EVALUATION OF BIOCONTROL AGENT AGAINST BLACK POD AND COCOA POD BORER

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ABSTRACT - *Major losses of cocoa yield and quality caused by soil-borne plant disease and pest have long threatened the ecology and economy of cocoa plantation. Biological control using microorganisms has become an alternative way in managing soil-borne pathogens and pests. Biological control agents isolated from healthy cocoa pods and the infected pod surface (resident antagonist) can inhibiting the growth of the pathogen. Therefore, one synergistic microbial agent formulations have been developed where the microbes produced Bio surfactant which create unfavorable condition to Cocoa Pod Borer lay the eggs on the cocoa pod surface beside destruction and retardation of mycelium growth. The trial was aim to evaluate the efficacy of biocontrol agent with control treatment. There are two treatments used in this study which is T1 – application of biocontrol agent formulation and T2 – application of control treatment. The application of microbial was done once in every two weeks, while data of black pod incident and cocoa pod borer infestation were recorded after a week of microbial application. The objective of this study was to determine the efficacy of microbial biocontrol agent for controlling Black Pod and Cocoa Pod Borer in mature cocoa tree. In the presence of Biocontrol agents resulted in decreasing incidents of Black pod in 2018 and 2019.*

Key words: Biological control, biosurfactant, black pod, cocoa pod borer and cocoa

INTRODUCTION

Plant disease caused by biological factors lead to tremendous loss of crop productivity and its quality. Numerous strategies can be used for the prevention and control of plant diseases. Despite of good agricultural practices, most farmers rely on chemical fertilizers, insect pesticides and herbicides (Geissen *et al.*, 2021). Although, chemical agents have improved crop productivity expressively for many years, their possible opposing effects and excessive use lead to large damage to the soil ecosystem and increased environmental pollution. Approximately 3.0 to 4.6 million tons of pesticides are used yearly, and the global intensive use of chemical fertilizers was about 109.1, 45.5 and 37.6 million ton of N, P_20_5 and K_20, respectively in 2017 where it directly endangers soil and water resources (Sanchez-Montesinos *et al.*, 2021). Therefore, extensive research has been done to develop eco-friendly approaches to control plant diseases and simultaneously increase the crop productivity and quality. The use of biological control agents is one from the alternative strategies that involve with the application of organisms to control plant diseases and environmentally friendly alternative solutions to manage crop production with reduced use of pesticides and fertilizer (Stenberg *et al.*, 2021).

In plant diseases, the term biocontrol or biological control, is widely used without alarming the environment. The organisms that suppress the growth of pathogens are referred to as biological control agents (Umer *et a*l., 2021). Biological control, by definition, provides a non-chemical technique, such as microorganisms for management of plant disease by using other living entities, such as microorganisms. Capacity of a microbe in the biocontrol were resulted from production of antibiotic compounds, depletion of iron from the rhizosphere, or enzymes capable of fungal cell wall lysis, induced systemic resistance, and competition for niches with pathogens within the rhizosphere (Parani and Saha, 2012). Production of one or more antibiotics is a mechanism most usually related with biocontrol ability. They are several number of biocontrol strains were also produced antifungal enzymes, for example chitinases, β1, 3-glucanases, proteases, or lipases, with the capacity to lyse fungal cells (Pirttilä *et al.*, 2021). Numerous biocontrol strains can protect the host plant by out-competing phytopathogens for nutrients. They help the plant by colonizing niches in the rhizosphere and avoiding pathogens from contaminating the plant (Kloepper *et al.*, 2004).

Microbial surfactants or biosurfactants are intracellular or extracellular metabolites of fungi and bacteria (Thurasi *et al.*, 2011). It was categorized into different structural and functional groups such as lipopeptides, glycolipids, polysaccharide-protein complexes, phospholipids, neutral lipids and fatty

acids, therefore these molecules can perform dissimilar natural roles in the growth and reproduction of microorganisms (Ron and Rosenberg, 2001). They can accumulate on cellular surfaces or can be released into the extracellular medium. These amphiphilic molecules are preferred over their chemical homologues because of their low toxicity, biodegradability and efficiency in extreme temperatures and pH conditions (Sharma *et al.*, 2016). Biosurfactant properties such as emulsifying, antiadhesive and antimicrobial behaviour are vital in the food, pharmaceutical and oil industries where they also used as hydrocarbon dissolution agents (Santos *et al*., 2016). In this study, biological control agent was isolated from healthy cocoa pod and one synergistic microbial agent formulation has been developed to avoid Cocoa Pod Borer lay the eggs on the pod surface and inhibiting the growth of mycelium. Therefore, this present study was developed to evaluate the potential of this formulation in controlling black pod and cocoa pod borer.

