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Analysis of Various Concentrations of Botanical Insecticide from Virginia Tobacco Stem Bark (Lombok) on the Predator–Prey Ratio Between Spiders and Armyworm Pests (*Spodoptera litura* F.) in Potato Plants

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Abstract: Analysis of Various Concentrations of Botanical Insecticides from Virginia Tobacco Bark (Lombok) on the Predator–Prey Ratio Between Spiders and Armyworms (*Spodoptera litura* F.), conducted by Fatimah Adibah under the supervision of M. Taufik Fauzi and Lestari Ujianto.This study was carried out to examine how different concentrations of botanical insecticides derived from the bark of Virginia tobacco influence the population and attack intensity of the armyworm *Spodoptera litura* F., the population of spider predators (*Araneae*), and the resulting predator–prey ratio on potato plants. The research was conducted in potato cultivation fields and at the Plant Protection Laboratory, University of Mataram. Various concentrations of the botanical insecticide were applied, and observations were made on pest and predator populations, attack intensity, predator–prey ratios, as well as predation ability and pest mortality. The findings revealed that increasing concentrations of the botanical insecticide resulted in a reduction in the population and attack intensity of *Spodoptera litura* F. The 10% concentration (100 ml/L) was the most effective, as it significantly suppressed pest populations, increased mortality rates, and produced the lowest attack intensity. Correspondingly, the predator–prey ratio also declined at higher insecticide concentrations, with the lowest ratios recorded at 10% (family *Lycosidae*: 1:40.32; *Oxyopidae*: 1:28.99). The predation test showed a positive linear relationship between the number of prey and the predation rate, indicating that predators play an important role as natural enemies. Overall, the botanical insecticide derived from Virginia tobacco stems proved effective in controlling the armyworm *Spodoptera litura* F, while remaining indirectly safe for predator populations, making it a promising component for use in Integrated Pest Management (IPM) programs.

Keywords: Potato Plant, *Spodoptera Litura* F., *Araneae*, Virginia Tobacco Stem Botanical Insecticide.

Introduction

The potato is an annual vegetable crop that can be grown in both highland and lowland areas (Prayugo, 2021) . Potatoes are a major food staple worldwide and are widely cultivated because they support food diversification, In addition, potatoes also have high nutritional value due to their content of vitamin A, B vitamins, fat, phosphorus, calcium, and protein, and can serve as a primary source of carbohydrates for communities—equivalent to corn and rice—playing a crucial role in meeting global food needs (Aria, 2023).

One factor influencing fluctuations in potato production is the presence of plant pests in potato cultivation. Pests that frequently hinder potato growth include the leaf miner (*Lyriomiza huidobrensis*), the tuber borer (*Phthorimaea operculela*), cutworms (*Agrotis ipsilon*), aphids (*Myzus persicae*), thrips (*Thrips palmi*), armyworms (*Spodoptera litura* F), leaf-rolling caterpillars (*Chrysodeixis* sp.), and whiteflies (*Bemisia tabaci*) (Safira, 2020).

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The armyworm (*Spodoptera litura* F) is a pest belonging to the order Lepidoptera and the family Noctuidae; it is polyphagous with a wide host range, including soybeans, peanuts, cabbage, sweet potatoes, and potatoes (Samsudin, 2008) . This pest attacks potato leaves during both the vegetative and generative phases, potentially causing yield losses in potato crops of 20–80%. The cutworm attacks potato leaves by creating holes in the leaves and then chewing through the inner leaf tissue, causing the leaves to become translucent and leaving only the leaf veins intact (Moekasan et al., 2005).

