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Application of the local entomopathogenic fungus *Beauveria Bassiana* Vuill against larvae *Oryctes rhinoceros L*. in immature oil palm plants in Sei Siasam, Rokan Hulu Regency, Riau Province, Indonesia

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Abstract

The decline in oil palm production can be caused by pest attacks. The main pest that attacks oil palm is the horn beetle. Control is usually done by using chemical pesticides. The use of chemical pesticides can cause resistance, resurgence, destruction of natural enemies, and environmental pollution. The use of chemical insecticides can be minimized by using environmentally friendly and sustainable control alternatives, namely by using the local entomopathogenic fungus *B. bassiana*. This study aimed to obtain the best dose of local *B. bassiana Vuill* in controlling *O. rhinoceros* larvae in immature oil palm plantations in Sei Siasam, Rokan Hulu Regency, Riau Province. The study was carried out in Sei Siasam, Rokan Hulu Regency and the Plant Pest Laboratory, Faculty of Agriculture, University of Riau. Completely Randomized Design with five treatments doses of local entomopathogenic fungus *B. bassiana* 30 g/hole, 35 g/hole, 40 g/hole, 45 g/hole, 50 g/hole and four replications, in order to get 20 experimental units. The results showed that the application of local Riau *B. bassiana* at a dose of 40 g/hole was the best dose capable of causing death of 72.5%. Early death 77 hours after application and Lethal time 50 180.75 hours after application.

Keywords: *Beauveria bassiana*; Local entomophatogenic fungi; *Oryctes rhinoceros*; Immature oil palm

1 Introduction

Oil palm is a plantation crop that has high economic value and plays an important role in increasing the country's foreign exchange, absorbing labor and improving the Indonesian economy. According to the Riau Central Statistics Agency [1], oil palm production in Riau Province in 2018 was able to produce production of 7,683,535 tons and decreased in 2019 to 7,466,260 tons. The decline in oil palm production can occur due to several factors, including the attack of the horn beetle (Oryctes rhinoceros).

The decrease in production caused *O. rhinoceros* can reach 69% in the first year and can kill young plants by up to 25% [2] and causes the death of young plants up to 20% of the land area [3]. Damage from *O. rhinoceros* attack can be both indirect and direct. Indirect damage such as leaf midrib which will reduce the process of photosynthesis resulting in a decrease in production. The direct damage caused is the death of oil palm plants [4].

Controls that can be done are physical, biological, mechanical and chemical. Control that is usually applied is with chemical pesticides. The use of chemical pesticides has the potential to cause a faster death of pests, but also has a negative impact, namely the occurrence of resistance, resurgence, disturbing human health, environmental and ecosystem pollution [5]. Therefore, there is a need for alternative control that is safer and environmentally friendly, namely by utilizing biological agents. According to Wahyono [6], the use of biological agents such as entomopathogenic

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fungi has several advantages, namely high reproductive capacity, short life cycle, and can survive in unfavorable conditions. One of the potential entomopathogenic fungi in controlling pests in the field is Beauveria bassiana. According to Brown et al [7], the use of local isolates was chosen because it is easier to adapt to the local ecosystem, so it does not cause disruption of the ecosystem balance.

The results of a previous study by Salbiah et al [8] stated that the administration of local *B. bassiana* at a dose of 30 g/m2 on *O. rhinoceros* larvae was able to cause 77.50% mortality. However, further research is needed using higher doses to achieve optimal larval mortality in the field in immature oil palm plantations. This study aimed to obtain the best dose of local *B. bassiana Vuill* in controlling *O. rhinoceros* larvae in immature oil palm plantations in Sei Siasam, Rokan Hulu Regency, Riau Province.

2 Material and methods

2.1 Research Site and Materials of the Research

The research was carried out in Sei Siasam, Rokan Hulu Regency and the Plant Pest Laboratory, Faculty of Agriculture, Riau University. The oil palm used is the immature plants of oil palm plant that are 3 years old located in Sei siasam, Rokan Hulu Regency, Riau Province. *Oryctes rhinoceros* larvae were taken from experimental garden of Agriculture Faculty Riau University, local fungus *B. bassiana* collection of Desita Salbiah.

2.2 Research Design

The study was conducted experimentally using a Completely Randomized Design consisting of 5 treatments and 4 replications, obtained 20 experimental units. The dose of the local entomopathogenic fungus Riau *B. bassiana* was 30 g/hole, 35 g/hole, 40 g/hole, 45 g/hole and 50 g/hole.

