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SHORT COMMUNICATION

A PRELIMINARY STUDY ON EVALUATION OF THE EFFECTIVENESS OF FERTIGATION THROUGH DRIP AND SPRINKLER SYSTEMS FOR MATURE COCOA CULTIVATION

Hanif Fahmi, M. Z.*, Jenrry, S. and Azizul Rahman, S.
Malaysian Cocoa Board, Cocoa Research and Development Centre Madai Baturong, KM25, Tingkayu Road, WDT 175 Madai Baturong, 91207
Kunak, Sabah.
**Corresponding author: hanif@koko.gov.my*

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ABSTRACT – *This paper presents an evaluation of the effectiveness of fertigation towards mature cocoa cultivation in CRDC Madai involving the implementation of a fertigation system using drip and sprinkler irrigation for cocoa plants (Theobroma cacao). Objectives of the research are to determine the best irrigation system which can be applied for farmers based on the pod collection analysis results obtained from the experiment. Fertigation, the simultaneous application of water and fertilizers through an irrigation system, has gained attention as an efficient method to enhance nutrient uptake and water efficiency in various crops.. In addition, plant nutrients supplied using dilute AB fertilizer shows the best result in producing high yield instead of granule fertilizer. Besides that, initial soil sampling shows that the soils are acidic with pH value of 4 and 5 compare to optimum pH value for productive soil of 6.5 and 7. Thus, results from these preliminary studies shows potential irrigation systems that are most suitable for cocoa cultivation are sprinkler systems with the highest pod collected during throughout the experiment compare to drip irrigation system although the initial cost of RM 10, 000 are high for farmers but worth every penny invested to the systems with future yield expected and reducing the load for farmers during fertilizing season.*

Keywords: Fertigation, drip, sprinkler, irrigation systems, mature cocoa cultivation

INTRODUCTION

Fertigation is an efficient method of nutrient application in which fertilizers are injected through an irrigation system. With promising results that suggest its ability to dramatically improve water- and nutrient-use efficiency, fertigation technology is gaining in popularity across the world (Thompson *et al*., 2018).

Water is very important for growing crops. There are several methods used for watering plants, each method has different advantages and disadvantages. Determining a plant watering system to suit the needs of users was difficult because there were several factors that must be considered together. Watering system that prevalence is currently such as drip, micro sprinkler, and spray (Shukla *et al*., 2018). Results from each model were appropriate to varies depending on the type of the crop, cultivation, environment, investment, and the amount of water plants need.

Drip irrigation systems is done focusing on roots of plants. Besides that, for minimizing the cost of irrigation and fertilizers, the adoption of drip irrigation with fertigation is essential which can maximizes nutrient uptake while using the minimum amount of water and fertilizer (Roma & Arun, 2014). Roots grow in a rhythmic pattern like that of leaf flushes. Fertilizing and irrigating crops through fertigation increases water and N-use efficiency (Ashrafi *et al*., 2020). Because nutrients are supplied through irrigation water, they are already in soluble forms available for plant uptake (Shirgure, 2013).

Sprinkler irrigation is a method of applying irrigation water that is similar to natural rainfall. Water is distributed through a system of pipes, usually by pumping, and then sprayed into the air through sprinklers so that it breaks up into small water drops. The pump supply system, sprinklers, and operating conditions must be designed to enable a uniform application of water (Mizyed & Kruse, 2008).

Applying nutrients using water has been shown to result in greater crop growth and yield in both fruit and vegetable crops when compared to traditional soil application methods of fertilizer (Sravani *et al*., 2020; Mohammad 2004). Fertigation not only supplies nutrients precisely towards the roots of plant and timely according to the irrigation schedule, but also provides monetary gain and ecological safety by avoiding

pollution of ground water resources (Patel & Rajput, 2000).

This research study aims to evaluate the approach to drip and sprinkler irrigation for cocoa cultivation to select the best systems for pod production to produce high yield, determining cost effectives systems for cocoa cultivation and determine whether the systems able to reduce load carrying fertilizer during fertilizing when using dilute fertilizer. At the end of the experiment supposedly the application of the irrigation systems can lead to better yield produced from pod collected and time taken for farmers to fertilizing their cocoa trees. This research also included the initial soil sampling for assessment of the soil condition before the application of the irrigation systems.