Plant-based pesticides are natural insecticides derived from organic materials that work through their scent or active compounds that are toxic to insects. Compared to synthetic pesticides, this type of pesticide is more environmentally friendly because it degrades easily and is relatively safe for non-target organisms, including natural predators. One potential source that can be utilized is the tobacco plant, particularly the stems, which are often considered waste. Using tobacco stems as a raw material for botanical pesticides not only helps control pest populations but is also expected to strengthen the role of natural enemies and reduce farmers' reliance on synthetic pesticides, which still dominate agricultural practices (Sarjan et al., 2021)

In addition to botanical pesticides, the use of natural enemies such as predators, parasitoids, and entomopathogens can serve as a method for pest population control. One natural predator found on potato plants is the spider, which preys on a wide range of invertebrates—including pests—thereby reducing the population of pests attacking potato plants and decreasing reliance on chemical pesticides.

This study aims to analyze the effect of various concentrations of tobacco stem bark botanical insecticide on the armyworm (Spodoptera litura F.) and spider predators to identify the optimal concentration of tobacco stem bark botanical insecticide for controlling the armyworm (Spodoptera litura F.) without disrupting spider populations and to determine the effect of the treatments on the ratio of spider predators to armyworm (Spodoptera litura F.) pests

Method

The experimental design used in this study was a Randomized Block Design (RBD) with 6 treatments, each repeated 4 times, resulting in 24 experimental plots. The treatments applied were P0 (no pesticide), P1 2% botanical pesticide (20 ml/1000 L water), P2: 4% botanical pesticide (40 ml/1000 l water), P3: 6% botanical pesticide (60 ml/1000 l water), P4: 8% botanical pesticide (80 ml/1000 l water), and P5: 10% botanical pesticide (100 ml/1000 l water). The initial preparation involved soaking 1 kg of dried tobacco stem bark in 2.5 liters of water for 24 hours at room temperature to ensure optimal dissolution of active compounds such as nicotinoids. The solution was filtered to separate the residue from the filtrate. The resulting filtrate served as the base solution of the tobacco stem bark extract, to which aloe vera was added as a binder. The botanical insecticide was applied according to the predetermined treatment concentrations. Spraying was conducted at one-week intervals, totaling 7 times, starting from 4 MST through 10 MST. The required dosage was adjusted according to the height and size of the plants. Spraying was performed evenly over all parts of the plant, particularly on the undersides of the leaves, as the armyworm (*Spodoptera litura* F.) typically resides in that area.

The observation parameters in this study included the population of armyworms (Spodoptera litura F.), the intensity of armyworm (Spodoptera litura F.) infestation, spider predator population, the ratio of spider predators to armyworms (Spodoptera litura F.), predator predation tests on the pests, and pest mortality tests using tobacco stem bark-derived botanical insecticide. Data analysis was performed using Analysis of Variance (ANOVA), and results indicating a significant effect were subjected to further testing using orthogonal polynomial analysis.

Results and Discussion

Population of the Armyworm (Spodoptera litura F.)

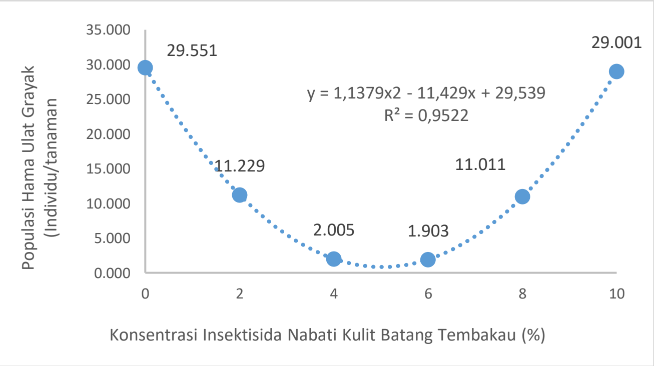

Figure 1. Graph showing the relationship between the application of various concentrations of Virginia tobacco stem-derived botanical insecticide and the population of armyworms (*Spodoptera litura* F.)

Based on the results of the orthogonal polynomial post-hoc test, a significant linear pattern was observed (Figure 1). The graph above shows a quadratic regression curve. This indicates that changes in the armyworm pest population follow a curvilinear pattern, as shown by the equation $y = 1.1379x^2 – 11.429x$

+ 29.539 with a coefficient of determination $R^2 = 0.9522$. At concentrations of 0% and 2%, the armyworm. This can be categorized as the optimal point for the effectiveness of the plant-based insecticide, since at that point the plant-based insecticide derived from tobacco bark was able to suppress the pest population. However, at concentrations of 8% and 10%, the armyworm pest population increased to 11,011 and 29,001 individuals per plant, respectively.

