Endophyte Initiation *Beauveria bassiana* (Balsamo) Vullemin (Hypocreales: Cordycipitaceae) in Reduction of *Aphis glycine* Matsumura (Hemiptera: Aphididae) Investation in Soybean (*Glycine max* (L.) Merrill) Plant

Mufidah Afiyanti¹, Rina Rachmawati², Achmad Faisal Akbar², Rose Novita Sari Handoko¹, Bambang Tri Rahardjo²

¹Master Program of Natural Resources Management. Postgraduate School. Universitas Brawijaya, Malang, Indonesia, 65145
²Department of Plant Protection, Faculty of Agriculture, Universitas Brawijaya, Malang, Indonesia, 65145

**Abstract**

Soybean (*Glycine max* (L.) Merrill) is a universal important plant. Its production has decreased each year. A major problem is a pest known as *Aphis glycine* Matsumura (Hemiptera: Aphididae) which caused the decline of yield up to 40%. Thus, there is a need to control *A. glycine*. Recent studies showed *B. bassiana* has a potency as endophyte in *Vicia faba* (Fabaceae) plant tissue. It could harm *A. gossypii* and causes death up to 57.7%. Therefore, the aim of this research is to control infestation of *A. glycine* by using *B. bassiana*. This research used Randomized Block Design with soybean plant Anjasmoro variety as samples. The initiation of *B. bassiana* was conducted by using seed-soaking and soil-wetting methods. The results showed that fungus *B. bassiana* was able to colonize soybean plants with a percentage of colonization reaching 6.67%. Colonization was only found in the stems of soybean plants. The results showed that fungus *B. bassiana* was able to colonize soybean plants with a percentage of colonization reaching 6.67%. Colonization was only found in the stems of soybean plants. The results showed that fungus *B. bassiana* was able to colonize soybean plants with a percentage of colonization reaching 6.67%. 

**Keywords:** Biological control, Environmental pest management, Greenfly

**INTRODUCTION**

Soybean (*Glycine max* (L.) Merrill) is a plant that has important value as a source of vegetable protein with an average production of the last two years reaching 968,982 tons and experiencing an increase [1]. Production factors that can eliminate the results are Plant Disturbing Organisms (OPT). *Aphis glycine* Matsumura *aphids* (Hemiptera: Aphididae) is one of the potential pests of soybean plants that can cause a decrease in yield of more than 40% [2], so control is needed for these pests. Biological control measures by utilizing natural enemies of pests. One of the natural enemies of *A. glycine* comes from a group of fungi namely *Beauveria bassiana* (Balsamo) Vullemin (Hypocreales: Cordycipitaceae). *Beauveria* fungi are cosmopolitan fungi and the range of this fungus host is about 100 species. This fungus also has unique properties which can act as endophytes in plant tissues. The potential of *B. bassiana* fungi as endophytes in the *Vicia faba* (Fabaceae) plant tissue can cause death by 57.7% [3]. The development of *B. bassiana* fungi as endophytes aims to increase the resistance of soybean plants from the attack of *A. glycine* aphids.

**MATERIAL AND METHOD**

This study uses Randomized Block Design (RCBD) with 4 treatments and 5 replications, so as to obtain 20 experimental units. The soybean plants used are Anjasmoro varieties. This research is divided into preparation and implementation of research. Preparation of the study included making media, propagating fungus *B. bassiana*, maintaining *A. glycine* aphids, and planting. Research implementation includes fungus initiation, direct pathogenicity testing, endophytic pathogenicity testing, and evaluation.

