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Effectiveness of Botanical Pesticides from Wastes of Virginia Tobacco Stems in Reducing Populations of Leaf-Sucking Pest and Occurrence of Virus Disease Symptoms on Potato Plants

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***Abstract*— *The potato plant (Solanum tuberosum L.) is a tuber-producing plant which is rich in carbohydrates, protein and minerals, and can be used as a staple food, and potatoes have great potential as one of the horticultural crops that can support world food diversification. One of the constraining factors in increasing potato productivity is leaf-sucking pests including aphids (Aphids spp.,), whitefly (Bemisia tabaci), and thrips (Thrips Palmi Karny), which besides damaging plants directly, can act as vectors for viruses that cause potato plant diseases such as Potato virus Y (PVY) and Potato leaf roll virus (PLRV). These two viruses can cause quite severe damage and through the health of the seeds they produce, they can reduce potato productivity by up to 70-80%. This study aims to determine the effect of several concentrations of botanical pesticides from Virginia tobacco stem waste on the emergence of viral disease symptoms in potato plants. The experiment was carried out in Sembalun Bumbung Village, East Lombok Regency (Indonesia), which was arranged using a Randomized Block Design consisting of 6 treatments namely control, abamectin, and Virginia tobacco stem waste botanical pesticides with concentrations of 2, 4, 6 and 8 ml/L. The results showed that the botanical pesticides from Virginia tobacco stem waste were effective in reducing leaf-sucking pest populations and suppressing the intensity of leaf-sucking pest attacks and were able to suppress the emergence of viral disease symptoms, with a concentration of 8 ml/L botanical pesticides more effective than other treatments in controlling populations. and attacks by potato leaf-sucking pests suspected as virus vectors.*

***Keywords*— Potato, Leaf Sucking Pests, Viruses, Botanical Pesticides, Tobacco Stem Waste**

I. INTRODUCTION

Potato is one of the most important vegetable commodities and has high economic value and is a plant with great potential as a horticultural crop that can support world food diversification. It is also the fourth leading food commodity in the world after rice, corn and wheat [1, 2]. Potatoes can be used to diversify carbohydrate sources, increase farmers' income, as non-oil and gas commodities, industrial raw materials and others. The potato market is not only domestic but also penetrates the export market. The need for potatoes continues to increase every year, but potato production has not been able to meet market demand which increases every year. Opportunities for the potato consumption market are quite promising and there is an ever-increasing increase in demand, resulting in the development of potato marketing in the local and export markets [3].

Although potatoes can be grown in medium plains up to 350 meters above sea level, in Indonesia they are generally grown in high altitudes with relatively large rainfall. Therefore the use of pesticides in potato farming is very high. The unwise use of synthetic pesticides can cause losses, such as water and air pollution, poisoning in both humans and livestock, killing natural enemies, pest resurgence, accumulation of pesticide residues, and increased production costs which will weaken the competitiveness of the potato business in the market. In developing environmentally sound potato farming, the government has introduced the principles of integrated pest management (IPM) which include: (1) cultivating healthy plants, (2) utilizing natural enemies, (3) routine monitoring, and (4) farmers as experts IPM. Integrated Pest Management is a more comprehensive and integrated plant protection based on ecological and economic considerations, so that IPM is not only oriented towards increasing production, but also pays attention to environmental preservation and safety (health) of producers (farmers) and consumers (wide community).

Obstacles that are often faced in efforts to increase potato production are Plant Disturbing Organisms (OPT). Attacks caused by pests can reduce the quality and quantity of crops [4]. There are about 14 species of bacteria, 13 species of fungi, 7 species of viruses, 4 species of nematodes, 18 species of pests that inhibit the productivity of potato plants, so that pest attacks are a limiting factor in potato cultivation today. The reasons mentioned above, from an economic perspective, still justify the application of synthetic pesticides to control OPT on a scheduled basis, using pesticides that are persistent and have high toxicity, regardless of the principles as recommended in an integrated pest control system (IPM).

As is the case with other high economic value commodities, the role of synthetic pesticides in the potato production process has reached the level of insurance for the success of potato cultivation, so that their use tends to be more and more excessive (excessive). The use of pesticides is one way for farmers to deal with pests, but in their use, farmers often do not pay attention to the type and dosage of pesticides used. It is feared that the use of excessive doses intensively with shorter spraying intervals will have a negative impact on farmers, consumers and the environment [5]. The excessive use of chemical pesticides will also have an impact on pests and plant diseases so that they become resistant and the development of pests is increasing rapidly [5].