The effectiveness of tobacco stalks in suppressing the armyworm (Spodoptera litura F.) is due to the presence of active chemical compounds such as nicotine, flavonoids, alkaloids, and tannins. These compounds are toxic and act as both contact and stomach poisons. Their mechanism of action affects the pests' nervous and respiratory systems, thereby reducing the caterpillars' feeding activity. These disruptions ultimately make tobacco stem extract effective for controlling and reducing the armyworm population (Dávila, 2024).

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Intensity of Armyworm (Spodoptera litura F.) Infestation

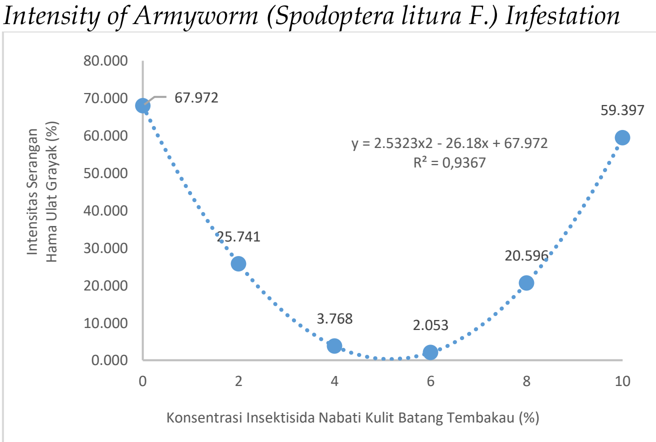

Figure 2. Graph showing the relationship between the application of various concentrations of tobacco stem insecticide and the intensity of the armyworm *(Spodoptera litura* F.) infestation

Based on the orthogonal polynomial graph of the intensity of armyworm (Spodoptera litura F.) infestation in Figure 2, the graph shows that at concentrations of 0% and 2%, the highest infestation intensity was 67.97, then decreased to 25.74; this indicates that at a 2% concentration, the plant-based insecticide derived from tobacco stem bark was already capable of reducing the infestation intensity of the armyworm. At concentrations of 4% and 6%, there was a drastic decrease in infestation intensity to 3.78 and 2.05, respectively. Based on the quadratic equation $y = 2.5323x^2 - 26.18x + 67.972$, the optimal concentration that maximizes the effectiveness of the tobacco stem bark insecticide against the armyworm was determined to be 5%, resulting in an infestation intensity of 0.26%.The intensity of the tobacco cutworm infestation increased again at concentrations of 8% and 10%, reaching 20.59 and 59.39, respectively.

Spider Predator Population (Araneae sp)

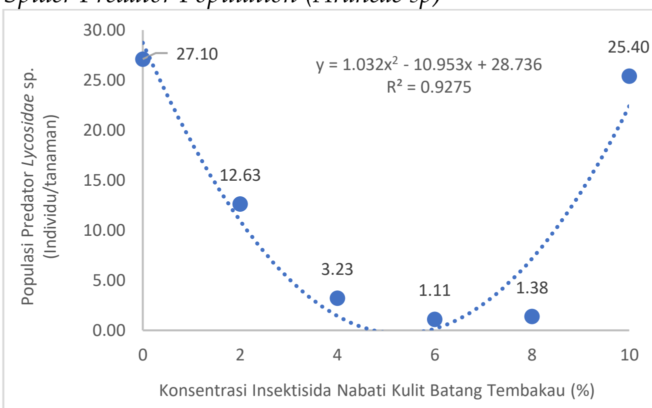

Figure 3. Graph showing the relationship between the application of various concentrations of Virginia tobacco stem plant-based insecticide and the population of *Lycosidae* sp. predators