2.3 Application

The application was carried out by mixing 1 kg of Oil Palm Empty Fruit Bunches (OPEFB) with corn starter and then stirring evenly in each experimental unit. The application was carried out 24 hours after the infestation of *O. rhinoceros* larvae at 18.00 WIB.

2.4 Statistical Analysis

The initial mortality data, lethal time 50, total mortality were statistically analyzed using analysis of variance. The results of the analysis of variance which showed significant differences were then tested with Duncan's New Multiple Range Test (DNMRT) at the 5% level.

3 Results

3.1 Early time of death (hours)

The results of observations of the initial time of death after being analyzed by variance showed that the treatment of various doses of local *B. bassiana* on oil palm plants did not produce significant differences in the early mortality of larvae. The results of further tests with DNMRT at the 5% level can be seen in Table 1.

Table 1 Early time of death of *O. rhinoceros* larvae after application of local *B. bassiana Vuill* treatment doses on immature oil palm plantations

Dose of Local *B. bassiana* (g/hole)	Early time of death (Hours)
30	92,50 a
35	85,25 ab
40	77,00 bc
45	66,25 c
50	49,00 d

The numbers in the rows followed by lowercase letters that are not the same are significantly different according to the DNMRT test at the 5% level

3.2 Lethal time 50 (Hours)

The results of Lethal time 50 observations after being analyzed by variance showed that the treatment of various doses of local *B. bassiana* on oil palm plants did not produce significant differences in the lethal time of 50 larvae of *O. rhinoceros*. The results of the DNMRT further test at the 5% level can be seen in Table 2.

Table 2 Average Lethal time 50 of *O. rhinoceros* larvae after application of local *B. bassiana Vuill* treatment doses on immature oil palm plants (hours)

Dose of Local *B. bassiana* (g/hole)	Lethal time 50 (Hours)
30	193,75 a
35	186,50 b
40	180,75 c
45	176,25 d
50	168,00 e

The numbers in the rows followed by lowercase letters that are not the same are significantly different according to the DNMRT test at the 5% level

3.3 Total Mortality (%)

The results of the application that had been carried out on total mortality after analysis with variance showed that the application of various doses of local *B. bassiana* to immature oil palm had a significant effect on the total mortality of *O. rhinoceros* larvae. The results of the DNMRT further test at the 5% level can be seen in Table 3.

Table 3 Average total mortality of *O. rhinoceros* larvae after application of local *B. bassiana Vuill* treatment doses on immature oil palm plantations

Dose of Local *B. bassiana* (g/hole)	Total mortality (%)
30	57,5 c
35	67,5 bc
40	72,5 b
45	77,5 ab
50	85,0 a

The numbers in the rows followed by lowercase letters that are not the same are significantly different according to the DNMRT test at the 5% level after being transformed with Arcsin√y

4 Discussion

4.1 Early time of death (hours)

The application of local *B. bassiana* with dose of 50 g/hole of caused the earliest time of death of *O. rhinoceros* larvae, which was 49 hours after application, compared to the application of doses of 30 g/hole, 35 g/hole, 40 g/hole, and 45 g/hole (Table 1). This is because the local *B. bassiana* with dose of 50g/hole is the highest dose so that the time required to kill the earliest *O. rhinoceros* larvae will be faster. The higher dose the local *B. bassiana* caused the higher the chance for the conidia to attach to it. cuticle, germinated and penetrated the body of *O. rhinoceros* larvae. The local entomopathogenic fungus *B. bassiana* while in the body of the larvae of *O. rhinoceros* secretes the toxin beauvericin. According to Zhang et al [9], the beauvericin toxin causes damage to the body tissues of infected insects as a whole which causes the death of insects.

The application of local *B. bassiana* with dose of 30 g/hole resulted in a longer initial time of death for *O. rhinoceros* larvae, which was 92.50 hours after application. This was due to the low dose and the small amount of toxin produced, resulting in a lower ability to infect *O. rhinoceros* larvae and a longer initial time of death for *O. rhinoceros* larvae. Neves and Alves [10] stated that the time of death of insects was influenced by the virulence of different doses of entomopathogenic fungi at the time of application.

