on a clean bond paper. The pattern is precisely cut and weighed using an analytical balance. Prior to that, a baseline weight of 0.737 was determined from a 10 x 10 cm or 100 cm^2 bond paper of the same kind. The weight of the cut bond paper traced from the leaf was divided into 0.737 and multiplied by 100. Leaf surface area is expressed in square centimeters (cm^2).

Root length. Eight (8) weeks after planting, root length data were determined by carefully washing out the soil media using water. The roots were cleaned and dumped on tissue paper. Measurement was taken from the base of the pseudostem, where the roots originate until the end of the longest primary root. Root length data were expressed in centimeters (cm).

Cost analysis. Cost of labor and materials using standard price, minimum wage, and labor efficiencies were determined to evaluate the profitability of the treatments. Cost per seedling was derived by computing the total amount of fertilizer, chemicals, and labor used during the entire weeks in the nursery using recommended rates and actual efficiencies. Cost per seedling at 6 WAP was also determined to consider early release of seedlings from the nursery when the desired plant height is attained. The seedling cost per hectare is computed by multiplying the cost per seedling by 1850 seedlings per hectare area.

Statistical Analysis

The data gathered were analyzed using Statistical Package for Social Sciences (SPSS) software, determining the analysis of variance (ANOVA) at a 5% level of significance and Duncan's Multiple Range Test (DMRT) for treatment mean comparison.

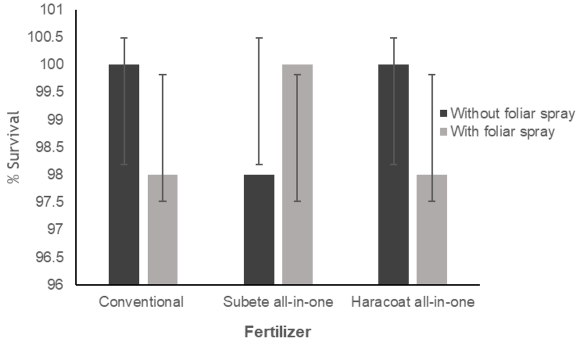
Results and Discussion

Percent survival

Survival rate is a key factor in maintaining the population unit, which is the primary indicator of productivity. Figure 1 presents the percent survival of GCTCV-218 seedlings affected by different fertilizers with and without foliar spray. No mortality was observed at 2 WAP; however, at 4 WAP, one seedling applied with Haracoat all-in-one and foliar spray was dead (2.5%). At 6 WAP, another mortality was recorded in seedlings applied with Subete all-in-one and one applied with conventional fertilizer and liquid humus. No additional mortality was observed at 8 WAP. The average percent survival based on fertilizer material was uniform across all treatments. Seedlings applied with conventional fertilizers, Subete, and Haracoat all-in-one all recorded a percent survival of 99%. Furthermore, it was observed that seedlings applied with foliar spray have a percent survival rate of 98% but are not significantly different from 99% without foliar spray. The recorded mortalities were due to root damage but not pathological in nature since all treatments were applied with fungicide and insecticide as commercial practice for leaf disease and aphids' control as Sigatoka and banana bunchy top virus (BBTV) are critical in the nursery.

Figure 1

Percent (%) survival of GCTCV-218 seedlings as affected by different fertilizers with and without foliar spray



Plant Height

Plant height visually indicates seedling growth and development. As a key determinant of maturity and basis for release from the nursery, plant height is a very significant parameter in the commercial aspect of seedling production (Robinson & Galán, 2009). Typically, industry practice entails that 15-20 cm height seedlings are ready for release and field planting. As shown in Table 1, seedlings applied with Haracoat all-in-one fertilizer were observed to have reached the average of 15.50 cm as early as 6 WAP. This could be translated into a saving of input and a higher return on investment. Table 1 further shows a significant difference ($p < .05$) in plant height was observed at 4, 6, 7, and 8 WAP. At 4 WAP, seedlings applied with conventional and Haracoat all-in-one fertilizers were significantly ($p < .05$) taller than those applied with Subete all-in-one. At 6, 7, and 8 WAP, Haracoat all-in-one significantly ($p < .05$) showed the highest plant height. It was also observed that the application of foliar spray significantly affected the plant height of the GCTCV-218 seedlings. At 7 WAP, seedlings applied with foliar spray were significantly taller at 21.86 cm and 26.10 cm at 8 WAP.