MATERIALS AND METHODS

This study consisted two fertigation systems of drip and sprinkler type with four repetitions and four treatments in total as shown in Figure 1. The treatment are T1—Drip + Granular Fertilizer, T2—Sprinkler + Granular Fertilizer, T3—Drip + Dilute AB Fertilizer, T4— Sprinkler + Dilute AB Fertilizer with controlled treatment (C). The controlled treatment was maintained with standard cultural-practiced adopted by CRDC Madai cocoa growing method. Each treatment consisted of 64 cocoa trees planted on 3m x 3m planting distances as shown in Figure 2 bordered using 2 rows of cocoa trees in between with 6m distance for each border as shown in Figure 1. Design layout of the research using RCBD design.

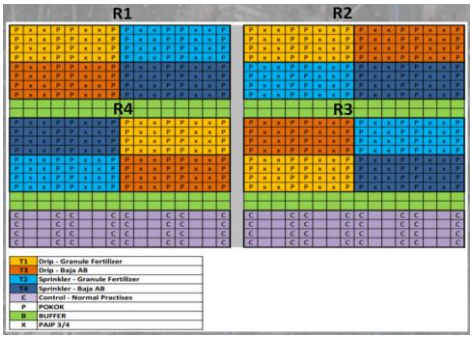

Figure 1: Layout plan for research treatment

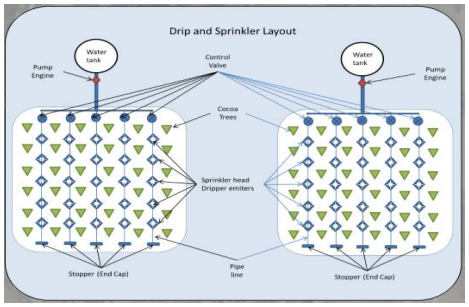

Figure 2: Layout for Drip and Sprinkler systems position in between cocoa trees

For T1, T2, T3 and T4, the plants were irrigated two times per day, every day before 9am and after 3pm for 10 minutes in each session with estimated 20 liters of water given each day. For T1 and T2, each treatment were given 500 grams of granular fertilizer per trees 3 times annually follows the conventional method, C. As for T3 and T4, dilute AB fertilizer will be applied for 5 days a week and another two days with plain water only to leach out the chemical content from AB fertilizer application to avoid nutrient lock on the roots (Patel and Rajput, 2000) of cocoa trees. The application of dilute AB fertilizer will depends on the amount of rainy days in CRDC Madai because the concentration of dilute AB fertilizer should be increase on continuous rainy days.

The installation for the systems needs tank and water pump housing platform with dimension 2m x 4 m as shown in Figure 3, 3 unit water tanks placed on the platform with 2 tanks of 450 gallons and 1 tank with 200 gallons and connected to 2HP water pump to facilitate faster water distribution during fertigation through main pipe, line of dripper and sprinkler emitters that placed in between of the cocoa trees.

Figure 3: Tanks and water pump platform

For initial soil sampling, 8 soil samples collected randomly from the each R1, R2, R3 and R4 area using an auger to assess the soil condition of the research area. The sampling collected at the depth of 0-15m and 15-30m for soil moisture, nutrient content and soil texture of the research area. Another soil sampling will be taken in August 2024 to evaluate any differences from the initial soil sampling.

Evaluation of the effectiveness between the two irrigation systems measured from the crop productivity of cocoa trees using pod counting analysis. The pod collected from 6 trees selected randomly from each treatment 2 times each month. The first pod collected taken after 3 months after research treatment applied.