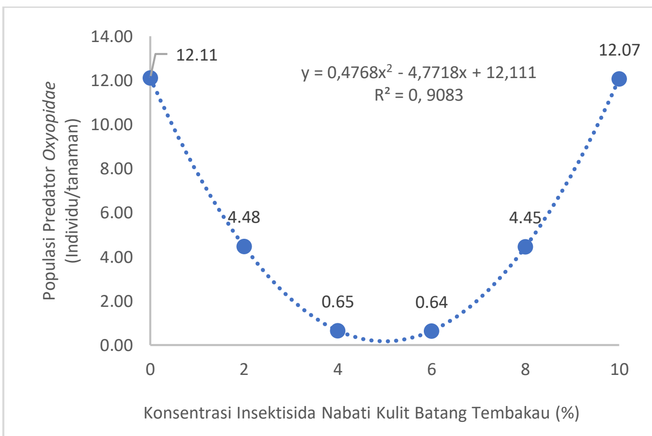

Figure 4. Graph showing the relationship between the application of various concentrations of Virginia tobacco stem bark-based botanical insecticide and the population of *Oxyiopedae* sp. predators.

Based on the results of the orthogonal polynomial analysis, the response of spider predators to various concentrations of plant-based insecticides derived from Virginia tobacco bark was shown to follow a quadratic regression pattern. Graph 4.10 shows the response of *Lycosidae* sp. predators. The curved graph illustrates the equation $y = 1.032x^2 - 10.953x + 28.736$, with a coefficient of determination $R^2 = 0.9275$. At plant-based insecticide concentrations ranging from 0% to 2%, the predator population decreased from 27.10 individuals per plant to 10.63 individuals per plant. The maximum decrease occurred at concentrations of 4% and 6%, where the predator population reached 3.23 and 1.11 individuals per plant, respectively. Based on the quadratic equation, the optimal concentration was determined to be 5%, resulting in the lowest predator population of 0.32 individuals per plant. However, at a concentration of 8%, the predator population increased to 1.38 individuals per plant, and then rose sharply at the 10% treatment to 25.40 individuals per plant.

Furthermore, the *Oxyopesidae* sp. predators exhibited a response to various concentrations of the plant-based insecticide derived from tobacco bark, as modeled by a quadratic regression equation. Changes in predator populations followed a quadratic pattern described by the equation $y = 0.4768x^2 - 4.7718x + 12.111$, with a coefficient of determination $R^2 = 0.9083$. At plant-based insecticide concentrations ranging from 0% to 2%, the predator population decreased drastically from 12.11 individuals per plant to 4.48 individuals per plant. The greatest decline occurred with botanical insecticides at concentrations of 4% and 6%, where the predator population reached 0.65 and 0.64 individuals per plant, respectively. The optimal concentration, determined using the quadratic equation, resulted in the lowest predator population at the 5% concentration, with 0.175 individuals per plant.

Ratio of Spider Predators to Armyworm Pests (Spodoptera litura F.)

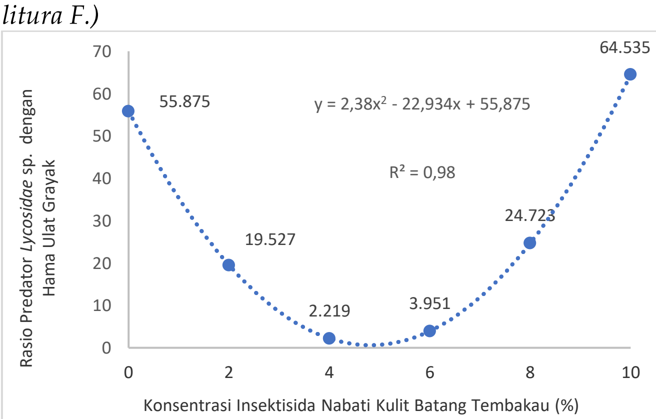

Figure 5. Graph of the ratio of *Lycosidae* sp. predators to armyworm pests resulting from the application of various concentrations of plant-based insecticides derived from tobacco stem bark