The implementation of the research included fungal initiation, direct pathogenicity testing, endophytic pathogenicity testing, and evaluation. Analysis of data using analysis of variance, if the treatment shows a significant effect, followed by the LSD test at the error rate of 5%. In fungal initiation, there is a formula:
- Calculation of density

\[ J = \left( \frac{t \times d}{n \times 0.25} \right) \times 10^6 \]

- Conidia viability calculation

\[ V = \left( \frac{g}{g + u} \right) \times 100\% \]

Identification of Fungus *Beauveria bassiana*

Macroscopic observations showed that the color of the colony is white, the edges are white and have a white base on the bottom. The surface of the convex colonies with the center is thicker than the edges and the surface texture is rather rough. The type of distribution of colonies is centered or concentric and round in shape. Microscopic observations showed that hyphae had hyaline and hyaline colors. Hyphae has a width of 1.48 μm and a length of 10.26 μm. Conidiofor grows in a zig-zag pattern, has hyaline color, and has no branches. Konidia has a size of 2.68 x 2.63 μm.

**Result and Discussion**

**Evaluation of *Beauveria bassiana* as Endophytes in Soybean Plants**

Colonization of *B. bassiana* fungus on the stem of soybean plants reached 20%. The mean percentage of ability of fungus *B. bassiana* to colonize soybean plants reached 6.67% of the total number of experimental units on stems. This may be caused by the symptoms of fungal colonization has not yet been visible. Previous study also demonstrated that several fungal endophytes may colonize in different part of plant including branches, stems, fruits, flowers, roots and leaves even without showing visible symptoms [4]

The low percentage of presence of *B. bassiana* fungus may also influenced by the readiness of plant metabolism in cope with inoculation time. Soybean plants used for inoculation of this fungus in soil wetting and seed soaking treatments were 5 days after planting.

Previous study also indicated that successful inoculation of several plants was carried out at the age of plants around 12, 14, 30, and 35 days [5,6,7,8]

| Treatment | Part of Plant (%) | Mean (%) |
|-----------|-------------------|----------|
|           | Root | Stem | Leaf | Root | Stem | Leaf | |
| Soaking seed with distilled water | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Wetting soil with distilled water | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Soaking seed with *B. bassiana* | 0.00 | 20.00 | 0.00 | 6.67 |   |   | |
| Wetting soil with *B. Bassiana* | 0.00 | 0.00 | 0.00 | 0.00 |   |   | |

**Effect of *Beauveria bassiana* Fungus Initiation on Plant Growth**

Symbiotic interactions between plants and insect pathogenic fungi result in increased plant growth. This increase occurs due to the reciprocal relationship between insect pathogenic fungi that provide nitrogen and plants that provide nutrients in the form of carbon from photosynthesis [9, 10]. Other research also demonstrated that the growth of sun flower plant were greatly increased after treated with *Penicillium citrinum*, but not significant after treated with *Aspergillus terreus*
This may suggest that the ability and of endophytic fungi to enhance the growth of host plant is likely depend on the compatibility of endophytic fungus and host plant. Our result showed there was no significant different on the growth of soybean plant between treated and untreated plant with endophytic fungi, B. bassiana. This may be caused by B. bassiana may not have high compatibility with soybean plant thus could not increase the growth of plant significantly. However, further research still need to be conducted.

Table 2. Mortality of aphids for 7 days of observation (%)

| Concentration (conidia / mL) | 1   | 2   | 3   | 4   | 5   | 6   | 7   |
|------------------------------|-----|-----|-----|-----|-----|-----|-----|
| $10^5$                       | 0.71| 0.71| 13.99| 26.40| 34.19| 40.57| 45.96|
| $10^4$                       | 0.71| 0.71| 19.31| 29.04| 37.22| 44.92| 53.83|
| $10^3$                       | 0.71| 2.1 | 22.79| 34.15| 42.04| 47.97| 55.07|
| $10^2$                       | 0.71| 3.71| 27.09| 40.00| 49.19| 55.31| 60.31|

Further research is needed on the level and concentration volume of insect pathogens given, abiotic factors such as temperature and pH levels, stability of insect pathogenic fungi in plant tissues, and interactions between plants, insect pathogenic fungi and insect pests or natural enemies. Further research is also on the biology of pests that can survive after the application of endophytic insect fungi, in addition, the detection of the distribution of insect pathogenic fungi in plant tissues using the sequencing method.

