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Effectiveness *Beauveria bassiana* as Pest Control *Spodoptera frugiperda* on Sweet Corn

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Abstract

Spodoptera frugiperda is the main pest that attacks corn plants so control efforts need to be made. One alternative control method is using entomopathogenic fungi Beauveria bassiana (Bb). In this research, mushrooms were used B. bassiana against larvae S. frugiperda. This research aims to determine the effectiveness of B. bassiana in handling S. frugiperda in sweet corn plantations. This research used a Completely Randomized Design (CRD) with 6 treatments and 4 replications. Treatment uses a concentration of 102, 104, 106 and 108 mushrooms B. bassiana and as a comparison, namely sterile water which acts as control 1 and chemical insecticide as control 2 in this study. Research observations were carried out for 7 weeks. The results of this research indicate that the average percentage of plants attacked by entomopathogenic fungi B. bassiana own ability to suppress population S. frugiperda at a concentration of 106 and 108 namely 20.53 and 21. And the average percentage of attack intensity at a concentration of 106 and 108 namely 2.28 and 3.2.

Keywords : entomopathogens, plant percentage, attack intensity

Introduction

South Kalimantan Province is a fairly large corn producer in Indonesia. According to the South Kalimantan Central Statistics Agency (2023), corn production in South Kalimantan in 2020 reached 152,797 tons. In 2021, corn production in South Kalimantan will decrease by 135,326 tons. Meanwhile, in 2022 corn production will increase again by 152,225 tons. However, in 2023 corn production in South Kalimantan will experience a significant decline, namely 119,009 tons. From these data, the decline in production was due to an obstacle caused by attacks by plant pests (OPT).

Spodoptera frugiperda one of the pests that is very detrimental to corn plants. This pest attacks all stages of corn plants from the vegetative to the generative phase. According to Megasari & Khoiri, (2021) Damage caused by pests *S. frugiperda* reached 60%. Damage to plants is characterized by larval crack marks, namely there is a coarse powder resembling sawdust on the upper surface of the leaves and around the tops of the corn plants. (Lubis *et al.*, 2020).

One alternative control that can be done to suppress pest attacks *S. frugiperda* is by utilizing entomopathogenic mushrooms. Potentially controlling entomopathogenic fungi *S. frugiperda* in corn plantings because it can produce endotoxin which is toxic to insects (Pohan, 2024). One of the entomopathogenic fungi used is *Beauveria bassiana*. *B. bassiana* produces metabolite compounds in the form of beauvericin, bassianin, bassiacridin, bassianolide, cyclosporine, and tenellin which are very toxic in damaging the nervous system, disrupting the insect's digestive process, causing death for the insect if infected (Jaber & Ownley, 2018).

According to several research results, entomopathogenic fungi *B. bassiana* It is

reported that it is able to control various types of armyworms *S. litura* and *S. frugiperda*. This can be said to be a fungus *B. bassiana* have the opportunity to control *S. frugiperda* in South Kalimantan. Use of entomopathogenic fungi *B. bassiana* in South Kalimantan it is rarely done so research is needed on the effectiveness of the fungus *B. bassiana* in handling *S. frugiperda* in sweet corn plantations. Based on this research, the aim is to determine the effectiveness of *B. bassiana* in handling *S. frugiperda* in sweet corn plantations

Research Method

This research took place on agricultural land, Guntung Payung subdistrict, Landasan Ulin subdistrict, Banjarbaru city, South Kalimantan. (-3.431251,114.793198). This research used a one-factor Completely Randomized Design (CRD) method consisting of 6 treatments and 4 replications, totaling 24 experimental units. The treatment used is as follows:

K1 = Control
K2 = Control chemical insecticide 0.6 ml/l water (active ingredient Emamectin Benzoate)
A = Density of *Beauveria bassiana* conidia 10^2
B = Density of *Beauveria bassiana* conidia 10^4
C = Density of *Beauveria bassiana* conidia 10^6
D = *Beauveria bassiana* conidia density 10^8

Media Creation *Potato Dexstrose Agar*

Ingredients used: 100 gram potatoes, *Dextrose* 10 grams, 10 grams agar powder, and 500 ml distilled water. Potatoes are washed clean and cut into small sizes then boiled in 500 ml of distilled water. Pour the boiled potato water into a beaker then add 10 grams of dextrose and 10 grams of agar powder, stir until dissolved. Pour the resulting mixture into a glass bottle and close tightly for wet sterilization using an autoclave for 30 minutes.

