United International Journal for Research & Technology
Volume 05, Issue 03, 2023 | Open Access | ISSN: 2582-6832

The Effective Microorganism (EM) Responses On Banana Seedlings Performance

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***Abstract*—** The study was started to look into the influence of varying rates of EM on the growing performance of banana seedlings. This experiment was carried out at the Net House Mardi Klang in Selangor. Berangan of the banana kind were used when they were one month old. GENKiMO-1 was used as an EM on 1-month-old banana seedlings that were diluted by adding distilled water in the ratios of T1 (control), T2 (1:350), T3 (1:700), T4 (1:1050), and T5 (1:1400) every week for 5 weeks. The plant's diameter and perimeter, stem height, plant height, number of leaves, number of roots, root length, and root weight were all measured. The results also demonstrated the great effect of plants grown at various EM speeds. T1 represents the most crucial reading of the banana seedling's growth characteristics. T5 indicates the most important reading of the physiological data obtained. Further field assessments are required to evaluate the robust link effect on EM rates and kinds at the field stage with NPK supplies in generating banana planted growth and yield.

***Keywords*—** Effective microorganism, Growth, Physiology, Banana seedling, Genkimo-1

1. INTRODUCTION

Effective microorganisms (EM) are a broad class of microorganisms that include lactic acid bacteria, photosynthetic bacteria, actinomycetes, fermenting fungi, and yeast. When applied to field crops, EM is considered environmentally beneficial since it provides a variety of benefits. Effective microorganisms are mixed cultures of naturally occurring beneficial organisms that may be employed as inoculants to increase the microbial diversity of the soil environment. Under greenhouse circumstances, in vitro and ex vitro inoculation with bacterial inoculum combinations successfully improve the development characteristics of tissue culture banana plantlets (Mon et al., 2021).

Microbes are very small units of life that exist everywhere in nature and play an important role in maintaining ecological balance. By enhancing plant tolerance to biotic and abiotic challenges and encouraging growth, probiotic endophytes can improve banana output and sustainability (Beltran et al., 2021). EMS-induced banana mutation using the micro-cross-section culture system has the potential to be effective for banana improvement (Chen et al., 2013).

Plant growth promoter (PGP) can be employed as a bioenhancer and biofertilizer for sustainable banana production; however, large field studies with bananas inoculated with PGPR strains need to be carried out in order to obtain consistent and exact findings (Mia et al. 2010). Banana rhizospheric bacterial isolates contain plant growth-enhancing features and can be used as biofertilizers in agriculture to increase banana growth and production (Gechemba et al., 2016). Biohardened micropropagated banana plantlets with endophytic B. Subtilis induce systemic resistance to pathogens and might thus be exploited as possible biological control agents for rhizome rot disease in tissue culture banana cv (Rajamanickam et al., 2018).

A healthy soil ecology may protect plants against soil-borne diseases caused by pathogenic bacteria and parasites. Identification and control of bacterial contaminants in banana in vitro cultures were performed, and treatment with certain antibiotics eliminated the bacteria but also resulted in a reduction in shoot multiplication and growth, ultimately contributing to minimising losses in commercial micropropagation of banana (El-Banna et al., 2021). The objectives of the study were to examine the effect of different rates of EM on the growth performance of banana seedlings.

2. METHODOLOGY

This experiment took place at the Net House Mardi Klang in Selangor. Berangan of the banana variety were employed in a totally randomised design at a spacing of 30 cm between seedlings at the age of one month. 'GENKiMO-1' was used as an EM on 1-month-old banana plant seedlings procured from a tissue culture facility in this investigation. Every week, the EM stock concentration was diluted by adding distilled water in the following ratios: T1 (control), T2 (1:350), T3 (1:700), T4 (1:1050), and T5 (1:1400).

The diluted EM concentration was cultured anaerobically at room temperature for two days before being sprayed on the plant's soil surface. The EM treatment is administered once a week for five weeks. The trial used a completely randomised design with two replicates and five treatments, one of which was a control.

There are five plants in each treatment. The plants were placed under natural light and temperature conditions. The plants were watered using tap water. Using a calliper and measuring tape, the diameter and perimeter of the plant's stem were measured.