Table 1

Plant height of GCTCV-218 seedlings as affected by different fertilizers with and without foliar spray

Factor	Weeks After Planting (WAP)				
	2	4	6	7	8
Fertilizer	ns	*	*	*	*
Conventional	3.22	6.93a	13.32b	21.28b	24.74b
Subete All-in-one	3.24	6.46b	12.34c	20.36b	24.78b
Haracoat All-in-one	3.36	7.27a	14.69a	22.78a	26.81a
Foliar Spray	*	*	*	*	*
without foliar	3.16b	6.65b	13.10b	21.08b	24.80b
with foliar	3.38a	7.12a	13.80a	21.86a	26.10a
Fertilizer x Foliar spray	ns	ns	*	ns	ns
CV (%)	16.20	18.76	16.68	14.00	11.81

Note: * significant at 5% level, *ns* - not significant

Furthermore, an interaction effect ($p < .05$) was observed at 6 WAP as shown in Figure 2. GCTCV-218 seedlings applied with Haracoat all-in-one and at the same time applied with liquid humus foliar spray were significantly taller among the other treatments at 15.50 cm. Interestingly, this height is releasable from the nursery for field planting.

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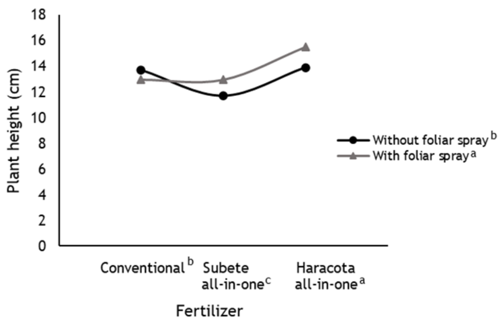
Figure 2

Interaction effect between fertilizers and foliar spray on the plan height of GCTCV-218 seedlings at 6 WAP



Number of Leaves

Naturally, leaves are ideally equally spaced along the pseudostem with wide internodes, not rosette at the top of a bare pseudostem, and a minimum of five healthy green leaves on a plant ready for field planting. It also had a bearing on the photosynthetic activity of the plant and the adaptation to the sudden change in the field's erratic conditions, wherein the better the condition of the leaves, the higher the potential to survive in the field (Robinson & Galan, 2009). Table 2 presents the number of leaves of GCTCV-218 seedlings as affected by different fertilizers with and without foliar spray. The different fertilizer materials showed significant differences ($p < .05$) at 4 and 6 WAP. Seedlings applied with Haracoat all-in-one fertilizer significantly produced the highest number of leaves. In addition, at 6 WAP, seedlings applied with foliar spray significantly ($p < .05$) produced more leaves than those not applied with foliar spray.

Table 2

Number of leaves of GCTCV-218 seedlings as affected by different fertilizers with and without foliar spray

Factor	Weeks After Planting (WAP)			
	2	4	6	8
Fertilizer	ns	*	*	ns
Conventional	2.41	3.08^{ab}	5.17^{b}	6.22
Subete All-in-one	2.41	2.98^{b}	5.18^{b}	6.41
Haracoat All-in-one	2.50	3.21^{a}	5.49^{a}	6.38
Foliar Spray	ns	Ns	*	ns
without foliar	2.48	3.11	5.14^{b}	6.33
with foliar	2.40	3.07	5.41^{a}	6.34
Fertilizer x Foliar spray	ns	ns	ns	ns
CV (%)	20.35	19.29	11.88	11.63

Note: * significant at 5% level, *ns* - not significant
Means with the same letter superscript are not significantly different at 5% level using DMRT

Pseudostem Circumference

Robinson (1999) stated that pseudostem size, referring to its girth or circumference, dictates the capacity of the plant to produce more leaves and eventually influences the size of the bud it will produce. Large buds usually produce a greater number of hands, therefore, a higher box-to-bunch ratio. Table 3 shows the pseudostem circumference of GCTCV-218 seedlings as affected by different fertilizers with or without foliar spray. The result shows a significant difference ($p < .05$) at 4 and 6 WAP. At 6 WAP, seedlings applied with Haracoat all-in-one fertilizer significantly produced the largest pseudostem circumference. At 4 WAP, seedlings applied with foliar spray were significantly different ($p < .05$) from those not applied with foliar spray.

