

The Effect of Dry Skin Extract of Tobacco Stems (*Nicotiana tabacum* var. Virginia) on the Armyworm Insect Pest (*Spodoptera litura* F.) and Its Predators on Potato Plants (*Solanum tuberosum* L.)

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ABSTRACT

This study aims to determine the effect of various concentrations of dry tobacco stem bark extract (*Nicotiana tabacum* var. Virginia) on armyworm pests (*Spodoptera litura* F.) and the presence of predators on potato plants (*Solanum tuberosum* L.). The experiment was conducted in Sembalun Village, East Lombok Regency, from July to September 2024. The parameters observed were pest population, intensity of pest attacks, presence of pest enemies, number of tubers, and tuber weight. This study used a Randomised Block Design consisting of 6 treatments (T) with four replications, namely T0 (control), T1 (abamectin), T2 (tobacco extract 30 ml/1000 ml water), T3 (tobacco extract 40 ml/1000 ml water), T4 (tobacco extract 50 ml/1000 ml water) and T5 (tobacco extract 60 ml/1000 ml water). The results showed that the use of botanical pesticides from dry tobacco stem bark can reduce the population and intensity of armyworm attacks. Application with a concentration of 30 ml/L water (T2) had a different effect compared to the control treatment

(T0). The higher the concentration used, the higher the ability to suppress pest populations and the intensity of pest attacks. The percentage of dry tobacco bark yield at a concentration of 60 ml/L water (T5) did not differ significantly from the chemical pesticide abamectin (T1) in suppressing the population and intensity of attacks by armyworms (*Spodoptera litura* F.).

ARTICLE INFO

Article history:

Received: 05 May 2025

Accepted: 28 January 2026

Published: 24 February 2026

DOI: <https://doi.org/10.47836/pjtas.49.1.108>

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Keywords: Armyworms, botanical pesticides, potatoes, tobacco

INTRODUCTION

Modern agriculture faces significant challenges, including pest management, particularly for food crops like potatoes (*Solanum tuberosum* L.). Potatoes are a vital agricultural commodity, serving as a food source and a globally valuable economic commodity. Potatoes are known to play a crucial role in agriculture, from households to large-scale industries in Indonesia, contributing to the production of flour and chips (Haverkort et al., 2023; Mulyono et al., 2017). Furthermore, potatoes are a staple food in many countries and also provide essential nutrients. However, potato production is often affected by various pests that can cause significant losses, including attacks by armyworms (*Spodoptera litura* F.) (Chakrabarti et al., 2022).

The armyworm (*Spodoptera litura* F.) is a well-known leaf-eating pest that is highly detrimental to farmers. This pest is polyphagous, meaning it damages not only food crops but also plantation crops. Furthermore, armyworm larvae can also reduce crop yields (Chisonga et al., 2023). Armyworm larvae often attack plants, especially their leaves, in large groups. This pest is active at night, so larval attacks usually occur at this time. The damage profile usually includes holes in the leaves, leaving only the leaf veins (Supartha et al., 2021).

Chemical pesticides are often the primary control method used by farmers, but continued reliance on their use can raise environmental and health concerns. Excessive reliance on synthetic insecticides can lead to pest resistance, ecological imbalances, and the death of non-target organisms (Rani et al., 2021). In response, there is growing interest in developing environmentally friendly alternatives that are biodegradable and leave minimal residues. Botanical pesticides derived from plants may offer a solution, offering several advantages, including their ability to degrade in the environment, their effectiveness, and their safety for non-target organisms (Khursheed et al., 2022). One promising source is the dried bark of tobacco (*Nicotiana tabacum* var. Virginia), which contains nicotine, a compound toxic to insects (Sarjan et al., 2021). This agricultural byproduct, often considered waste, can be reused as a plant-based insecticide while enriching soil organic matter. Sarjan et al. (2019) have formulated a liquid form of this product marketed as *Nabati BT Virginia* (Virginia tobacco stem), which has been shown to be effective against Lepidoptera pests on vegetable crops.

Repellents can act against various plant pests. Sarjan et al. (2021) stated that tobacco contains nicotine, which is toxic to insects, making it effective as an insecticide. Tobacco stems that have not been used optimally (often considered waste) can actually be used as a plant insecticide. Additionally, tobacco stems also have the potential to serve as a source of organic matter, providing essential nutrients to plants. Sarjan et al. (2019) also developed a formulation in the form of a liquid solution, which they used as a prototype for commercialisation under the pesticide brand *Nabati BT Virginia* (Virginia Tobacco Bar).

Currently, this pesticide is recommended for controlling pests of the order Lepidoptera (e.g., caterpillars) on various vegetable crops.

On the other hand, a promising approach to controlling armyworm pests on potato plants is to use natural enemies, such as predators, which can reduce the population and intensity of these pests' attacks. Predators of armyworms include: *Oxyopes javanus* Thorell (Nazli & Butt, 2020), *Lycosa pseudoannulata* (Luo et al., 2024), *Paederus fuscipes* (Chamankar et al., 2023), *Rhinocoris sp.* (Xuan Lam et al., 2024), *Andralus sp.* (Bayu et al., 2022), *Coranus sp.* (Mhlanga et al., 2022), *Vespidae* (Otis et al., 2023) and *Solenopsis geminata* (Lee et al., 2021). The presence of predators in agricultural land is influenced by several environmental factors, including biotic and abiotic factors (Sarjan, 2018). According to Furlong and Zalucki (2010), the amount of food (prey) or insect pests is an important factor that is positively related to predator population. This can be interpreted as the population density of insect pests increases, the predator population also tends to increase and vice versa. Therefore, expanding the use of botanical pesticides in the field and assessing the impact of natural enemies, such as predators, on controlling the population and intensity of armyworm pest attacks is very important. Hence, a study was conducted with the title "The Effect of Dry Skin of Tobacco Stems (*Nicotiana tabacum* var. Virginia) on Armyworm Pests (*Spodoptera litura* F.) and their predators on potato plants (*Solanum tuberosum* L.)"