MATERIALS AND METHODS

This study was carried out at mature cocoa plot (Block 2) at Cocoa Research and Development Centre, Jengka, Pahang. The main objective of this study was to evaluate the efficacy of biocontrol agent against black pod, cocoa pod husk and yield of cocoa tree in CRDC Jengka. It consisted of two treatments as listed: T1 – application of biocontrol agent formulation and T2 – application of control treatment which is no treatment is applied in the plot area. The application of microbial was done once in every two weeks, while data of black pod incident and cocoa pod borer infestation were recorded after a week of microbial application. The Average Damage Severity Index (ADSI) which reflect the damage cause by cocoa pod borer. For actual harvested data of cocoa pod, it is recorded each time of harvesting. The data were collected and recorded throughout the year. Statistical analysis was performed at 5% level using the Statistical Analysis System Package (SAS Institute, ver. 8.2).

RESULTS AND DISCUSSIONS

The effects of biocontrol agent and control treatment on the black pod incident and cocoa pod borer infestation on the yield performance of cocoa were evaluated in Block 2 at CRDC Jengka. All data were taken from January 2018 until December 2019. Data recorded was actual harvested yield, cocoa pod borer and black pod incident twice in a month. Incidence of black pod covering more than 75% of pod surface was visible on all observation months except for June 2018 (Figure 1). In January, April, May and August 2018, treatment by using biocontrol agent showed lowest incidence of black pod and were significantly different compared to control treatment. Meanwhile, in February, Mac, July, and November showed no significant difference on black pod infestation, however application of biocontrol agent still showed lower result compared to control treatment. In September, October and December 2018, the application of biocontrol agent showed higher incident of black pod compared to control treatment. This might be due to the rainy seasons and highest number of pods collected in biocontrol agent treatment compared with control treatment. In 2019, infestation of Black pod covering more than 75% was visible on all observation month (Figure 2). In April, June and December 2019, biocontrol agent treatment showed the lowest black pod incident and were significantly different compared to control treatment. As for January, February, March, May, July, August, September, October and November, the biocontrol agent still showed lower result compared to control treatment, however, there is no significant difference among the treatment.

Figure 3 showed the frequency of pod infected by cocoa pod borer in 2018. In this figure, it showed the Average Disease Severity Index for cocoa pod borer infestation and actual yield data recorded in 2018. There is no significant different among the treatments for cocoa pod borer infestation in 2018. In January, March, April and May 2018, application of biocontrol agent showed higher cocoa pod borer infestation compared with control treatment. In February, June, July, August, September, October, November and Disember, biocontrol agent treatment showed lowest infestation of cocoa pod borer compared to control treatment. For actual cocoa pod harvested, there were no significant difference among the treatments except in November and December 2018. Application of biocontrol agent showed higher cocoa pod number with 41.52% and 89.39% respectively compared with control treatment in November and December 2018. In Mac, April, May, September and November, the aplication of biocontrol agent showed higher harvested number of cocoa pod as compared to control treatment. Meanwhile, in January, February, June and August, control treatment showed higher harvested number of cocoa pod compared with application of biocontrol treatment. Figure 4 showed the frequency and trend of pod infected by cocoa pod borer in 2019. In January and December 2019, treatment by