Soil Sampling

The soil taken for isolation came from the root soil of corn plants at a depth of 15-20 cm

Isolation *Beauveria bassiana*

Isolation *B. bassiana* carried out using the insect bait method with *Tenebrio molitor* (*The Dark One*) which was put into a container containing 10 pieces of corn root soil and sprayed with sterile water to maintain soil moisture in the container. After 14 days, Hong Kong caterpillars that show symptoms are sterilized with 3% NaOCl then rinsed with sterile water 3 times and air-dried. Then the Hong Kong caterpillars were placed on PDA media in a petri dish.

Microscopic Observation

Observation This is done using cube media which is made by inserting tissue into a petri dish and placing a toothpick then placing a glass slide on top of the toothpick. The PDA media is cut into cubes and placed on top of the preparation and then the pure isolate *B. bassiana* Place it on the cube media and cover it with a slide

glass. The tissue is moistened with sterile water to maintain moisture in the cup. Leave until the isolate grows and observe under a microscope.

Land Management

The land is cleared of weeds and the land is cultivated by making 24 plots measuring 1×1 meter.

Planting

Corn seeds are planted at a distance of 25×25 cm between plants with a plant hole depth of 3 cm. Each plant hole is filled with 2 corn seeds so that you get 16 plants per plot.

Maintenance

Watering is done twice a day, replanting, fertilizing and cleaning weeds around the plot. Fertilization is carried out when the plants are 10 days after planting (DAP) using NPK 16:16:16 fertilizer which is mixed at a dose of 30 grams for 15 liters of water.

Suspension Making and Density Test

The suspension was made by carrying out multilevel dilutions up to the 10. Carry out a spore density test *Beauveria bassiana* by taking a 10^{2}, 10^{4}, 10^{6} and 10^{8} 0.2 ml each and dripped into the device *haemocytometer*. Calculation of spore density can use the following formula:

$$S=\frac{X}{L.t.d} \times 10^{3}$$

Information:

S : spore density per ml of solution
X : average number of spores in boxes A, B, C, D, E
L : area of the calculation box ($0.04 \times 5 = 0{,}2$ mm^2)
t : calculated field depth (0.1 mm)
d : dilution factor
10^3 : calculated suspension volume (1 ml = 10^3 mm^3)

Application *B. bassiana* on Corn Planting

Suspension *B. bassiana* applied 2 times in 1 week at the age of corn plants 7, 14, 21, 28, 35, 42 and 49 days after planting (DAP). Each treatment at each concentration level was applied at 5 ml/plant.

Observation Parameters

Observations began when the corn plants were 14 DAP and were carried out at intervals of every 7 days. Observations are made before the next application is carried out. The samples observed for attack intensity were 4 sample plants located in the middle of the plot using the diagonal method (Untung, 2010). The parameters observed are the percentage of plants attacked and the attack intensity can be calculated using the formula:

Percentage of Attacked Plants *S. frugiperda*

The first observation parameter is the percentage of plants affected *S. frugiperda*

calculated using the formula (Wiryadiputra, 2012):

$$P = \frac{H}{T} \times 100\%$$

Information :
P = Percentage of attacks
H = Number of plants attacked
T = Total number of plants (16 plants / 1 × 1 m)

Attack Intensity *S. frugiperda*

The second observation parameter is the intensity of the attack *S. frugiperda* which is calculated using the formula (Minarno & Ika, 2011):

$$IS = \frac{\sum(n \times v)}{Z \times N} \times 100\%$$

Information :
IS = Attack intensity
n = Number of leaves showing scale (v)
v = Leaf score value (0-4)
Z = Highest scale
N = Number of leaves observed

Results and Discussion

Isolation *Beauveria bassiana*

Beauveria bassiana obtained from trap using soil from the roots of corn plants at a depth of 15-20 cm using *Tenebrio molitor*. It is suspected that at this depth the soil still has a lot of high organic material content so there are entomopathogenic fungi in it. After going through an incubation period of 20 days, the body of the *Tenebrio molitor* (*The Dark One*) covered in white, cotton-like mycelium, the caterpillar's body shrinks and dries up. *Tenebrio molitor* with symptoms as described previously were transferred to PDA media and then the plates were covered with white mycelium, so it was suspected that the fungus was *B. bassiana*. According to Utami *et al*., (2014), mycelium *B. bassiana* chalky white like cotton that grows on *Tenebrio molitor*. *Tenebrio molitor* that die as a result of being infected with this fungus will see the outer layer of skin covered with chalky white mycelium.