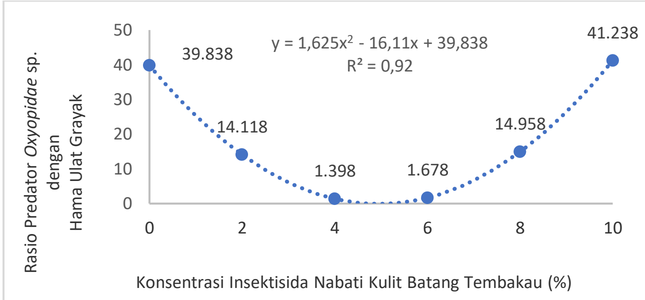

Figure 6. Graph of the ratio of *Oxyopedae* sp. predators to armyworm pests resulting from the application of various concentrations of plant-based insecticide derived from tobacco stem bark.

It can be seen that there is a relationship between the concentration of the plant-based insecticide derived from tobacco stem bark and the armyworm pest. The highest ratio was obtained in the control treatment (no concentration) at 1 : 0.179, then gradually decreased in the 2% and 4% treatments, with ratio values of 1 : 55.87 and 1 : 19.52, respectively. The ratio between predators and pests reached an optimum at a 5% concentration with a ratio of 1 : 2.03; subsequently, a gradual increase in concentration from 6% to 10% also increased the predator-to-pest ratio, with values of 1 : 3.95, 1 : 24.72, and 1 : 64.53, respectively. Furthermore, in Figure 4.19, the highest ratio was recorded in the control treatment at 1 : 39.83, with an optimum point at a concentration of 5% and a ratio of 1 : 0.08.

Predation Test

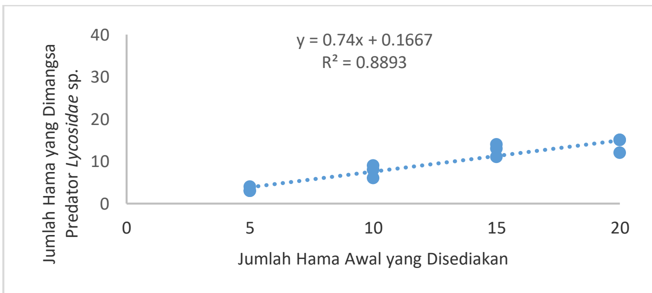

Figure 7. Graph of the Predation Test of the Predator *Lycosidae* sp. on the Pest *Spodoptera litura* F.

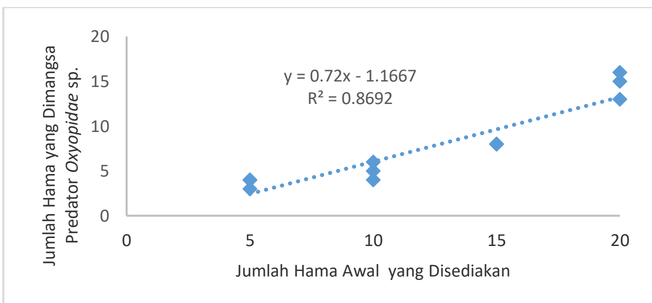

Figure 8. Graph of the Predation Test of the Predator *Oxyopedae* sp. on the Pest *Spodoptera litura* F.

The graph of the results of the predation test of the *Lycosidae* sp. predator on the armyworm (*Spodoptera litura* F.) shows a positive relationship between the number of available prey and the number of prey consumed, as indicated by the regression equation y = 0.166 + 0.74x and an R^2 value of 0.8893. This indicates that for every additional prey item, predation activity increases by 0.889% per individual. An increase in the number of armyworms provided (5, 10, 15, and 20 individuals) is directly proportional to the increase in the number of prey consumed by this Araneae sp., indicating that prey availability is the primary limiting factor in predation activity.