A steel ruler was used to measure the stem height from the base to the tip of the lowest frond. A steel ruler was also used to measure the plant height from the base to the tip of the shoot. The number of leaves and roots on each plant was counted and documented.

Each plant's root length and weight were measured with a measuring tape and digital scale. To find significant changes between the parameters gathered with two replications, analysis of variance tests was used.

The Duncan test (P 0.05) was used to compare the means of the measured variables using the appropriate ANOVA technique (SAS Institute 1989).

3 RESULTS AND DISCUSSION

ANOVA analysis of parameters

According to the ANOVA analysis, treatments had a significant impact on plant height and stem perimeters (Table 1). The therapies had no meaningful effect on the remaining metrics. The therapy, on the other hand, had no discernible effect on stem diameter, stem height, leaf number, or root number. It can be concluded that the EM used did not contribute to the difference between treatments in terms of root length and weight.

Effect of EM on plants height

Treatments had a considerable impact on plant height. Nonetheless, T1 had the greatest significant value, followed by T5, and T3 had the lowest significant reading (Figure 1).

The dilution ratio impacts the plant's efficiency as a plant growth regulator, with the lower thickness of dilution promoting greater development of banana plants at T1 and T5.

The application of arbuscular mycorrhizal fungus and plant growth-promoting rhizobacteria together has a significant advantage for banana plants and should be considered during the acclimatisation stage of micropropagated bananas (Rodrguez et al., 2005).

Table 1: *Mean square ANOVA effects of treatments on evaluated parameters.*

Sources of variance	**Parameter**							
	Plant height (cm)	Stem diameter (cm)	Stem perimeter (cm)	Stem height (cm)	Leaf number	Root weight (cm)	Root number (cm)	Root length (cm)
Treatments	21.84*	0.0016	0.19*	4.51	0.15	0.28	0.02	1.13
Replications	6.53	0.0067	0.04	1.44	0.04	0.05	0.06	0.78
Grand mean	22.49	0.53	2.90	9.58	5.14	2.39	5.84	32.50
C.V. (%)	6.75	9.87	5.10	8.90	5.70	14.47	6.45	10.13

Mean followed by * indicate significant different at 0.05
Mean followed by ** indicate significant different at 0.01

Effect of EM on stems perimeter of plants

Treatments had a considerable impact on the stem perimeter. Nonetheless, T1 had the greatest significant value, followed by T5, and T3 had the lowest significant reading (Figure 2).

Regardless, there is a substantial effect of the EM applied at a lower dilution ratio between the EM concentration and distilled water, which promotes plant vegetative growth.

Tissue-cultured bananas can benefit from the treatment of arbuscular mycorrhizal fungi such as Trichoderma and Bacillus to boost survival and development in the nursery phase as well as plant performance in the field (Mwangi et al., 2013).