Figure 1. The trap results *B. bassiana* using *T. molitor* on corn root soil.

Spore Density Test *Beauveria bassiana*

Based on the results of spore density test calculations, there was an increase in spore density along with increasing treatment concentration. In the 10^2 treatment the

spore density obtained was 820 × 10^5 spores/ml. The 10^4 treatment increased to 860 × 10^7 spores/ml. Furthermore, in the 10^6 treatment it reached 900 × 10^9 spores/ml and in the highest treatment, namely 10^8 with a result of 950 × 10^{11} spores/ml. according to Prayogo *et al.* (2005) the level of insect mortality is largely determined by the density of conidia of entomopathogenic fungi produced. The higher the density of fungus conidia, the higher the mortality rate.

Figure 2. *B. bassiana* macroscopically

B. bassiana microscopically

Percentage of Corn Plants Attacked *Spodoptera frugiperda*

Data on corn plants from weekly observations of attacks *Spodoptera frugiperda* can be seen in the following table:

Table 1. Percentage of Observations of Infested Corn Plants *S. frugiperda*

Treatment	Attack Intensity Observation% (week)						
	1	**2**	**3**	**4**	**5**	**6**	**7**
K1 (Water)	39,06	43,75	45,31	53,13	53,13	53,13	54,69
K2 (Insecticide)	**6,28**	**9,38**	**10,94**	**12,50**	**12,50**	**12,50**	**14,06**
A(10^2)	15,63	23,44	26,56	29,69	29,69	31,25	31,25
B (10^4)	18,75	23,45	28,13	29,70	29,70	31,26	31,26
C (10^6)	12,51	**14,06**	**18,75**	**23,44**	**23,44**	**25,00**	**26,56**
D (10^8)	**12,50**	15,63	20,31	**23,45**	**23,45**	**25,10**	**26,57**

In the first week of observation, the chemical insecticide control treatment was 6.28%. Meanwhile, in the concentration treatment *B. bassiana* the best is at a concentration of 10^8 amounting to 12.50% with a homogeneity of variance of 10.76%. The second week and third week of observations show the percentage of infected corn plants *S. frugiperda* on the treatment of giving *B. bassiana* The best concentration is 10^6 with a percentage of 14.06%. Meanwhile, the percentage of chemical insecticides applied was 9.38%. In the third week of observation the percentage was 10^6 amounting to 18.75%. Meanwhile, the application of chemical insecticides was 10.94%. Based on the results of observations in the second and third weeks of *B. bassiana* significantly different from the application of chemical insecticides which have a homogeneity of variance of 12.24% and 11.07%. In the fourth week of observation, the percentage of corn plants that were attacked *S. frugiperda* gift treatment *B. bassiana* at a concentration of 10^6 and 10^8 amounting to 23.44% and 23.45%. Both achieve the same results in suppressing population *S. frugiperda*. chemical insecticide treatment produces a percentage of 12.50%. Based on the results of this observation, this award is given *B. bassiana* significantly different from the application of chemical insecticides which have a homogeneity of variance of 12.45%.

Based on observations in the fifth week, the percentage development is still the same as the previous week's results. This is because the corn plant has entered the generative phase (flowering) so that the level of attack from larvae increases *S. frugiperda* tends to decrease and even stops for a moment and starts to attack again when the fruit appears on the corn plant. Sixth week of observation on the treatment given *B. bassiana* The best concentration is at 10^6 and 10^8 namely 25% and 25.10%. For the application of chemical insecticides in this observation the percentage was 12.50%. Based on the results of observations in the sixth week of *B. bassiana* significantly different from the application of chemical insecticides which have a homogeneity of variance of 12.05%. Meanwhile, in the seventh observation, the percentage of plants affected in the treatment *B. bassiana* The best concentration is 10^6 of 26.56% and 10^8 amounting to 26.57%. And the application of chemical insecticides was 14.06%. From the results of observations in the last week of *B. bassiana* significantly different from the application of chemical insecticides which had a variance homogeneity of 11.23%.

Based on the results of observations of the percentage of infected plants that have been carried out from the first week of observation to the seventh week of observation, it shows that this was given *B. bassiana* the best is at a concentration of 10^6 and 10^8. This is in accordance with the statement of Sibarani (2015) that the higher the level of fungus concentration given, the more and the higher the germination capacity of the spores so that it can accelerate the death of the larvae. *S. frugiperda*. Meanwhile, chemical insecticide treatment has a lower percentage of infected plants compared to *B. bassiana* at the best concentration of 10^6 and 10^8. This shows that applying chemical insecticides is more effective in suppressing the attack population *S. frugiperda*.