using biocontrol agent showed the lowest incidence of cocoa pod borer and were significantly different compared to control treatment. Meanwhile for actual harvested yield, treatment by using biocontrol agent showed highest pod number harvested and were significantly different compared to control treatment in June 2019. Application of biocontrol agent showed higher harvested number of cocoa pods with 70.87% as compared with control treatment. Application of biocontrol agent showed higher harvested pod number in every month except for February, Mac, September and December 2019. Based on both figures below, higher pod number will reduce number of cocoa pod borer outbreaks and lowest pod number will increase cocoa pod borer infestation. Based on the presented data in both years, the application of biocontrol agent showed positive interaction where it helps in reducing infestation of black pod and cocoa pod borer. The presence of biosurfactant in biocontrol agent may also lead to these issues. In this concept, the biosurfactant molecules act as mediators, which increase the mass transfer rate by making hydrophobic solution more available for microorganisms (Whang *et al.*, 2009). Alternatively, biosurfactants may also induce changes in the properties of cellular membranes, resulting in increased microbial adherence (Franzetti *et al.*, 2009). Besides that, biosurfactants in the formulation developed the unfavourable condition for cocoa pod borer to lay eggs and helps in retardation of mycelium growth.

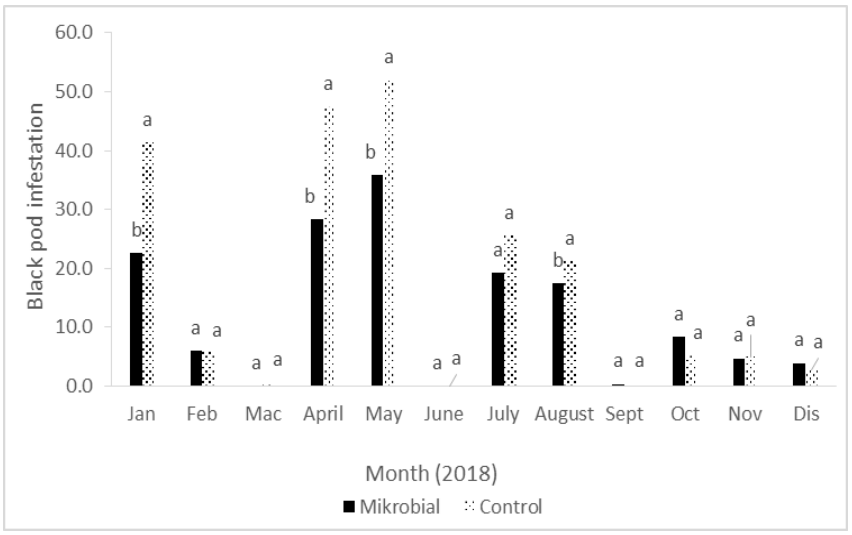

Figure 1: Black pod infection (>75%) on pod surface in 2018. Means denoted with letters are significantly different (P≤0.05)

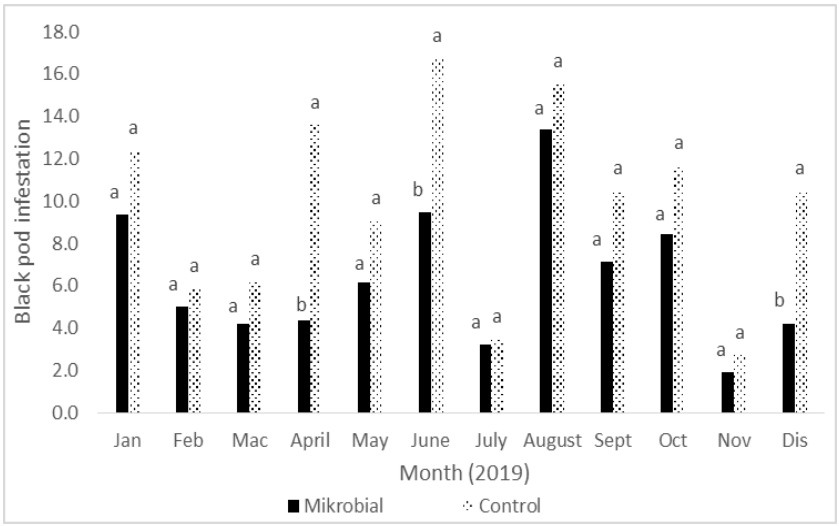

Figure 2: Black pod infection (>75%) on pod surface in 2019. Means denoted with letters are significantly different (P≤0.05)