CONCLUSION

Colonization of B. bassiana fungus may visibly formed in stem, but not in other part of soybean plant. However, compatibility between fungal endophytes and the host plant may plays role in the successfulness of endophytic fungus in enhancing the growth as well as its role in reducing the major pest in its host, in this case is Aphid glycine in soybean plant. Further research still need to be conducted regarding factors influence the compatibility of fungal endophytes and the host plant.

ACKNOWLEDGMENTS

This research was supported by Hibah Peneliti Pemula Program Universitas Brawijaya with the contract number 1352 year of 2018.

REFERENCES

[1]. Indonesian National Statistic, 2016
[2]. Tilmon, K. J., E. W. Hodgson, M. E. O’Neal, dan D. W. Ragsdale., 2011. Biology of the Soybean Aphid, Aphis glycines (Hemiptera : Aphididae) in the United States. Journal of Integrated Pest Management 2 (2): 1 – 7.
[3]. Akutse, K.S., N.K. Maniania, K.K.M. Fiaboe, J. Van Den Berg, S. Ekesi. 2013. Endophytic Colonization of Vicia faba and Phaseolus vulgaris (Fabaceae) by Fungal Pathogens and
Their Effects on The Lifehistory Parameters of Liriomyza huidobrensis (Diptera: Agromyzidae). Fungal Ecology 6 (4): 293 – 301.

[4]. Saikkonen K., Lehtonen P., Helander M., Koricheva J., Faeth S. H. (2006). Model systems in ecology: dissecting the endophyte–grass literature. Trends Plant Sci. 11 428–433.

[5]. Gurulingappa, P., P. A. McGee, G. A. Sword. 2011. Endophytic Lecanicillium lecanii and Beauveria bassiana Reduce the Survival and Fecundity of Aphis gossypii Following Contact with Conidia and Metabolites. Crop Protection 30 (3): 349 – 353.

[6]. Parsa, S., V. Ortiz, dan F.E. Vega. 2013. Establishing Fungal Entomopathogens as Endophytes: Towards Endophytic Biological Control. Journal of Visualized Experiments 74: 1 – 5.

[7]. Mantzoukas, S., C. Chondrogiannis, dan G. Grammatikopoulos. 2015. Effects of Three Endophytoc Entomopathogens on Sweet Sorgum and on The Larvae of The Stalk Borer Sesamia nonagrioides. Entomologia Experimentalis et Applicata 154 (1): 78 – 87.

[8]. Qayyum, M. A., W. Wakil, M. J. Arif, S. T. Sahi, C. A. Dunlap. 2015. Infection of Helicoverpa armigera by Endophytic Beauveria bassiana Colonizing Tomato Plants. Biological Control 90: 200 – 207.

[9]. Behie, S.W., P.M. Zelisko, dan M.J. Bidochka. 2012. Endophytic Insect – Parasitic Fungi Translocate Nitrogen Directly from Insect to Plants. Science 336 (6088): 1576 – 1577

[10]. Behie, S.W., C.C. Moreira, I. Sementchoukova, L. Barelli, P.M. Zelisko, dan M.J. Bidochka. 2017. Carbon Translocation from a Plant to an Insect – Pathogenic Endophytic Fungus. Nature Communications 8 (14245): 1 – 5.

[11]. Waqas, M, Khan AL., Hamayun M, Shahzad R, Kang SM, Kim JG dan Lee J. 2015. Endophytic fungi promote plant growth and mitigate the adverse effects of stem rot: an example of Penicillium citrinum and Aspergillus terreus

[12]. Behie, S.W., S.J. Jones, dan M.J. Bidochka. 2015. Plant Tissue Localization of The Endophytic Insect Pathogenic Fungi Metarhizium and Beauveria. Fungal Ecology 13: 112 – 119