RESULTS AND DISCUSSIONS

Table 1: Initial soil sampling data

TREATMENTS	DEPTH (cm)	MOISTURE CONTENT (%)	SOIL TEXTURE	SOIL pH	ORGANIC MATTER (%)	SULFUR (%)	TOTAL PHOSPORUS (meq/100g)
T1	0 - 15	21.75	SANDY CLAY	4.44	4.60	0.86	0.06
	15 - 30	20.29	SANDY CLAY	4.77	3.59	0.19	0.03
T2	0 - 15	23.59	SANDY CLAY	4.80	4.70	0.11	0.13
	15 - 30	21.11	SANDY CLAY	4.69	3.55	0.09	0.03
T3	0 - 15	22.80	SANDY CLAY	4.83	5.35	0.07	0.02
	15 - 30	18.68	SANDY CLAY	4.81	4.14	0.07	0.08
T4	0 - 15	22.34	SANDY CLAY LOAM	5.04	4.93	0.06	0.03
	15 - 30	20.32	SANDY CLAY	4.99	3.67	0.05	0.02

The initial soil sampling results in Table 1 shows that the moisture content are within the acceptable values of 20% which suitable for the cocoa cultivation and plant growth. Besides that, the pH value are in range of 4 and 5 which are acidic and not the favorable condition for cocoa cultivation as the best pH value for soil for cocoa cultivation are between 6.5 to 7 pH value. So the liming can reduce the acidity of the soil for better soil condition to ensure the cocoa trees grow well. The organic matter content of the soil are in between 3.5 to 5.4 percent, this value in range of productive agriculture soils its plays very important roles in soil productivity for cocoa trees growth.

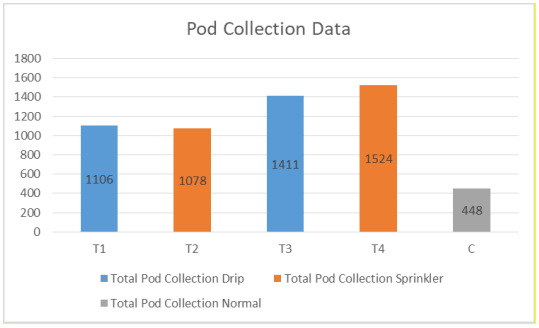

Figure 4: Data for total pod collection

The pod collection for cocoa trees with irrigation systems shows significant difference compare to controlled coca trees as shown in the Figure 4 above. This shows that the application of the irrigation systems affect directly towards the pod production of cocoa trees compare to the normal practices in mature cocoa cultivation. The figure indicates that the total pod produce from sprinkler system (T2 and T4) on cocoa trees are 2602 pods and for drip systems (T1 and T3) producing 2517 pods, this shows that there are no significant difference between the two systems for producing yields but from this experiment it shows that best systems that contributing for yield are sprinkler systems because of the 85 pod different collection.

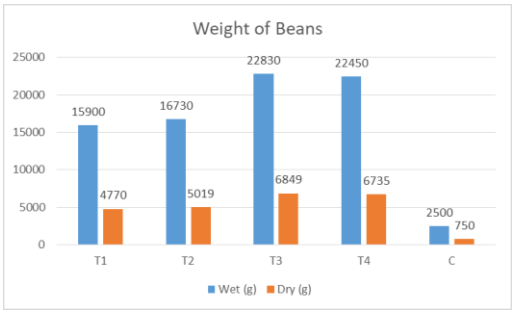

Figure 5: Comparison data of wet and dry beans weight (g)

Meanwhile, the Figure 5 shows that T3 has the highest wet beans weight follows by T4, T2, T1 and C. The figure also shows that application of dilute fertilizer gives better yield as compare to granular fertilizer because yields from T3 and T4 higher than both from T1 and T2 although has given the same amount of water distributed for cocoa trees except for C. While for the C, the total weight of wet beans are very low compare to others with irrigation systems. The wet beans weight can be affected from other factor such as the trees clone itself because different clone of cocoa trees are involves in this research.

Water resources for the agriculture sector may become scarce in the future. Therefore, it is important to develop innovative and applicable technologies in utilizing irrigation water more effectively and efficiently. Through fertigation amount of water that require for each cocoa trees can be controlled at 20L/day and this volume shows significant different for pod production when comparing T1 and C from the Figure 4 above. Maintaining soil moisture implies that more water is stored in the soil, and it can be utilized by plants more optimally for pod production.

Although this systems has their financial setback because it required high initial cost for construction of the platform for the tanks, water pump and piping systems to enable the irrigation systems application. The total cost for this project are RM 10, 000 with most of the budget are for equipment and materials. The input cost for the dilute AB fertilizer only about RM 3,000 annually for 10 set of AB fertilizer.