Attack intensity *Spodoptera frugiperda* on corn plants

Weekly observations of the intensity of infected corn plants *Spodoptera frugiperda* can be seen in the following table:

Table 2. Percentage of Attack Intensity Observations *S. frugiperda*

Treatment	Attack Intensity Observation% (week)					
	1	**2**	**3**	**5**	**6**	**7**
K1 (Water)	9,89 d	3,55 d	11,10 d	3,39 c	11,03 d	13,57 d
K2 (Insecticide)	**1,50 a**	**1,44 a**	**1,87 a**	**1,72 a**	**2,77 a**	**3,35 a**
A(10^2)	5,88 c	2,40 bc	7,17 c	2,53 b	6,42 c	6,38 c
B (10^4)	5,82 c	2,87 c	7,93 c	2,59 b	6,38 c	6,28 c
C (10^6)	3,24 b	**1,54 a**	**2,71 a**	**2,28 b**	**5,00 b**	**4,97 b**
D (10^8)	**3,03 b**	1,94 ab	4,01 b	2,31 b	5,30 b	5,24 b

Observation of the first week of attack intensity *S. frugiperda* on corn plants giving the best concentration *B. bassiana* is at treatment 10^8 amounted to 3.03% and applying chemical insecticides to corn plants produced a percentage of 1.50%. Based on the results of these observations, administering insecticide control is significantly different from administering *B. bassiana* concentration 10^8 with a homogeneity of 10.01%. When observing the intensity of attacks in the second week, third week and fifth week of giving the best concentration *B. bassiana* namely in treatment 10^6 respectively 1.54, 2.71 and 2.28%. Meanwhile, the attack intensity of chemical insecticide treatment respectively showed results of 1.44, 1.87 and 1.72%. With

variance homogeneity of 18.17, 12.95 and 12.35% respectively. These results show that the of chemical insecticides is significantly different from *B. bassiana* concentration 10^6.

The observation data for the intensity of attacks in the fourth week was the same as the observation data for the third week, that is, there was no change. Because according to information from local farmers, when the corn plants start to enter the flowering phase until the fruit is formed, pests attack *S. frugiperda* tends to decrease or even no attacks occur. However, the attack will reappear after the fruit appears on the corn plant. According to Suwarno's statement *et al*. (2012) said that corn plants entering the generative phase will experience a decrease in the intensity of damage due to the lack of production of young leaves as a food source. *S. frugiperda*. Meanwhile, in the sixth and seventh observations, the percentage of attack intensity was the best concentration given *B. bassiana* namely in treatment 10^6 namely 5.00 and 4.97%. Applying chemical insecticides to corn plants resulted in percentages of 2.77 and 3.35% with homogeneity of variance of 12.10 and 8.13% respectively. Based on observations in the sixth and seventh weeks, it was shown that the of chemical insecticide control was significantly different from the of concentration *B. bassiana* 10^6.

Based on the 7 weeks of observations of the intensity of attacks that have been carried out, it shows that this has been given *B. bassiana* the best average concentration in treatment 10^6. Meanwhile, the chemical insecticide control treatment had a lower percentage of infected plants compared to the application *B. bassiana* at the best concentration of 10^6. This shows that applying chemical insecticides is more effective in reducing the intensity of attacks *S. frugiperda*.

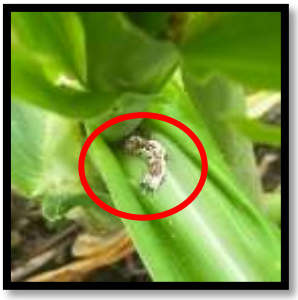

Figure 3. Larvae *S. frugiperda* who are infected *B. bassiana* in the third week of observation.

Larva *S. frugiperda* who are infected *B. bassiana* in the sixth week of observation.

In (Figure 3) a larval carcass has been found *S. frugiperda* who are infected by *B. bassiana* with symptoms of a body covered in white fungus mycelium with a hardened larval body. Herlinda *et al.* (2005) said that the time required for entomopathogenic fungi from starting to infect until causing death of the larvae ranges from 2-10 days after application.

Conclusion

The conclusion of this research is on *Beauveria bassiana* isolated from corn root soil has the ability to reduce the percentage of infected plants and the intensity of attacks caused by *Spodoptera frugiperda*. Based on the first observation to the seventh observation, the best concentration of *B. bassiana* is 10^6 and 10^8.

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