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Effect of Foliar Fertiliser on Banana

Noor Asma' Mohd Anuar Mushoddad*, Nurul Syaza Abdul Latif and Suhaimi Othman@Osman

Faculty of AgroBased Industry, Universiti Malaysia Kelantan, 17600 Jeli, Kelantan, Malaysia

ABSTRACT

An experiment was conducted at Bukit Perawas Ayer Lanas, Jeli Kelantan from December 2014 to April 2015 to study the effect of different rates of foliar fertiliser at vegetative stage for banana cultivation. Four levels of foliar fertiliser (0 ml L^{-1} [control], 1 ml L^{-1}, 2 ml L^{-1} and 3 ml L^{-1}) were applied monthly throughout the experimental period. Inorganic foliar fertiliser formulation HI-NK™, a product of ACM Sdn. Bhd, was used. It consisted of 16:8:16 of NPK and a few trace elements Fe, Mn, Mo, Cu, Zn, B and Mo. Data on growth parameters such as pseudostem height, pseudostem girth and leaf area were recorded for the first 16 weeks of planting. A logistic growth model was used to predict the response of the banana plant to foliar fertiliser (from the 16th week to the 24th week of planting). The highest vegetative growth (pseudostem height, pseudostem girth and leaf area) was yielded by the treatment that used foliar fertiliser was applied at 1 ml L^{-1}. The earliest results of plant growth response for treatment A, B and C could be seen in the second week of planting. The treatments followed the logistic growth curve in R^2 ranging from 0.92 to 0.96. The pseudostem height, pseudostem girth and leaf area of the banana plants applied with 1 ml L^{-1} at the 16th week of planting were 59.87 cm, 20.53 cm and 1718.28 cm^2, respectively. The prediction showed the maximum pseudostem height, pseudostem girth and leaf area at the 24th week of planting at the rate of 1 ml L^{-1} were 59.3 cm, 19.91 cm and 1785.17 cm^2, respectively.

Keywords: Banana, foliar fertiliser, logistic growth

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E-mail addresses:
noorasma0123@gmail.com (Noor Asma' Mohd Anuar Mushoddad)
syaza@umk.edu.my (Nurul Syaza Abdul Latif)
suhaimi.o@umk.edu.my (Suhaimi Othman@Osman)
* Corresponding author

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INTRODUCTION

The agricultural sector in Malaysia contributed significantly to the economic development of the country as the major source of income, employment and foreign exchange at one time. Relatively high levels of fertiliser are required to ensure achievable yield and quality of cultivated crops. During the growing seasons, crops absorb various amounts of nutrients. Nutrient uptake is influenced by soil, climate and plant factors. Conventionally, granular fertilisers are used to grow the crops and maintain soil fertility status. However, inorganic fertilisers are produced using non-renewable resources that may deplete over time. Recently, foliar fertilisers have been used to correct micronutrient deficiencies in plants (Christensen, 2005). Foliar fertilisers can be an appropriate alternative to reduce the usage of inorganic granular fertilisers. During vegetative growth, plants require well-balanced nutrition in order to achieve high yields and quality. Optimum rates of foliar fertiliser application are important for the banana plant to receive sufficient nutrients for their growth and to prevent environmental pollution (Naheret al., 2011). Foliar fertilisers can supply macronutrients, which can be absorbed by the plant through the leaves but under several conditions. The conditions are: foliar fertiliser should be applied several times, there should be sufficient leaf area for major absorption and there must be correct nutrient concentration. Several studies have looked into macronutrients for foliar fertiliser application. Therefore, the author preferred to test the effects of applying macronutrients on banana plants that have a larger leaf area compared with other plants as such leaves have a high nutrient demand (Fageria et al., 2009).