RESEARCH METHODS

Time and Place of Research

This research was conducted in Sembalun Village, Sembalun District, East Lombok Regency, West Nusa Tenggara, from July to September 2024.

Experimental Design

This research employed the experimental method. Meanwhile, the design used was a Randomised Group Design with six treatments. The six treatments used consisted of:

1. T0 (control)
2. T1 (abamectin)
3. T2 (tobacco extract 30 ml/1000 ml water)
4. T3 (tobacco extract 40 ml/1000 ml water)
5. T4 (tobacco extract 50 ml/1000 ml water)
6. T5 (tobacco extract 60 ml/1000 ml water)

Research Implementation

The research implementation is based on the work of Sarjan et al. (2021), which includes land preparation, plot and bed preparation, planting, extraction of a compound from

tobacco stem waste, and application of the tobacco stem waste extract. Land preparation is done using a hoe by loosening 5 hectares of land. Then plots and beds are prepared. In the experimental area, six treatment plots were prepared, followed by four replication plots for each, resulting in a total of 24 treatment plots. In 1 treatment, it consists of 2 beds. The length of the bed is 3 metres by 1 metre.

Meanwhile, the bed spacing and the distance between replicates are 50 cm each, with a planting distance of 30 cm x 60 cm. Two rows of potato plants were planted in each bed, with each row consisting of 13 plants, resulting in a total of 26 plants in one bed and 52 in one treatment. Next, drill a planting hole with a depth of about 5-10 cm and an inter-plant spacing of 30 cm. Planting is done by placing potato seeds in the prepared planting holes. One potato seed is placed in each hole with the sprout facing upwards, and then covered with soil. Tobacco stem waste extract is prepared by soaking 1 kg of tobacco bark in a bucket of 2.5 litres of clean water. The two ingredients are then stirred and kneaded by hand for 30 minutes, after which they are left to rest for 24 hours. After soaking for 24 hours, the water is filtered to separate the bark from the extract, which is then used for its intended purpose. Next, add 100 grams of Wings Dab Soap to the extract and stir for 5-10 minutes. After the Wings Soap dissolves, filter it again into a clean container, and the extract is ready to use.

Plant care includes fertilisation, irrigation, embankment, and weeding. Fertilisation is carried out twice: the basic fertilisation co-occurs with planting, and the additional fertilisation takes place when the potato plants are 21 days old. Urea and NPK are used as fertilisers. Irrigation of potato plants is typically done once a week, or more frequently depending on the weather, water, and soil conditions in the potato-growing environment. The cultivation is done three times, namely at 4 WAP, then at 6 WAP, and one week before harvesting the potato plants. Weeding was done three times, specifically when the potato plants were at 5 WAP, then at 7 WAP, and finally at 10 WAP, as evident from the condition of the weeds present at the time of the survey.

Observation

Pest observations were conducted 8 times, namely at 3 WO, 4 WO, 5 WO, 6 WO, 7 WO, 8 WO, 9 WO, and 10 WO. Pest observations were conducted using *yellow sticky traps*, *yellow pan traps*, and *pitfall traps*, which were installed in the morning between 07:00 and 09:00 Central Indonesia Time and left for 24 hours before being withdrawn in the morning. Insects caught in *yellow sticky traps* were counted directly in the field. Insects caught in *yellow pan traps* and *pitfall traps* were filtered and picked up using a brush to prevent damage to their body parts. The insect is then placed in a bottle filled with 70% alcohol and taken to the laboratory for identification and analysis. The parameters observed in this study were pest population, intensity of pest infestation, presence of pest enemies, number of potato tubers, and weight of potato tubers.

Data Analysis

The observational data in this study were analysed using ANOVA with a significance level of 5%. Prior to the analysis, an assumption test was conducted, followed by an Honest Significant Difference (HSD) test at a significance level of 5%. A regression test was then conducted to determine the relationship between population size and pest attack intensity.

RESULTS AND DISCUSSION

Morphological Characteristics and Symptoms of Armyworm Larvae Attacks

The armyworm's body has black spots that give it a dark appearance, but if you look closely, you can see brownish lines on the sides of its body (Figure 1). Adult armyworms are about 5 cm long and usually attack plants at night, while these caterpillars hide in the soil during the day. Armyworms undergo complete metamorphosis into egg, larva, pupa, and imago stages. Its life cycle lasts about 20 days before it develops into a cocoon (pupa) and finally a butterfly. The butterfly is a dark grey moth, and the female can produce up to 2,000 eggs or more. Eggs are usually laid in clusters on the underside of leaves and hatch within 3 to 5 days (Yulasari, 2016).

Symptoms of armyworm infestation begin in the larval stage, where the larvae attack and damage the leaves, leaving behind remnants of the upper epidermis and leaf veins (Figure 1). This causes the plant to lose leaves. Armyworms begin attacking plants in the early vegetative stage, and their population peaks when the plants are 38 days old. The caterpillar population then increased again after the plants were 73 days old. Infested young plants retard their growth and can lead to plant death in severe infestations. Pests that attack during the flowering stage and early pod formation can significantly reduce crop yields and potentially even hinder the harvest. The damage that occurs in plants aged 10 days after planting (DAT) is 12.5%, while damage in plants aged more than 20 days after planting can exceed 20%.



(a)



(b)

Figure 1. (a) Armyworm (*Spodoptera litura* F.) and (b) Attack symptoms

Average Population and Attack Intensity of Armyworm Larvae (*Spodoptera litura* F.)