Furthermore, for the *Oxyopidae* sp. predator, there was a positive relationship between the number of available prey and the number of prey consumed, as indicated by the regression equation y = 1.1667 + 0.72x and an R^2 value of 0.8692. This indicates that for every additional prey, predation activity increases by 0.869% per individual. This is consistent with research conducted by Hidayat et al. (2021), which found that prey abundance significantly influences predator consumption rates, with an increase in prey population capable of enhancing hunting activity and predation efficiency.

Pest Mortality

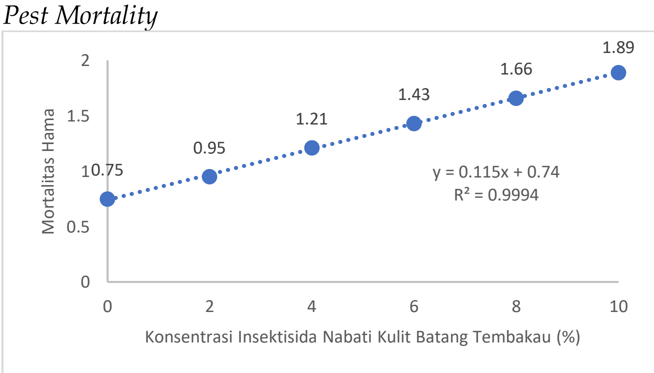

Figure 9. Graph of Mortality Tests on Armyworms *(Spodoptera litura* F.) Due to Plant-Based Pesticides Derived from Tobacco Bark

The graph shows that the mortality of the armyworm (*Spodoptera litura* F.) resulting from the application of various concentrations of plant-based insecticides derived from tobacco stem bark exhibits a linear increase, with the regression equation y = 0.0115x + 0.749 and R^2 = 0.99994. This positive linear relationship indicates that increasing the concentration of the applied botanical insecticide enhances the mortality of the armyworm.

The results of this study indicate that botanical insecticides derived from tobacco stems are highly effective in reducing the population of the armyworm (*Spodoptera litura* F.), with this effectiveness operating through two mechanisms: as a contact poison and by disrupting the insect's physiological processes. Active compounds such as nicotine, saponins, flavonoids, and terpenoids can disrupt insect physiological functions and act directly upon contact with the insect's body (Wahyuni et al., 2021). Nicotine and nornicotine in tobacco mimic the function of the neurotransmitter acetylcholine and bind to the insect's nerve receptors. This causes the nervous system to overact, leading to paralysis and ultimately death of the insect (Darmawan, 2024).

Mortality test results showed that the lowest mortality rate for armyworm pests was observed at a 2% concentration, while the highest mortality rate was observed at a 10% concentration. This demonstrates that the higher the concentration used, the higher the mortality rate of armyworm pests. Meanwhile, spider mortality results showed that the application of the plant-based insecticide derived from tobacco bark did not cause any deaths. The low and relatively consistent mortality rates across all treatment concentrations indicate that this botanical insecticide has no direct toxic effect on spiders. This aligns with previous research findings, as botanical insecticides effectively control pests without reducing the presence of natural enemies, thereby maintaining ecosystem stability (Pratiwi et al., 2025).

Conclusion

Based on the results of the study above, the following conclusions can be drawn: 1. The use of plant-based insecticides derived from tobacco bark at various concentrations on potato plants was able to reduce the population and intensity of cutworm infestations. This reduction was followed by a decrease in the number of spider predators, as a result of reduced prey availability in the field. 2. A 5% concentration of tobacco stem bark botanical insecticide (50 ml/1000 ml of water) is the optimal concentration for reducing the population and attack intensity of the armyworm without disrupting the presence of predators. 3. The greatest reduction in pest population and attack intensity occurred at the optimal concentration of 5% plant-based insecticide derived from tobacco stem bark, with a predator-to-pest ratio of 1:2.03 for *Lycosidae* sp. and the armyworm, and a ratio of 1:0.80 for *Oxyopidae* sp. and the armyworm.

Acknowledgments

It is recommended that future studies use the optimal concentration of 5% for controlling armyworm pests, taking into account the ratios consistent with the results of this study.

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