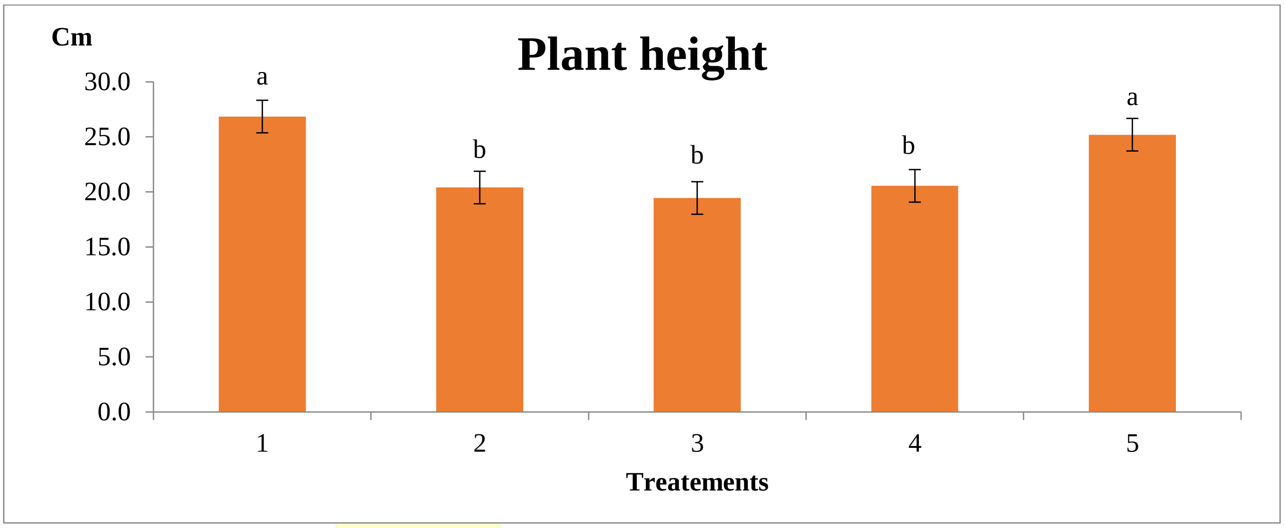

Figure 1: *The effect of EM treatments to plant height. Mean value with the same letter for each treatment are significantly different at P < 0.05*

Effect of EM on stem height and diameter of plant

The plant's stem height was evaluated in order to validate the effects of the administered EM (Table 2). It demonstrates that T1 signals the most important reading in relation to other treatments, followed by T5, and that T3 has the least impact on stem. Treatments had a substantial effect on stem diameter in the same manner. T1 regrettably has the lowest value; however, EM on T1 recorded the greatest meaningful reading, followed by T5. (Table 2). The development and performance of banana tissue cultures are greatly enhanced by the combined use of microbiological products and both organic and inorganic fertilisers (Kavoo et al., 2014).

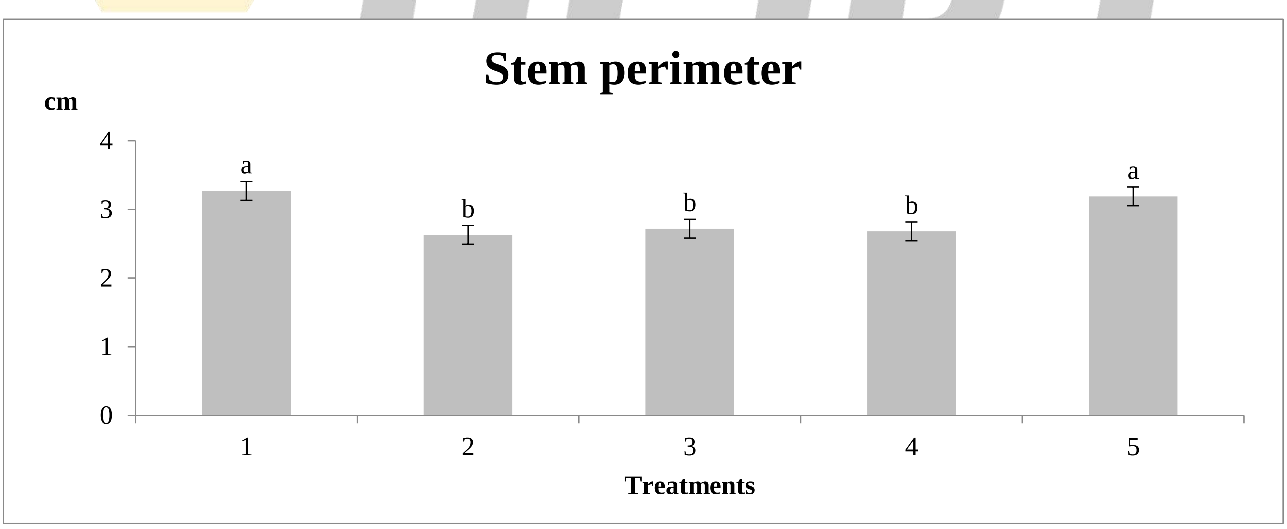

Figure 2: *The effect of EM treatments to stem perimeter. Mean value with the same letter for each treatment are significantly different at P < 0.05*

Table 2: *The effect of EM to stem height, leaf number and stem diameter*

Treatment	Stem height(cm)	Leaf number	Stem diameter (inch)
T1	11.40a	5.40a	0.65a
T2	8.50b	4.90b	0.48b
T3	8.05b	5.30a	0.47b
T4	9.00b	4.80b	0.48b
T5	10.95a	5.30a	0.63a