The results of further tests on the population and intensity of armyworm infestation showed significantly different results between the control and other treatments. The results of the analysis of variance are shown in Table 1.

Based on Table 1, the average population of armyworm pests in the T0 (control) treatment showed a significant difference compared to other treatments. This was because the T0 (control) treatment did not receive any pest control measures, resulting in a higher population of armyworms in the T0 treatment compared to the other treatments. The abamectin treatment (T1) was significantly different from the control treatment (T0) and 30 ml/L (T2). However, the abamectin treatment (T1) using chemical insecticides did not show any significant differences from the 40 ml/L (T3), 50 ml/L (T4), and 60 ml/L (T5) treatments. According to Khurshed et al. (2022), the higher the concentration of tobacco stem extract used, the more metabolite compounds it contains, so the active ingredient content also increases, and the toxic effect of plant biopesticides becomes stronger. The nicotine content in tobacco extract has a significant impact on its effectiveness as an insecticide. The nicotine contained in tobacco extract has a significantly effective insecticide effect. Nicotine, found in tobacco, can be found throughout the tobacco plant and is known to kill various types of organisms, including armyworms. Furthermore, Kaminski et al. (2020) in their research stated that nicotine is an alkaloid compound that occurs naturally in tobacco plants. This compound affects the pest's central nervous system and causes death in armyworm larvae. Besides nicotine, tobacco also contains various other chemical compounds, including acids, alcohols, aldehydes, ketones, alkaloids, amino acids, carbohydrates, esters, and terpenoids.

The average attack intensity in the control treatment (T0) was significantly different from the other treatments. This is because the control treatment (T0) is not controlled. The treatment with abamectin (T1) up to the 60 ml/L treatment (T5) showed no significant

Table 1

*Average population and intensity of attacks by armyworms (*Spodoptera litura* F.)*

Treatment (T)	Population (Individuals)	Intensity (%)
T0 (control)	8.00 ^a	16.85 ^a
T1 (Abamectin)	1.72 ^c	2.22 ^b
T2 (30ml/L)	4.13 ^b	6.64 ^b
T3 (40ml/L)	3.88 ^{b^c}	6.20 ^b
T4 (50ml/L)	3.56 ^{b^c}	5.84 ^b
T5 (60ml/L)	1.66 ^c	2.24 ^b
HSD 5%	1.98	4.14

Note. Numbers followed by the same letter in the same column do not differ significantly in the 5% HSD test

differences. This is because tobacco contains saponin compounds that can inhibit the taste receptors in the mouth of the larvae, resulting in the armyworm larvae not receiving taste stimuli. Saponin also has a bitter taste that causes larvae to be reluctant to feed (Arbaiatusholeha et al., 2016). Thus, the intensity of attacks in the treatment with plant extracts from tobacco stems could compensate for the results obtained in the abamectin (T1) treatment, which used chemical insecticides.

Average Tuber Number and Weight of Potato Tubers (*Solanum tuberosum* L.)

Based on the results of further tests on the number and weight of potato plant tubers, this is shown in Table 2.

Based on Table 2, the average tuber number and tuber weight of potato plants in the control treatment (T0) were significantly different from the other treatments, with an average tuber number of 7.03 and tuber weight of 0.30 kg. This is believed to be due to armyworm attacks on potato leaves, which disrupt the photosynthesis process and ultimately produce only a small number of tubers. This statement is in line with the opinion of Daudi et al. (2021) in their research, which explains that leaf damage caused by armyworms negatively impacts and disrupts photosynthesis, which in turn leads to reduced crop yields. However, the extent of crop losses depends on the severity of the leaf damage and the plant's growth stage at the time of infestation.

Treatment with abamectin (T1), a chemical insecticide, was not significantly different from treatment with 60 ml/L (T5), but treatment with abamectin (T1) was significantly different from treatment with 20 ml/L (T2), 30 ml/L (T3), and 40 ml/L (T4). This is related to the population and intensity of attacks in abamectin (T1) and 60 ml/L (T5) treatments, which were not significantly different. The population size and intensity of attacks depend on the condition of the plant's structure, specifically its leaves. Under healthy leaf conditions, the rate of photosynthesis can be maximised, allowing the plant to produce

Table 2

Number of tubers and tuber weight of potato plants (Solanum tuberosum L.)

Treatment (T)	Number of Tubers (Grains)	Tuber Weight (kg)
T0 (control)	7.03 ^c	0.30 ^c
T1 (20ml/L)	11.04 ^a	0.53 ^a
T2 (30ml/L)	9.41 ^b	0.43 ^b
T3 (40ml/L)	9.41 ^b	0.45 ^b
T4 (50ml/L)	9.54 ^b	0.45 ^b
T5 (60ml/L)	10.5 ^{ab}	0.50 ^{ab}
HSD 5%	0.71	0.05

Note. Numbers followed by the same letter in the same column do not differ significantly in the 5% BNJ test

sufficient assimilates that meet its needs and are stored in the tubers. (Saragih, 2019) states that leaves are among the plant organs that function as photosynthetic organs because they contain chlorophyll, a pigment that absorbs light energy and performs photosynthesis to produce sugar. The larger the leaf surface area, the more chlorophyll is present, indicating a higher rate of photosynthesis. By increasing the rate of photosynthesis, plant growth and yield will be faster.