Negative impact consequences as a result of excessive pesticide application have been detected. As an illustration, the leafminer fly *Liriomyza huidobrensis* Blancard, which was not previously the main pest of potato plants, exploded and even formed new strains that are resistant to various kinds of active ingredients of synthetic insecticides [6].

In potato plants there are several species of leaf-sucking insect pests including aphids (Aphids spp.), whitefly (*Bemisia tabaci*), and thrips (Thrips Palmi Karny). Leaf-sucking pest attack is one of the factors that can reduce the yield of potato productivity. Aside from being a direct pest on potato plants, leaf-sucking insect pests can also indirectly act as virus vectors on potato plants. According to Anggraini [7] leaf-sucking pests are known to act as vector pests for several types of viruses that interfere with the growth of potato plants. The types of viruses that are often found in potato growing areas in Indonesia are Potato virus Y (PVY) and Potato leaf roll virus (PLRV). Both of these viruses can cause quite severe damage and the health of the seeds produced greatly affects crop production. This viral disease can reduce potato productivity by up to 70-80% and the disease will also be carried over to the next crop.

In dealing with the problems above, one alternative that can be applied to replace the use of chemical pesticides is by using plant-based pesticides from waste of Virginia tobacco stems. Tobacco contains nicotine and the very specific organic compounds from Virginia tobacco was produced by a research team from the Faculty of Agriculture, University of Mataram under the name Botanical Pesticides “BT VIRGINIA” [8], which has been tested against pests from the Lepidoptera order such as *Spodoptera litura* on soybean [9]. Utilization of Virginia tobacco stem waste as a botanical pesticide is expected to have a positive effect on dealing with pest problems and increase the role of natural enemies to suppress pests that are suspected of being virus vectors in potato plants. Not many farmers have taken advantage of the use of Virginia tobacco stem wastes, especially in West Nusa Tenggara, in an effort to control the relationship between leaf-sucking insect pests and the symptoms of the virus.

One alternative that can be applied to replace the use of chemical pesticides is the use of plant-based pesticides from Virginia tobacco stem waste, so this research was conducted with the aim of knowing the effect of virginia tobacco stem waste pesticides on populations and the damage caused by leaf-sucking pests and disease symptoms. virus on potato plants in Sembalun, West Nusa Tenggara Province (Indonesia).

II. MATERIALS AND METHODS

This research was conducted in August-November 2020 in Sembalun Village, East Lombok, West Nusa Tenggara using an experimental method. The stages of the research started from determining the land and taking sample plants and maintaining the plants to the application of botanical pesticides from Virginia tobacco stem waste.

2.1. The experiment and treatments

The experiment was arranged using a randomized block design (RCBD) consisting of 6 treatments namely control, abamectin 35 EC 0.5 ml/L, botanical pesticides from

Virginia tobacco stem waste with concentrations of 2, 4, 6 and 8 ml/L.

The land used was about 3 acres (350 m2) with a length of 21 m and a width of 17 m, which was accompanied by the condition of the location being 100% planted with potatoes. Land was processed first to loosen the soil, with the aim of breaking the life cycle of pests and diseases that live in the soil, smoothing air circulation in the soil so that plant growth and development can take place optimally. After plotting the area, 18 experimental plots were made with an area of 4.3 x 2.5 m per plot, each experimental plot having 40 plants. During direct observation, 10% of the plant population (4 plants/plot) was observed in each plot.

Before planting, the potato seeds are first selected between healthy and diseased seeds, then planting holes are made 5-10 cm deep with a spacing of 20 cm. Planting is done in the planting hole by inserting one potato seed into the planting hole with the bud facing upwards and then covering it with soil. The application of fertilizer to the potato plants was carried out in the initial phase of planting using 30 kg of NPK fertilizer, 150 kg of Petroganik organic fertilizer and 5 kg of “Sinarbio” biological fertilizer, which was carried out by planting the potatoes together. Potato plants were irrigated 2 times during the growing season, namely at the beginning of planting and after soiling. Watering is done until the soil reaches field capacity. Hilling was done twice: at the age of 30 and 37 days after planting (DAP). This was done so that the growth of the potato plants becomes better. Weeding was done twice during growing season.

2.2. Preparation and application of the pesticide

The process of making botanical pesticides from extracts of Virginia tobacco stems is as follows. Tobacco stem waste that has been chopped into small pieces using a machete, the skin is separated using a knife, then air-dried until the moisture content (12%). The dried pieces of tobacco stems were mashed with a blender, and 250 g of the tobacco stem powder was mixed with 200 ml of water, and added with sufficient soap, then stored for 24 hours. At the time of packaging, the bottle which was already filled with Virginia tobacco stem extract was added with sufficient sugar and labeled.