Banana and plantain represent the largest fruit crop produced in the world and are known as a heavy feeder crop. They require large amounts of mineral nutrients to maintain high yields in commercial plantations. Intensive use of inorganic fertilisers is essential to supply sufficient nutrients to the plants, especially in areas with the problem of nutrient deficiency. The market price for inorganic granular fertilisers is high and its continuous usage can cause environmental pollution. There is a need for alternative fertiliser sources. Kumar and Kumar (2007) reported that spraying foliar fertiliser at the reproductive stage of the banana would increase the number of leaves having high chlorophyll content and improve fruit bunch weight. Foliar fertiliser application at the vegetative stage (before the reproductive stage) may lead to better growth performance of banana and higher quality of the fruit produced.

The prediction of plant growth is important in fertiliser application decision-making (Wardhani & Kusumastuti, 2013). In this study, the logistic growth model was used to predict the response in banana plant growth as a result of the different rates of foliar fertiliser application. The model was used as a tool for developing foliar fertiliser application decision-making. Based on the prediction, growers can plan the time when the foliar fertiliser must be applied or track the existence of any unfavourable condition that they can treat instantly to have healthier banana plants.

METHODS

Experiment Design

The experiment was conducted at post-nursery stage in a banana plantation, Bukit Perawas, Ayer Lanas, Jeli, Kelantan from December 2014 to April 2015. Banana (*Musa acuminata* cv. Berangan) seedlings originated from banana corn seedlings were planted on 16 December, 2014 at the post-nursery plot. The experiment was laid out in a randomised block design replicated three times. Inorganic foliar fertiliser HI-NK™, a product of Agrichem (Sdn. Bhd), in liquid form was used. The N:P:K ratio was 16:8:16 and a few of the trace elements were Fe, Mn, Mo, Cu, Zn, B and Mo. The foliar fertiliser was diluted in water before it was sprayed on the banana plants. The four levels of foliar fertilisers were: A (1 ml L^{-1}), B (2 ml L^{-1}), C (3 ml L^{-1}) and D (0 ml L^{-1}, control). These fertilisers were applied monthly using an electric power sprayer early in the morning.

Data Collection

Data were collected weekly for 16 weeks of the vegetative stage. Non-destructive parameters measured were leaf area, pseudostem height and pseudostem girth. Banana leaf area (LA) was determined from length (L) and width (W) of the lamina according to the formula (Al-Harthi & Al-Yahyai, 2009):

$$LA = 0.83 \times L \times W \qquad [1]$$

Statistical Analysis

The analysis of variance (ANOVA) for pseudostem height, pseudostem girth and leaf area was performed following the F test. When F was significant at the $p<0.05$ level, treatment means were separated using Tukey's test. Data were analysed following standard procedures using the SPSS software (version 21.0). Computation and preparation of graphs were done using the Microsoft Excel 2007 Programme.

The logistic growth model was used for model development (Wardhani & Kusumastuti, 2013):

$$y = \frac{K}{1 + Ae^{-rt}} \qquad [2]$$

where the parameter values were described as:

y=Vegetative growth (pseudostem height [cm], pseudostem girth [cm] and leaf area [cm^2] at time, t

t=Time (week)

K=Carrying capacity (cm)

A=Constant

r=Growth rate (cm w^{-1})

This model was derived from the logistic growth equation. The logistic growth model was used to predict the growth of corns and this model was found to fit better in describing the growth of corns compared to the Gompertz model (Wardhani & Kusumastuti, 2013). The logistic growth model has varied congruence for explaining the growth pattern for many species of animals and plants (Shi et al., 2013). The structure of this equation is simple and the parameters have clear biological meanings. The exponential curve of this model provides an adequate approximation to the growth for the initial period of plants' growth. The experimental data and the parameters of this model are theoretically described using curve fitting.