The Ability of Botanical Pesticides of Dry Tobacco Stem Skin to Suppress the Population and Attack Intensity of Armyworm

Based on Table 3 above, the ability to suppress plant pests using the dry peel of tobacco stems (*Nicotiana tabacum* var. Virginia) under abamectin (T1) chemical insecticide treatment resulted in a 78.50% reduction in the average population of armyworm pests, with an average attack intensity of 86.82%. Under the treatment of plant pesticides, namely 20 ml/L (T2), 30 ml/L (T3), 40 ml/L (T4), and 60 ml/L (T5), respectively, the ability to suppress plant pesticides in tobacco stems increased by 20 ml/L (T2) on average. Suppressed the population by 48.37 % and suppressed the average attack intensity by 60.59%. In the 30 ml/l (T3) treatment, the average suppressed population was 51.50%, and the average suppressed attack intensity was 63.20%. In the 40 ml/l (T4) treatment, the average suppressed population was 55.50%, and the average suppressed attack intensity was 65.34%. In the 50 ml/l (T5) treatment, the average suppressed population was 79.25%. The average attack intensity was reduced by 86.70%. Thus, it can be said that the ability of herbal pesticides to suppress the dry skin of tobacco stems (*Nicotiana tabacum* var. Virginia) is *dependent* on the population and intensity of armyworm pest infestation (*Spodoptera litura* F.), exceeding 50%. At the highest concentration, the suppression effect

Table 3
Plant pesticides on the skin, dry tobacco stems, and the ability to increase tuber yield

Treatment (T)	Suppression Ability		Ability to Increase the Yield	
	Population	Intensity (%)	Number of Tuber	Tuber Weight
T1 (Abamectin)	78.50 ^b	86.82 ^a	56, 81 ^a	74.75 ^a
T2 (20ml/l)	48.37 ^c	60,59 ^c	33.66 ^c	42.62 ^c
T3 (30ml/l)	51.50 ^d	63.20 ^d	33.80 ^d	48.85 ^d
T4 (40ml/l)	55.50 ^c	65.34 ^c	35.51 ^c	49.18 ^c
T5 (50ml/l)	79.25 ^a	86.70 ^b	43.75 ^b	65.24 ^b
HSD 5%	-	-	-	-

reached 79.25%. Based on the research results of Syahwal (2023), it was found that the ability of plant pesticides from paitan plants to suppress the population and intensity of armyworm pest infestations exceeded 50%. At the highest concentration, namely 60 ml/L of paitan extract, the population and intensity of armyworm infestation reach 80%. It can be said that comparing the suppression ability of plant pesticides from dry tobacco skin and those from paitan plants does not make much difference.

Related to the ability of plant pesticides from dried tobacco stem skin (*Nicotiana tabacum* var. Virginia) to suppress the population and intensity of armyworm infestation in the treatment T1, which is 78.50% and 86.82 %, respectively, can increase the number of tubers by 56.81 % and tuber weight by 74.75 %. In addition, the average population and attack intensity in treatment T2 were 48.37% and 60.59%, respectively, resulting in a 33.66% increase in tuber number and a 42.62% increase in tuber weight. For treatment T3, the average population and intensity were 51.50% and 63.20%, respectively. The results showed that the number of tubers was 33.80%, and the tuber weight was 48.85%. In treatment T4, the average population and attack intensity were 55.50% and 65.34%, respectively, resulting in a 35.51% increase in the number of tubers and a 49.18% increase in tuber weight. In treatment T5, the average population and attack intensity were 79.25% and 86.70%, respectively, resulting in a 43.75% increase in the number of tubers and a 65.24% increase in tuber weight.

Development of the Armyworm Population (*Spodoptera Litura* F.) Weekly Observations

Based on observations of the armyworm (*Spodoptera litura* F.) population, each observation was repeated eight times on potato plants, yielding the population data presented in the graph (Figure 2).

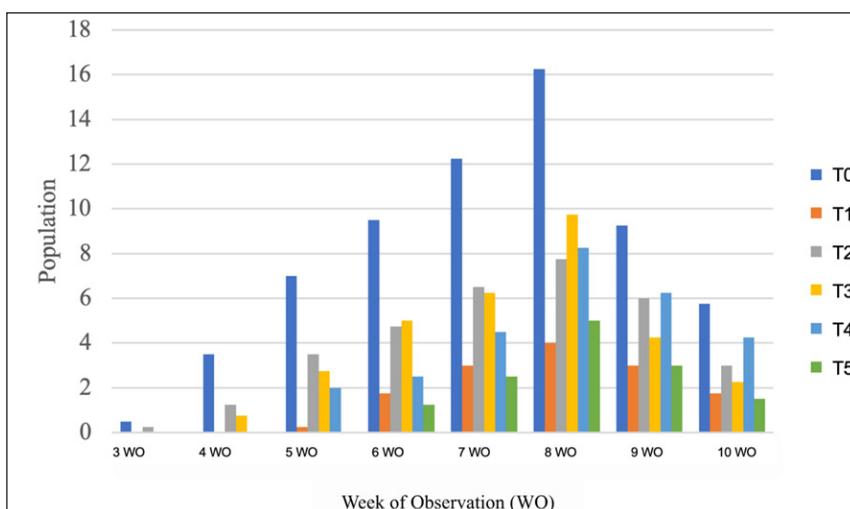


Figure 2. Number of armyworm (*Spodoptera litura* F.) populations per week

Based on Figure 2, it is a graph of the evolution of the armyworm population in each week of observation (WO). At the first observation (3 WO), the armyworm population began to emerge. Then the population increased until the highest population was reached at the sixth observation (8 WO) with an average population of 16.25 in the control treatment (T0). This is believed to be due to the abundant availability of food, as the quality of available food has a significant impact on the growth and development of the armyworm population. Pest population increases can be influenced by extrinsic and intrinsic factors (Supartha et al., 2021). Extrinsic factors include environmental factors such as food availability, natural enemies, climate, space, and competition. Intrinsic factors, on the other hand, include high adult fecundity and a short life cycle. Alvarez and Rodríguez (2024) also explained in their findings that dense plant leaves can serve as protection for various insects from sunlight and attacks by natural enemies. Differences in plant age also influence insect pest behaviour, as these pests tend to be attracted to areas with high fertility or abundant food sources.