CONCLUSIONS

Generally, the initial soil sampling provide the information that the research area soil are acidic and its should be treated with liming the area to increase the pH value that should give better results on pod production for treated trees because acidic soil not suitable for mature cocoa cultivation. While for the soil

moisture content and organic matter, the soil sampling results are good.

The effectiveness of the drip and sprinkler systems are varies depending on the climate changes and dry weather intensity at CRDC Madai. In fertigation, dilute fertilizers are delivered to plants with drip and sprinkler irrigation systems. The best irrigation systems from this study are sprinkler systems. The sprinkler systems producing highest pod collection compared to other treatments and producing higher numbers of pod will lead to higher yield. So this systems are recommended for the farmer to increase their income from cocoa trees.

Besides that, the application of dilute AB fertilizer also able to reduces the load of fertilizing because the farmers does not need to carry the granular fertilizer as in traditional fertilization methods. Therefore the application of fertigation systems in cultivation of cocoa enable the soil to maintain its moisture as the water will still be irrigated to the cocoa trees during drought season. Fertigation is more efficient in agriculture by reducing fertilizer waste and land contamination and increasing crop production, fertigation is a win-win for farmers and the environment.

Although the application of the irrigation systems require high initial cost, but the cost for buying nutrient input which are the most important input to make sure that cocoa trees can produce high yield can be reduce and saves a lot annually compare to granular fertilizer.

From this experiment its shows that, application of dilute AB fertilizer through fertigation system in T3 and T4 lead to better pod production for cocoa trees in CRDC Madai and introduction of this method for farmers will enable farmer gains more income and less burden to their body because they do not need to carry granular fertilizer during fertilizing season like they did currently follows the conventional practices.

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REFERENCES

Ashrafi, M. R., M. Raj, S. Shamin, K. Lal. and G. Kumar. 2020. “Effect of Fertigation on Crop Productivity and Nutrient Use Efficiency.” *Journal of Pharmacognosy and Phytochemistry* **9 (5)**: 2937–2942.

Kumar, M., T. B. S. Rajput, and N. Patel. 2012. "Effect of System Pressure and Solute Concentration on Fertilizer Injection Rate of a Venturi for Fertigation." *Journal of Agricultural Engineering* **49 (4)**: 9–13.

Mizyed N, Kruse EG. Emitter discharge variability of subsurface drip irrigation in uniform soils: Effect on water application uniformity. ASAE, 2008; **26**:451-458.

Mohd, Y. S., A. M. Arshad, N. F. Muhamad, and N. J. Sidek. 2016. “Potential and Viability of Chilli Cultivation Using Fertigation Technology in Malaysia.” *International Journal of Innovation and Applied Sciences* **17 (4)**: 1114–1119.

Patel, N. and Rajput, T.B.S. 2000. Effects of fertigation on growth and yield of onions. In: Proc. International Conference Micro and Sprinkler Irrigation Systems

Roma Kumari and Dr. Arun Kaushal. Performance evaluation of drip irrigation systems Agricultural and Food Sciences. 2014.

Shirgure, P. S. 2013. “Citrus Fertigation—A Technology of Water and Fertilizer Saving.” *Scientific Journal of Crop Science* **2(5)**: 56–66.

Shukla, M., A. C. Sadhu, A. R. Chinchmalatpure, I. Prasad, S. Kumar, and D. Camus. 2018. “Fertigation—Modern Technique of Fertilizer Application.” Indian Farmer **5 (9)**: 1062–1071.

Sravani, G. C., L. Singh, and M. Bakshi. 2020. “Performance Evaluation of Drip Irrigation (Fertigation) in Citrus Cultivation: A Review.” *Journal of Pharmacosnosy and Phytochemistry* **9 (5)**: 2557–2560.

Thompson, R., I. Delcour, E. Berckmoes, and E. Stavridou. 2018. “Reducing Environmental Impact: Nutrient Removal and Recovery.” In The Fertigation Bible. FERTINNOWA and the European Union’s Horizon Research and Innovation Program.