RESULTS AND DISCUSSION

Effect of Foliar Fertiliser on Growth Parameters of Banana

Table 1 shows the banana pseudostem height, pseudostem girth and leaf area at the 16th week of planting. The pseudostem height ranged from 19.53 to 59.87 cm, with the highest height in A (1 ml L^{-1}) and the lowest in the control. The pseudostem girth at the 16th week of planting ranged from 9.67 to 20.53 cm. At this interval, the pseudostem girth in treatment A was once again significantly higher ($p<0.05$) than in the control. A also showed higher girth values compared with B (2 ml L^{-1}) and C (3 ml L^{-1}).The leaf area ranged from 1718.28 to 336.05 cm^2. The results indicated that the leaf area of treatment A and B (2 ml L^{-1}) were significantly higher ($p<0.05$) than in the control, with the value of 1718.28, 1434.60 and 336.05cm^2, respectively.

Table 1
Effect of foliar fertiliser application on banana pseudostem height, pseudostem girth and leaf area

Treatment	A	B	C	Control
Pseudostem Height (cm)	59.87±29.5^{b}	50.67±35.2^{b}	37.73±24.85^{ab}	19.53±12.5^{a}
Pseudostem Girth (cm)	20.53±10.04^{b}	17.53±11.32^{ab}	14.00±8.64^{ab}	9.67±4.29^{a}
Leaf Area (cm^2)	1718.28± 1243.8^{b}	1434.60± 1497.21^{b}	842.05± 879.94^{ab}	336.05± 345.43^{a}

Note. Mean ± standard deviation, values in the same row with different letters indicate significant difference ($p<0.05$) by Tukey.

Fitting Models

The model of pseudostem height, pseudostem girth and leaf area follows the logistic equation curve and perfectly fit with the experimental data, with R^2 ranging from 0.90 to 0.98. Using this model, the vegetative growth of banana plants after the 16th week of planting can be estimated. For this purpose, the time of simulation was extended to the 24th week (early reproductive stage) of planting. The prediction showed that the banana plants treated with 1 ml fertiliser L^{-1} of water recorded the highest pseudostem height, pseudodstem girth and leaf area at the 24th week of planting, which were 59.30 cm, 19.91 cm and 1785.17 cm^2, respectively. It was indicated that 1 ml L^{-1} was the best rate of foliar fertiliser application for banana plants. This indication was similar to the findings using ANOVA analysis as shown in Table 1.

The data proved that the prediction method and the usage of regression analysis tools were able to track and predict plant growth and enable quicker realisation of any factors that may inhibit plant growth such as weather, fertilisers and pests. In this study, the growth of banana predicted was lower than the optimum growth that ought to have been achieved during the reproductive stage of banana plants. As a general rule, the optimum height of the banana pseudostem at the reproductive stage is 2 m, while girth is 1 m and leaf area is 25 m^2 (Robinson & Sauco, 2010).