In the seventh (9 WO) and eighth (10 WO) observations, the armyworm population decreased. This is because the potato plant has entered the generative phase, which is characterised by a decrease in nutrient content in the potato leaves. This finding is consistent with the research of Syahwal et al. (2024), which stated that the decline in pest populations was caused by reduced food availability, particularly in plant leaves. This condition is characterised by many leaves starting to turn yellow, wilt, dry out, and eventually fall off.

Development of the Attack Intensity of the Armyworm (*Spodoptera litura* F.) Every Observation Week

Based on observations of the attack intensity of the pest *Spodoptera litura* F., each observation was conducted eight times on potato plants, resulting in the attack intensity data shown in the graph (Figure 3).

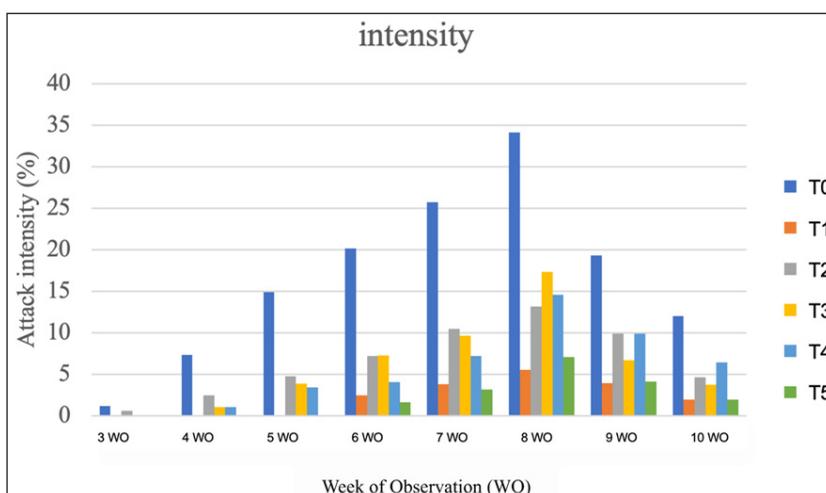


Figure 3. The intensity of attacks by armyworm pests (*Spodoptera litura* F.) per week

Based on Figure 3 above, it is a graph of the evolution of armyworm pest attack intensity in each week of observation (WO). At the first observation (3 weeks after planting), the attack intensity of armyworm pests began to appear. Then it increased until the highest attack intensity was reached at the sixth observation (8 WO) with an average attack intensity of 23.55% in the control treatment (T0). This is due to the increasing number of pest populations, which will lead to an increasing intensity of attacks caused. According to Palit et al. (2016), the greater the pest population, the higher the intensity of attacks caused by armyworm pests. The high intensity of armyworm pest attacks is also due to this pest being polyphagous. This corresponds to the conditions in the field, where other host plants, such as tomatoes, shallots, spinach, and cabbage, are present. Therefore, when other host plants are present, armyworm pests remain, increasing the intensity of their attacks.

From the seventh observation (9 WO) to the eighth observation (10 WO), the intensity of the armyworm pest attack decreased. The reason for the decrease in attack intensity is that the potato plants have entered the generative phase, and food availability is reduced, as evidenced by the fact that the leaves of the potato plants start to fall.

Main Predator Species in Controlling Armyworm Pest Populations (*Spodoptera litura* F.)

Based on Table 4, the main predators identified in this study included spider species from the Salticidae family, followed by the Black Ant (*Dolichoderus thoracicus*) and the Wasp (*Dusona douragia*). The highest predator abundance was observed in T0 (Control) with 22 individuals, while the lowest population was recorded in T1 (Abamectin), with only 2 individuals. Notably, Salticidae spiders were found in all treatments, but their populations were significantly higher in T2 (30 ml/L) compared to the chemical control (T1). This suggests that the botanical pesticide tobacco stem, at low concentrations, may be less harmful to predatory spider populations than synthetic alternatives.

Table 4 shows that as the concentration of tobacco extract increased (from T2 to T5), the predator population showed a gradual decline (15 individuals in T2 to 7 in T5). This decline is likely due to two factors: increased toxicity at high doses and a significant decrease in prey availability (armyworm).

Based on Table 4, the main predator identified in this investigation is a spider species from the family Salticidae. The average population of Salticidae spiders found in the field was 30 individuals. According to Oberg (2007), spiders are one of the important predators in plant ecosystems. As general predators, spiders have diverse prey and play an important role in reducing and preventing natural pest infestations in crop production. Spiders also help increase biodiversity in agroecosystems. Apart from this, the main predators found in the field include black ants (*Dolichoderus thoracicus*), with a total population of 25 individuals, and wasps (*Dusona douraguia*), with a total population of 16 individuals.

Table 4
Main predators of field armyworm pests (*Spodoptera litura* F.)

No.	Predator Species	T0	T1	T2	T3	T4	T5	Total Population (Individuals)	Pictures
1.	Spider family Salticidae	9	1	6	5	5	4	30	
2.	Black Ants (<i>Dolichoderus thoracicus</i>)	8	1	5	5	4	2	25	
3.	Wasp (<i>Dusona douraguia</i>)	5	0	4	3	3	1	16	
Total		22	2	15	13	12	7	71	

The increase in the number and diversity of predators is not always accompanied by an increase in the number of pests they prey on. The research results of Aprilizah (2006) found that a large population of predators is not always compensated for by an increase in the number of pests they hunt. Begon et al. (1986) also found that this phenomenon is caused by the type of interference (mutual interference) from other predators, which can reduce the level of predation. This shows that predator efficiency does not always increase with increasing predator diversity.