The effect of EM to root weight, number and length

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A similar pattern in which a substantial influence was established may be seen in the root weight (Table 3). T5 had the largest weight of roots, followed by T1, and T3 had the smallest weight of roots. The relevant reading of the root number parameters is likewise displayed in Table 3 according to a similar pattern. T5 had the largest weight of roots, followed by T1, and T2 had the lowest weight of roots. Regretfully, T2 displays the smallest root reading, even though T1 has the longest root. It was shown that EM enhanced the banana's physiological performance in metrics that were highly correlated with the plant's vigour. The findings showed that the administration of EM helped banana seedlings' roots develop more widely. Co-culturing Piriformospora indica with tissue-cultured banana seedlings has the potential to improve the development and quality of tissue-cultured banana plants, as evidenced by its ability to decrease rooting times and increase plant biomass (Li et al., 2019). By greatly boosting plant height, number of leaves, vegetative and radical weight, number and weight of new shoots, and leaf area, the employment of efficient microorganisms can enhance quality and growth (Domenico, 2019).

Correlation analysis between parameters collected

Table 4 presents the results, which indicate a strong positive correlation (r = 0.96, 0.93, 0.97, and 0.74, p <0.01) between plant height and stem diameter, stem perimeter, stem height, and root length fronds. To this end, stem diameter positively correlates significantly with stem height, stem perimeter, number of leaves, root weight, and root length (r = 0.98, 0.98, 0.68, 0.74, and 0.72, p <0.01). Positive correlations between root width and root numbers (r = 0.85, p <0.01) are achieved for additional parameters. In conclusion, practically every parameter gathered shows a strong correlation with one another.

CONCLUSIONS

The growth of banana seedlings was shown to be significantly correlated with EM (Genkimo-1) as per the data collected from all the parameters. The great impact of plants cultivated at various EM dilution rates per plant (control, 1:350, 1:700, T4 1:1050, and 1:1400) was also demonstrated by the data. The most notable effects of the treatments are shown in the plant's height and stem circumference.

T1 represents the most important reading for nearly all of the growth data that were gathered, including plant diameter, plant perimeter, stem height, plant height, and leaf count. In the meantime, T5 had the most notable impact on the plant physiology metrics, including the quantity, length, and weight of roots. When distilled water and EM concentrations were diluted to the ideal ratio, banana seedling development was enhanced by EM.

The information from the Genkimo-1 study for glasshouse and in-field stages of banana seedlings, particularly in Malaysia, is limited, which adds to the study's weaknesses. Few studies have compared the effects of EM on the performance of banana seedlings at the nursery and field levels at different stages.

Table 3: *The effect of EM to root weight, number and length*

Treatment	Root weight (gm)	Root number	Root length (cm)
T1	3.19a	6.10a	40.73a
T2	1.19c	5.10b	21.70c
T3	1.65c	5.60b	30.88b
T4	2.03b	5.90b	29.04b
T5	3.93a	6.50a	40.15a

Mean value with the same letter for each treatment are significantly different at P < 0.05

Table 4: *Correlation analysis between parameters collected of banana seedlings*

	Plant height	Stem diameter	Stem perimeter	Stem height	Leafs Number	Root weight	Root number	Root length
Plant height	1	0.96	0.93	0.97	0.64	0.67	0.31	0.74
		**	**	**	*	*	ns	**
Stem diameter		1	0.98	0.98	0.68	0.74	0.39	0.72
			**	**	**	**	ns	**
			1	0.95	0.68	0.79	0.44	0.75

Stem perimeter				**	*	**	ns	*
Stem height				1	0.58 ns	0.74 **	0.43 ns	0.71 **
Leafs Number					1	0.43 ns	0.18 ns	0.59 ns
Root weight						1	0.85 **	0.65 *
Root number							1	0.39 ns
Root length								1

Note: mean followed by * indicate significant different at 0.05
mean followed by ** indicate significant different at 0.01

ACKNOWLEDGEMENT

The authors are grateful to the Malaysian Agriculture Research & Development Institute (MARDI) for providing the project fund. The authors were also grateful to all the supporting staff of MARDI Klang management team especially for Mrs. Noor Amy Edayu Mat Jaafar and Mis Shubathra Arumugam for assisting in experimental site preparation, data collection, and logistic accommodation.

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