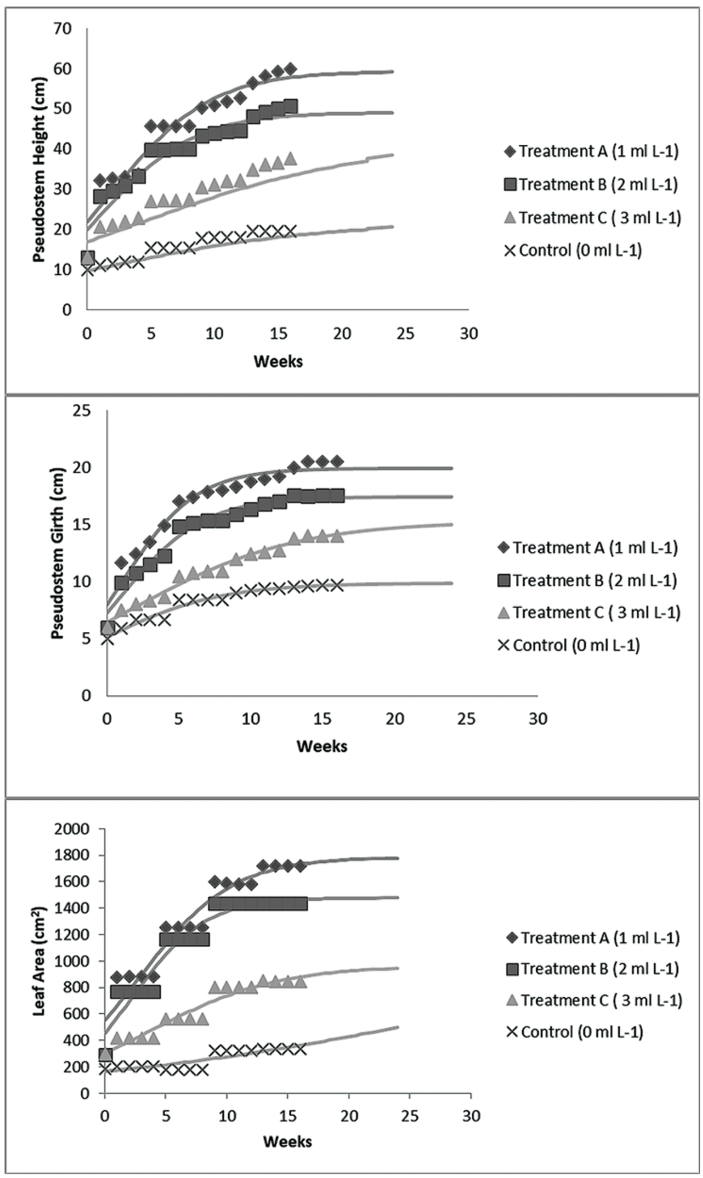

Figure 1. Pseudostem height, pseudostem girth and leaf area of the banana plant at different weeks after planting as influenced by different treatments (increase per five weeks)

According to Figure 1, treatment A (1 ml L^{-1}) presented faster growth performance starting from the first foliar fertiliser application than the other treatments. The earliest result of plant growth response for treatment A, B and C were seen in the second week of planting i.e. one week after the first foliar fertiliser application. However, the growth performance pattern decreased from the eighth week to the 16th week of planting. Plant growth rates depend on environmental factors. During the eighth to the 16^{th} week of planting, the average monthly temperature was 26-28˚C. During this period, very little rain fell i.e. between 0 and 50 mm per month. The banana plants, therefore, underwent water stress, which inhibited growth.

Drought causes excess excitation energy at the chloroplast level and reduces photosynthesis capacity and thus, modifies plant growth. The impact of this is seen in reduced leaf area and altered biomass resulting in a slow growth rate (Zewdieet al., 2007). Knowing the proper rate of foliar fertiliser to apply is very important at early vegetative stages of the banana plant because the plant requires a sufficient amount of nutrients for its growth and the production of fruit i.e. resulting in higher yields. High yield in crop production refers to the quality and quantity of the harvests (Passam et al., 2007).

CONCLUSION

Based on the results, 1 ml L^{-1} showed the optimum dose of foliar fertiliser application and this can be recommended for the vegetative growth of banana with a single application per month complemented with adequate moisture availability through watering. Usage of foliar fertiliser can reduce the cost of chemical fertiliser application to the soil for banana cultivation. Foliar fertiliser application is required in a small amount and involves minimum labour costs as it can be applied using a machine (power spray) for one time of application. Foliar fertiliser application can also be mixed with insecticides and fungicides at the same time. Therefore, the time and cost of labour can be minimised. Mathematical modelling predicted that vegetative growth parameters for the banana plant that had foliar fertiliser applied at 1 ml L^{-1} would be significantly higher than for the plants that had other rates of foliar fertiliser applied. As shown in the results, the effect of using foliar fertiliser was a growth spurt at just the first five weeks after fertiliser application, and this slowly decreased in the following weeks. The decreasing pattern in growth occurred starting from the eighth week to the 16th week of planting. This condition was related to the low rainfall received. Planters also need to be concerned about weather conditions when they plan to start banana planting.

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