Relationship Between Population Size and Intensity of Armyworm Pest Infestation (*Spodoptera litura* F.)

Results of the regression analysis between population variables and attack intensity by armyworm pests (*Spodoptera litura* F.)

Based on Figure 4, the regression analysis plot for all treatments shows that the equation $Y = 2.3075x - 2.1611$ can be interpreted as meaning that for each additional individual of the pest *Spodoptera litura* F., the intensity of the attack caused by this pest increases by 2.3075%, with a coefficient of determination of 98%. This shows that the degree of relationship between population and attack intensity has a powerful influence.

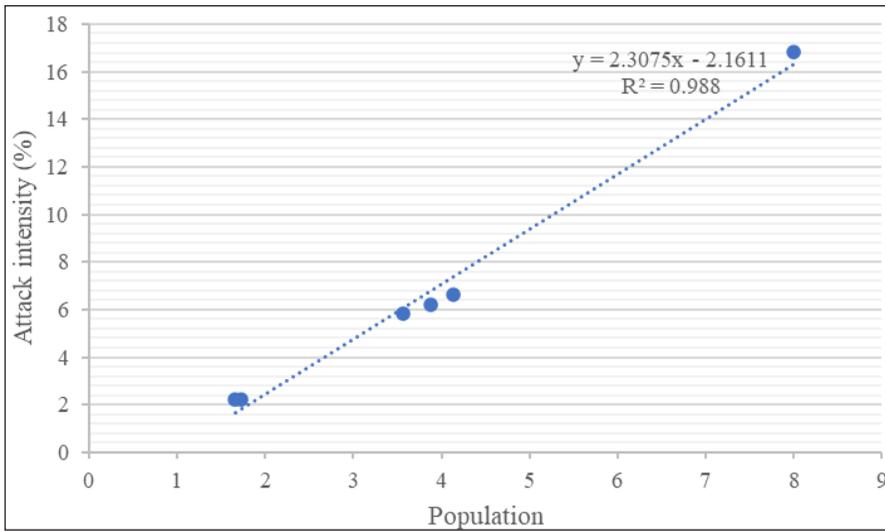


Figure 4. Regression analysis of the relationship between population size and attack intensity

The Relationship between Population Suppression Ability and the Intensity of Attacks on Potato Tuber Yields.

Results of regression analysis between population variables and the intensity of attacks by armyworms (*Spodoptera litura* F.) on potato crop yields.

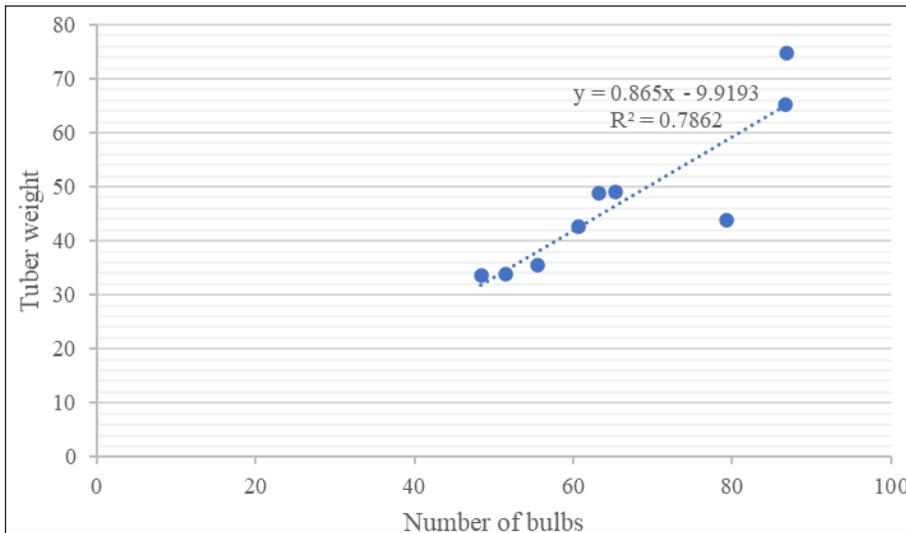


Figure 5. Regression analysis between the ability to suppress populations and the intensity of attacks on potato tuber yields

Based on Figure 5, the regression analysis diagram of suppression ability shows that the equation $Y = 0.865 - 9.9193$, with an R-squared value of 0.78, can be interpreted as meaning that for each additional suppression ability of botanical insecticides, the yield of potatoes increases by 0.865%, with a coefficient of determination of 78%. This shows that the degree of relationship between pressing ability and the number of tubers yields has a strong influence. It is clear that the higher the concentration used, the greater the ability to suppress pest population and intensity, and the higher the crop yield.

CONCLUSION

The findings of this study indicate that herbal pesticides derived from dried tobacco stem husks play an important role in reducing armyworm attacks, which have implications for increasing crop yields. The results of the study specifically showed that the application of a water concentration of 30 ml/l (T2) showed a significant difference in effectiveness compared to the control treatment (T0). Furthermore, there was a clear trend indicating that higher extract concentrations had an effect on increasing efficacy in suppressing pest populations and increasing the percentage of tuber yields. It is worth noting that a water concentration of 60 ml/l (T5) of the extract showed a comparable effect to the chemical pesticide abamectin (T1) in controlling armyworm populations (*Spodoptera litura* F.) and in increasing potato (*Solanum tuberosum* L.) yields. In addition, this study also identified the main natural predators of armyworm pests in the field, including Salticidae spiders, black ants (*Dolichoderus thoracicus*), and wasps (*Dusona douraguia*), which can contribute to the biological control of this pest. Broadly speaking, these results highlight the potential use of herbal pesticides as a viable and sustainable alternative to chemical pesticides in agricultural practices.