Table 3

Pseudostem circumference of GCTCV-218 seedlings as affected by different fertilizers with and without foliar spray

Factor	Weeks After Planting (WAP)			
	2	4	6	8
Fertilizer				
Conventional	9.99	21.77	48.73[b]	71.56
Subete All-in-one	11.06	22.91	48.86[b]	73.67
Haracoat All-in-one	10.92	23.45	52.87[a]	75.28
Foliar Spray				
without foliar	9.93[b]	21.92[b]	49.85	72.65
with foliar	11.38[a]	23.50[a]	50.45	74.36
Fertilizer x Foliar spray	ns	ns	ns	ns
CV (%)	28.70	21.16	16.50	17.04

Note: * significant at 5% level, *ns* - not significant

Means with the same letter superscript are not significantly different at 5% level using DMRT

Leaf Surface Area

Photosynthetic activity of the plant happens mostly in the leaves. A larger foliar area means more photosynthates to the growing seedling. The first leaves produced from the central meristem of a developing plant are scale leaves, followed by narrow sword leaves and, finally, broader leaves with gradually widening laminae until mature, full-sized leaves are produced within six months. The laminae often appear shredded into strips between veins because it has little resistance to transverse tearing in windy conditions. This is a normal phenomenon and is yield-limiting only if the strips are so thin. Stomata occur on both surfaces, but the abaxial surface density is about three times that of the adaxial surface. Figure 3 shows the leaf surface area of GCTCV seedlings affected by different fertilizers with and without foliar spray. The result revealed a significant difference ($p < 0.05$) in the leaf surface area of GCVTCV-218 seedlings at 8 WAP. Seedlings applied with Haracoat all-in-one exhibited the highest leaf area. The presence of trace elements like magnesium, zinc, and boron in Haracoat all-in-one greatly affects the development of its leaves. Moreover, those applied with foliar spray were significantly higher ($p < 0.05$) than those without the spray.

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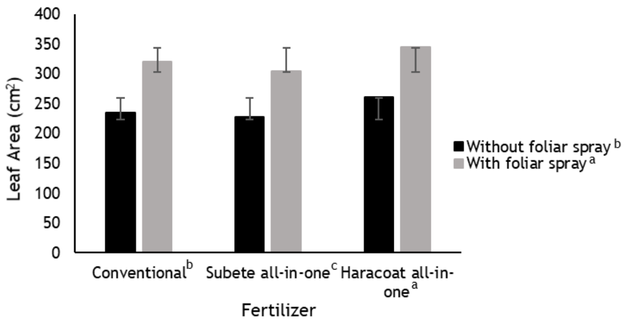
Figure 3

Leaf surface area of GCTCV-218 seedlings at 8 WAP as affected by different fertilizers with and without foliar spray

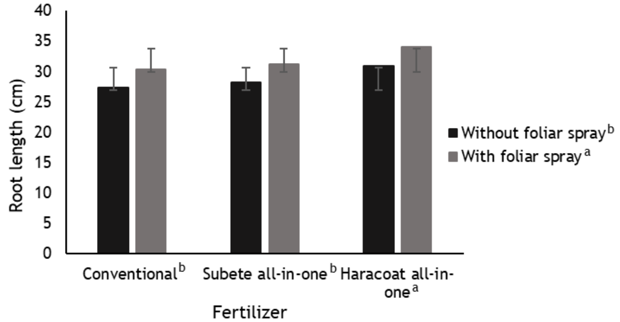


Root Length

As the main organ for water absorption and nutrient uptake, the root system's growth and health are critical to a juvenile plant (Marschner, 2002). In banana plants, the root system is fleshy and adventitious from the beginning. There is no main tap root. Primary roots originate in groups of three or four from the surface of the central cylinder within the rhizome. Both horizontally and vertically, root distribution is strongly influenced by soil type, compaction, and drainage. A good correlation exists between bunch weight and root length and volume (Rapetti & Dorel, 2022). Figure 4 shows the root length of GCTCV-218 seedlings as affected by different fertilizers with or without foliar spray. It shows a significant difference ($p < 0.05$) with the seedlings applied with Haracoat all-in-one and foliar spray. It was observed that most of the seedlings under this treatment have their roots coming out of the seed bags. One of the benefits of foliar spray application is improved root development, which promotes and enhances nutrient uptake (Khaled & Fawy, 2011).