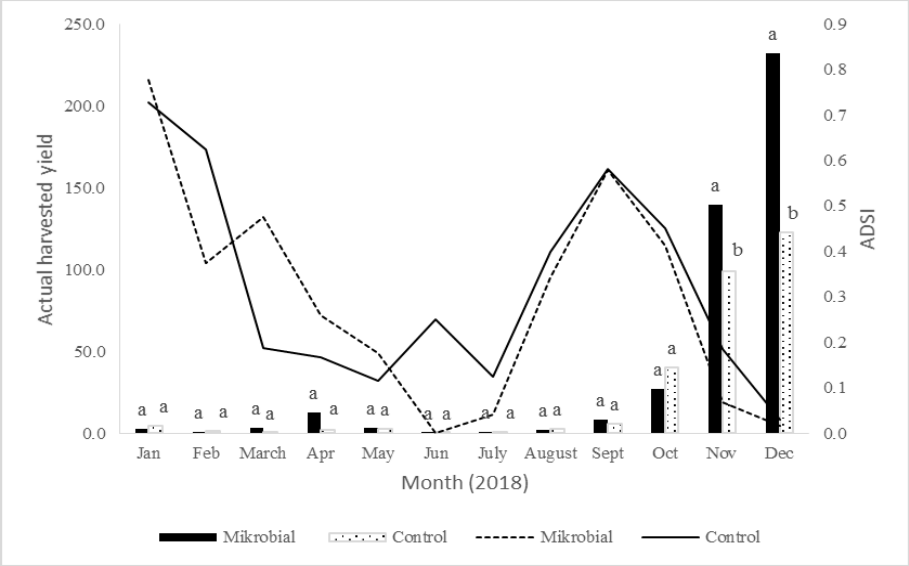

Figure 3: Frequency of pod infected by Cocoa Pod Borer based on actual pod harvested in 2018. Means denoted with letters are significantly different (P≤0.05)

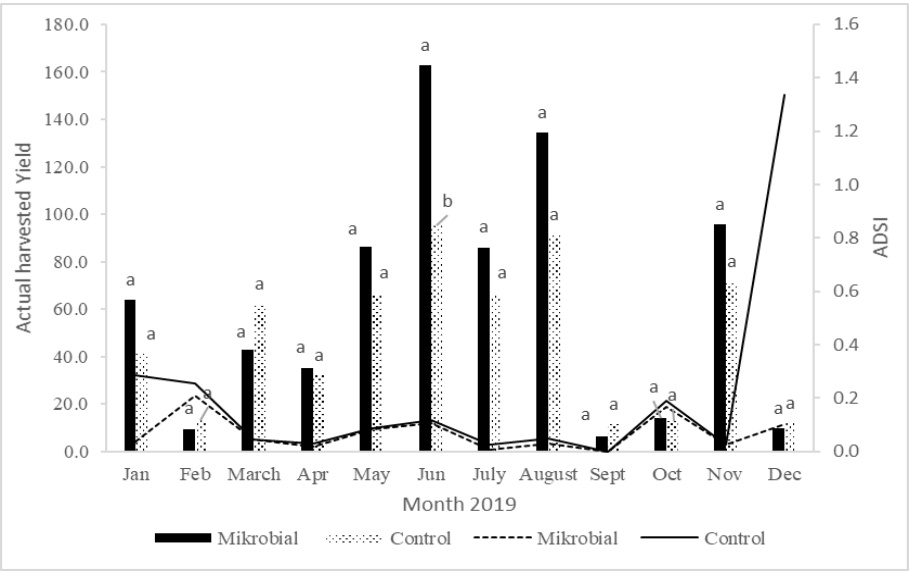

Figure 4: Frequency of pod infected by Cocoa Pod Borer based on actual pod harvested in 2019. Means denoted with letters are significantly different (P≤0.05)

CONCLUSIONS

In the present study, application of biocontrol agent resulted in the lowest black pod and cocoa pod borer infestation of cocoa yield. These biocontrol agents contain beneficial and biosurfactant bacteria live in the formulation, which create unfavorable condition to CPB lay the eggs on the cocoa pod surface beside destruction and retardation of mycelium growth The results suggest that this biocontrol agent formulation can be used as shield protector and reduced the infestation of black pod and cocoa pod borer in cocoa plantations.

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