ACKNOWLEDGEMENT

The authors would like to thank the Directorate General of Higher Education, Ministry of Higher Education, Science, and Technology for its support of the Fundamental Research Scheme.

REFERENCES

- Alvarez, T. C. O., & Rodríguez, A. G. (2024). How do plants protect themselves against animal attacks? *Frontiers for Young Minds, 11*, Article 991723. <https://doi.org/10.3389/frym.2023.991723>
- Aprilizah, T. (2006). *Pengaruh kerapatan predator terhadap pemangsaan larva Spodoptera litura F. (Lepidoptera: Noctuidae)* [The effect of predator density on the predation of *Spodoptera litura* F. larvae (Lepidoptera: Noctuidae)] [Unpublished bachelor's thesis]. Institut Pertanian Bogor.
- Arbaiatusholeha, R., Yulawati, S., & Saraswati, L. (2016). Uji efikasi ekstrak batang tembakau (*Nicotiana* spp.) untuk pengendalian rayap tanah (*Coptotermes* spp.). [Efficacy test of tobacco stem extract (*Nicotiana* spp.) for the control of subterranean termites (*Coptotermes* spp.)]. *Jurnal Kesehatan Masyarakat, 4*(1), 201-210.

- Bayu, Y., Harnowo, S. W., & Mejaya, D. (2022). Biopesticide efficacy against main pests, diseases, and natural enemies of mungbean (*Vigna radiata* L.). *Applied Ecology and Environmental Research*, 20(2), 931-945. https://doi.org/10.15666/aecer/2002_931945
- Begon, M., Harper, J. L., & Townsend, C. R. (1986). *Ecology: Individuals, populations and communities*. Blackwell.
- Chakrabarti, S. K., Sharma, S., & Shah, M. A. (2022). Potato pests and diseases: A global perspective. In *Sustainable management of potato pests and diseases* (pp. 1-23). Springer. https://doi.org/10.1007/978-981-16-7695-6_1
- Chamankar, B., Maleki-Ravasan, N., Karami, M., Forouzan, E., Karimian, F., Naeimi, S., & Choobdar, N. (2023). The structure and diversity of microbial communities in *Paederus fuscipes* (Coleoptera: Staphylinidae): From ecological paradigm to pathobiome. *Microbiome*, 11(1), 1-20. <https://doi.org/10.1186/s40168-022-01456-z>
- Chisonga, C., Chipabika, G., Sohati, P. H., & Harrison, R. D. (2023). Understanding the impact of fall armyworm (*Spodoptera frugiperda* J. E. Smith) leaf damage on maize yields. *PLOS ONE*, 18(6), e0279138. <https://doi.org/10.1371/journal.pone.0279138>
- Daudi, S., Luboobi, L., Kgosimore, M., & Kuznetsov, D. (2021). Modelling the control of the impact of fall armyworm (*Spodoptera frugiperda*) infestations on maize production. *International Journal of Differential Equations*, 2021, Article 8838089. <https://doi.org/https://doi.org/10.1155/2021/8838089>
- Furlong, M. J., & Zalucki, M. P. (2010). Exploiting predators for pest management: The need for sound ecological assessment. *Entomologia Experimentalis et Applicata*, 135(3), 225-236. <https://doi.org/https://doi.org/10.1111/j.1570-7458.2010.00988.x>
- Haverkort, A. J., Linnemann, A. R., Struik, P. C., & Wiskerke, J. S. C. (2023). On processing potato: 1. Survey of the ontology, history and participating actors. *Potato Research*, 66(2), 301-338. <https://doi.org/10.1007/s11540-022-09562-z>
- Kaminski, K. P., Goepfert, S., Ivanov, N. V., & Peitsch, M. C. (2020). Production of valuable compounds in tobacco. In N. V. Ivanov & M. C. Sierro (Eds.), *The tobacco plant genome* (pp. 249-263). Springer International Publishing. https://doi.org/10.1007/978-3-030-29493-9_15
- Khursheed, A., Rather, M. A., Jain, V., Wani, A. R., Rasool, S., Nazir, R., Malik, N. A., & Majid, S. A. (2022). Plant based natural products as potential ecofriendly and safer biopesticides: A comprehensive overview of their advantages over conventional pesticides, limitations and regulatory aspects. *Microbial Pathogenesis*, 173, Article 105854. <https://doi.org/10.1016/j.micpath.2022.105854>
- Lee, C. M., Lee, D. S., Kwon, T. S., Athar, M., & Park, Y. S. (2021). Predicting the global distribution of *Solenopsis geminata* (Hymenoptera: Formicidae) under climate change using the MaxEnt model. *Insects*, 12(3), Article 229. <https://doi.org/10.3390/insects12030229>
- Luo, Y., Cheng, Y., Liu, L., & Fu, D. (2024). The complete mitogenome of the pond wolf spider *Pardosa pseudoannulata*, with phylogenetic implications for the Lycosidae. *Mitochondrial DNA Part B*, 9(4), 475-478. <https://doi.org/10.1080/23802359.2024.2337791>
- Mhlanga, L., Kapembeza, C., Sithole, R., & Kativu, S. (2022). Variation in ground insect diversity, composition and abundance across land use types in an African savanna, Zimbabwe. *Scientific African*, 16, Article e01204. <https://doi.org/10.1016/j.sciaf.2022.e01204>