Figure 4

Root length (cm) of GCTCV-218 seedlings at 8 WAP as affected by different fertilizers with and without foliar spray

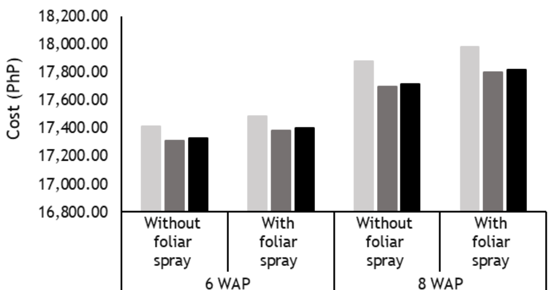


Cost Analysis

Labor and material efficiencies are a major concern in any form of business. Where there are savings in production costs, profitability comes in. Figure 5 shows the costs at 6 and 8 WAP, respectively, per seedling and the total cost on a hectare basis of all treatments considering 1,850 population units per hectare. With or without foliar spray application, both All-in-one fertilizers were lower than conventional ones. However, since desired height is already achieved by seedlings applied with Haracoat all-in-one and foliar spray as early as 6 WAP, it is relatively lower in cost than the rest of the treatments. Further, Figure 5 presents a savings of 31 cents per seedling or equivalent to PHP 580.23 on a hectare basis, which can be made if seedlings are released at 6 WAP using Haracoat all-in-one and foliar spray than at 8 WAP using conventional and foliar spray.

Figure 5

Cost comparison (PhP/ha) of GCTCV-218 seedlings as affected by different fertilizers with and without foliar spray grown until 6 and 8 WAP



	Without foliar spray (6 WAP)	With foliar spray (6 WAP)	Without foliar spray (8 WAP)	With foliar spray (8 WAP)
Conventional	17,412.20	17,487.68	17,880.21	17,980.85
Subete all-in-one	17,309.60	17,385.08	17,695.96	17,796.60
Haracoat all-in-one	17,325.14	17,400.62	17,716.68	17,817.32

Crop Performance Analysis

GCTCV-218 seedlings were observed to have good vigor in the nursery during the experiment. The leaves were green with a reddish-brown maturity stain on the surface. The red pigments on the leaf and leaf stalk margins were very prominent and showed the ideal characteristics of the variety (Tang, 2012). Very low mortality (Figure 1) was recorded since the nursery is well-equipped with an irrigation system and appropriate shading. As the all-in-one fertilizers contain three (3) primary macronutrients for optimum plant growth, the additional magnesium, zinc, and boron gave the seedlings more vigor (e.g., agronomic parameters) than seedlings applied with conventional fertilization. Between Haracoat and Subete all-in-one fertilizers, Haracoat gave superior plant vigor due to the higher content concentration of magnesium and boron. Interestingly, Marschner (2002) has provided the detailed function of these two essential elements in plant physiological response, such as magnesium is a component of chlorophyll, thereby aiding in photosynthesis, while boron dictates cell wall formation and reproductive tissue, thereby having a more prominent improvement of growth for Haracoat in comparison to Subete all-in-one fertilizer.

Seedlings applied with foliar spray exhibited better results compared to seedlings without foliar spray. This confirms the effects of humic acid on plants' growth and development by improving fertilizers' effectiveness, reducing nutrient leaching, enhancing root development, and improving nutrient uptake (Khaled & Fawy, 2011). Overall, using all-in-one fertilizers, particularly Haracoat all-in-one, showed remarkable advantages by reducing labor costs and providing a more efficient fertilization program. This implies the significant potential as a sustainable alternative in the nursery management of GCTCV-218 seedlings.

Conclusion and Recommendation

GCTCV-218 seedlings attained a significant plant height when applying a combination of Haracoat all-in-one fertilizer and foliar spray. Although the pseudostem circumference and number of leaves were not significantly different, leaf surface area and root length were significantly high in the same treatment. Cost analysis also revealed a positive return when using Haracoat all-in-one and foliar spray. At 6 WAP, the desired height for planting is already attained (15-20 cm), thereby cutting the cost of labor and materials for the remaining weeks spent on other treatments. Although it was observed that minimal profit and price risk susceptibility are associated with Haracoat all-in-one fertilizer, higher savings could be obtained if we value the time saved due to faster growth, leading to early disposal of seedlings.

It is concluded and recommended that a fertilization program with positive return can be attained when Haracoat all-in-one fertilizer and foliar spray are applied in GCTCV-218 seedlings under nursery conditions. Further studies on using the same fertilizer can be conducted under different nursery stress conditions. To save on costs further, studying different frequencies of application under nursery conditions can also be conducted.

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