Application of local *B. bassiana* with dose below 50 g/hole resulted in a longer initial time of death for *O. rhinoceros* larvae. This was due to the low dose and less toxin produced, resulting in a low ability to infect *O. rhinoceros* larvae. The results of Salbiah et al [8] research, a dose of 30 g/m2 was able to cause early death of *O. rhinoceros* larvae at 90 hours after application, but with an increase in dose of 50 g/hole it was able to cause the early death of *O. rhinoceros* larvae to be faster, namely 49 hours. This is because the toxin produced by local *B. bassiana* is more so that it can kill the larvae of *O. rhinoceros* more quickly. The speed of death of *O. rhinoceros* larvae is caused by damage to the inside of the larval body due to toxins released by the fungus Rustama et al [11].

4.2 Lethal time 50 (Hours)

Table 2 shows that the application of a local *B. bassiana* with dose of 50 g/hole caused the death of 50% of *O. rhinoceros* larvae more quickly, 168 hours after application. The dose of 50 g/hole was significantly different with doses of 45 g/hole, 40 g/hole, 35 g/hole, and 30 g/hole. This is because local *B. bassiana* with dose of 50 g/hole is the highest dose compared to other doses, the higher the dose applied will accelerate the death of 50% of *O. rhinoceros* larvae. This statement is in accordance with the results of research by Salbiah et al [8] which stated that the higher the dose given, the faster the larval death by up to 50%.

The local *B. bassiana* with dose of 35 g/hole and 40 g/hole at lethal time 50 were significantly different, but at early time of death (hours) (Table 1), the two doses were not significantly different. This was because at a lethal time of 50 local beauvericin *B. bassiana* toxin had entered the body of *O. rhinoceros* larvae and had worked optimally in infecting *O. rhinoceros* larvae, causing a significantly different lethal time of 50 *O.rhinoceros* larvae. Wahyudi [12] stated that beuavericin toxin can cause tissue damage, especially in the digestive tract, muscles, nervous system, and respiratory system. Furthermore, the beauvericin toxin in the body of the larvae of *O. rhinoceros* caused the death of the larvae of *O. rhinoceros*. This is in accordance with Hajek and Leger [13], who stated that in the body cavity of insects, the fungus *B. bassiana* produces beauvericin which can cause larval death.

The results of the study by increasing the local *B. bassiana* with dose of 50 g/hole caused a lethal time of 50 in *O. rhinoceros* larvae for 168 hours after application. This was due to the increase in the dose applied in this study so that more beauvericin toxin was produced and caused a faster lethal time for *O. rhinoceros* larvae. Hasyim [14] stated that the higher the *B. bassiana* dose applied, the more conidia that came into contact with the larval body, resulting in a faster mortality rate.

4.3 Total Mortality (%)

From the analysis of total mortality of *O. rhinoceros* larvae (Table 3) it was shown that the local *B. bassiana* with dose of 50 g/hole caused the highest total mortality of *O. rhinoceros* larvae, namely 85%. At the time of initial death, *O. rhinoceros* larvae died the fastest at 49 hours and the fastest lethal time 50 was 168 hours. The higher dose of local *B. bassiana* applied to *O. rhinoceros* larvae resulted in higher beauvericin toxin resulting in higher total mortality of *O. rhinoceros* larvae and low dose of local *B. bassiana* resulted in lower beauvericin toxin resulting in lower ability to kill larvae *O. rhinoceos* is also low. According to Volova [15], entomopathogenic fungi which is categorized as a bioinsecticide is entomopathogenic fungi which is able to control the test insects in the range of 72-95%. Based on this, it can be stated that application of local *B. bassiana* with dose of 40g/hole was the best dose because it was able to control *O. rhinoceros* larvae with a total mortality of 72.5%.

The 30 g/hole dose of local C *B. bassiana* caused the lowest mortality of *O. rhinoceros* larvae, namely 57.5%. This is because the beauvericin toxin produced by local *B. bassiana* to kill the larvae of *O. rhinoceros* produced is small. Boucias and Pendland [16] stated that the higher the dose given, the greater the chance of contact between the host and the pathogen, and the faster the insect death process. On the other hand, the lower the dose given, the less chance of contact between the host and the pathogen, and the slower the insect's death process.

5 Conclusion

The best dose of local *B. bassiana* which was applied was 40 g/hole as the control of *O. rhinoceros* larvae on immature oil palm plantations in Sei Siasam, Rokan Hulu Regency, Riau Province with a total mortality of 72.5%, early death 77 hours after application and Lethal time 50 180.75 hours after application.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors declare there is no conflict of interest in this paper.

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