- Mulyono, D., Syah, M. J. A., Sayekti, A. L., & Hilman, Y. (2017). Kelas benih kentang (*Solanum tuberosum* L.) berdasarkan pertumbuhan, produksi, dan mutu produk [Seed class potatoes based on growth, production, and quality products (*Solanum tuberosum* L.)]. *Jurnal Hortikultura*, 27(2), 209-216. <https://doi.org/10.21082/jhort.v27n2.2017.p209-216>
- Nazli, H., & Butt, A. (2020). Comparative study of two synthetic insecticides spiromesifen and thiamethoxam to determine their acute and residual toxicity against lynx spider (*Oxyopes javanus*). *Punjab University Journal of Zoology*, 35(1), 135-146. <https://doi.org/10.17582/journal.pujz/2020.35.1.135.146>
- Oberg, S. (2007). *Spiders in the agricultural landscape: Diversity, recolonisation, and body condition* [Doctoral dissertation, Swedish University of Agricultural Sciences]. SLU Service/Repro.
- Otis, G. W., Taylor, B. A., & Mattila, H. R. (2023). Invasion potential of hornets (Hymenoptera: Vespidae: *Vespa* spp.). *Frontiers in Insect Science*, 3, Article 1145158. <https://doi.org/10.3389/finsc.2023.1145158>
- Palit, G. P., Pinaria, B. A. N., & Meray, E. R. M. (2016). Populasi dan intensitas serangan larva *Spodoptera litura* pada tanaman kacang tanah *Arachis hypogaea* L. di Desa Kanonang Kecamatan Kawangkoan Barat [Population and attack intensity of *Spodoptera litura* larvae on groundnut *Arachis hypogaea* L. in Kanonang Village, West Kawangkoan District]. *COCOS*, 7(2).
- Rani, L., Thapa, K., Kanojia, N., Sharma, N., Singh, S., Grewal, A. S., Srivastav, A. L., & Kaushal, J. (2021). An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of Cleaner Production*, 283, Article 124657. <https://doi.org/10.1016/j.jclepro.2020.124657>
- Saragih, M. K. (2019). Hubungan luas daun dengan laju asimilasi bersih [The relationship between leaf area and net assimilation rate]. *Methodagro*, 5(1), 52-56.
- Sarjan, M. (2018). Potensi insektisida non-kimiawi sintetik dalam konservasi predator ulat grayak (*Spodoptera litura* F.) pada tanaman kedelai [Potential of non-chemical synthetic insecticides in the conservation of armyworm (*Spodoptera litura* F.) predators on soybean crops]. *AGROTEKSOS*, 13(4), 207-213. <https://agroteksos.unram.ac.id/index.php/Agroteksos/article/view/168>
- Sarjan, M., Fauzi, M. T., Thei, R. S. P., & Windarningsih, M. (2021). Pemanfaatan pestisida nabati dari limbah batang tembakau Virginia untuk mengendalikan hama penting tanaman kentang di Sembalun [Utilisation of botanical pesticides from Virginia tobacco stem waste to control important pests of potato plants in Sembalun]. *Jurnal Pepadu*, 2(2), 149-156. <https://doi.org/10.29303/pepadu.v2i2.2178>
- Sarjan, M., Fauzi, T. M., & Thei, P. S. R. (2021). Potensi limbah batang tembakau Virginia sebagai pestisida nabati untuk mengendalikan hama *Aphis* sp. pada tanaman kentang [The potential of Virginia tobacco stem waste as a botanical pesticide to control *Aphis* sp. pests on potato plants]. *Jurnal Prosiding SAINTEK*.
- Supartha, I. W., Sunari, A. A. A., Putra, G., Yudha, I. K., Putra, I. G., & Wiradana, P. (2021). Invasion, population development, and attack intensity of the fall armyworm (*Spodoptera frugiperda*) J.E. Smith (Lepidoptera: Noctuidae) on two varieties corn in Serongga Village, Gianyar Regency, Bali-Indonesia. *Technology Reports of Kansai University*, 63, 6945-6954.
- Supartha, I. W., Susila, I. W., Sunari, A. A. A. S., Mahaputra, I. G. F., Yudha, I. K. W., & Wiradana, P. A. (2021). Damage characteristics and distribution patterns of invasive pest, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) on maize crop in Bali, Indonesia. *Biodiversitas Journal of Biological Diversity*, 22(6), 3378-3389. <https://doi.org/10.13057/biodiv/d220645>

- Syahwal, R. (2023). *Efektivitas penggunaan beberapa konsentrasi pestisida nabati daun paitan (Tithonia diversifolia) terhadap populasi dan intensitas serangan hama ulat grayak (Spodoptera litura F.) pada tanaman kentang (Solanum tuberosum L.)* [The effectiveness of using several concentrations of paitan leaf (*Tithonia diversifolia*) botanical pesticide against the population and attack intensity of armyworm (*Spodoptera litura* F.) on potato plants (*Solanum tuberosum* L.)] [Bachelor's thesis]. Universitas Mataram.
- Syahwal, R., Sarjan, M., & Muthahanas, I. (2024). The efficacy of different concentrations of a botanical pesticide extracted from paitan leaves (*Tithonia diversifolia*) in controlling the population and reducing the severity of armyworm (*Spodoptera litura* F.) infestations in potato crops (*Solanum tuberosum* L.). *Jurnal Ilmiah Mahasiswa AGROKOMPLEK*, 3(2), 165-176.
- Xuan Lam, T., Ngoc Linh, H., Thanh Truc, T., Dac Dai, N., Quang Cuong, N., Eguchi, K., Quoc Viet, H., Noi, H., Dinh Phung High School, P., & Dinh Phung, P. (2024). Discrimination of Vietnamese species of the genus *Rhynocoris* (Hemiptera: Heteroptera: Reduviidae) with the utilisation of integrative taxonomy. *Academia Journal of Biology*, 46(2), 19-32. <https://doi.org/10.15625/2615-9023/20534>