Spraying was done after the plants were 21 DAP when the pests had started to appear on the potato plants. Spraying time was carried out in the afternoon from 16.00 to completion and observations were made the next day in the morning from 07.00 to completion.

2.3. Observation variables

2.3.1. Population

Observation of leaf-sucking pest populations was carried out using the visual method, namely by directly counting the number of pests and the incidence of virus symptoms present in the sample plants. Each experimental plot contained 40 plants and each plot observed 10% of the plant population. In addition, yellow adhesive traps are also used. Observations were made starting at 8 weeks with an interval of 7 days. Pest population data is used to calculate the dominance index value and relative abundance of each type of pest. To determine the intensity of attack (damage level) of leaf-sucking insect pests, it was carried out by observing the percentage of leaf damage symptoms of sample plants. Observational data were analyzed for diversity (ANOVA) and Tukey's HSD at 5% significance level, and to determine the relationship between pest populations and attack intensity and the relationship between pest populations and the incidence of viral symptoms, regression analysis was performed. Some of the equations used in this study are:

- Dominance of Leaf Sucking Pests: $C=\sum(in/N)^2$, in which **in=** the total number of individuals of a species; **N=** total number of individuals of all species.
- Relative abundance of leaf-sucking insects, equals to: **K = 100% in/N**.
- Intensity of the leaf-sucking pest attack, equals to: $P=\frac{\sum(ni \times vi)}{z \times N} \times 100\%$, in which **ni**= the number of plants or plant parts observed from each category; **vi** = scale value of each category of attack; **z** = highest attack category scale; **N** = number of plants or plant parts observed.
- PVY and PLRV viral disease occurrence.

2.3.2. Incidence of viral diseases found

This was calculated using the following equation:

$P=\frac{A}{N} \times 100\%$, in which P = Incidence of viral disease (%); A = Number of symptomatic plants; N = Number of plants observed.

III. RESULTS AND DISCUSSION

3.1. Leaf Sucking Pest Population

A total of 4,388 individual leaf-sucking pests were recorded in this study, represented by three species, namely *Bemisia tabaci* (Figure 1), *Thrips* spp. (Figure 2), and *Aphis* spp. (Figure 3).

Overall, the most abundant leaf-sucking pests were *Thrips* spp, with a total of 2,587 individuals, *Aphis* spp., with a total of 1,120 individuals and *Bemisia tabaci*, with a total of 681 individuals. Hama *Thrips* spp. has a shorter life cycle and is able to reproduce faster so it can breed well, followed by Aphis spp., and lastly *Bemisia tabaci*. Pests that have a short life cycle will benefit more than other pests during the rainy season, such as the conditions at the time of observation in the implementation of this study.

Fig. 1. *Bemisia tabaci*

Fig. 2. *Thrips* spp

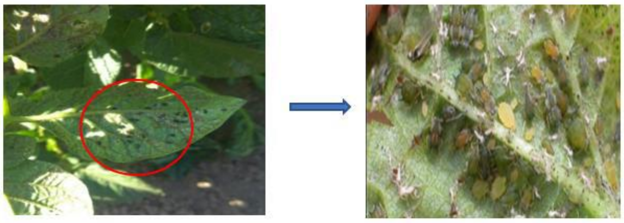

Fig. 3. *Aphis* spp

Table 1 shows that the highest population of leaf-sucking pests was found in the control treatment (without insecticides). This happened because no protection was given to potato plants in an effort to control leaf-sucking pest populations. There was no significant difference in the average population of potato leaf-sucking pests in the Abamectin insecticide treatment and the control (without insecticide).

Table 1. Average population of leaf-sucking pests on various treatments of potato plants

Treatments	Population
Control	603.4 ^{a}
Abamectin 0,5 ml/L	564.9 ^{ab}
Virginia tobacco pesticide 2 ml/L	449.9 ^{abc}
Virginia tobacco pesticide 4 ml/L	408.9 ^{abc}
Virginia tobacco pesticide 6 ml/L	365.7 ^{bc}
Virginia tobacco pesticide 8 ml/L	319.7 ^{c}
HSD 5%	67,2

Remarks: Numbers followed by the same letters are not significantly different

The lowest average population of leaf-sucking pests was found in the treatment of botanical pesticides from Virginia tobacco stem waste 8 ml/L. This shows that the higher the concentration of pesticides used, the higher the ability to control pest populations. The results of Shatriadi's research [10], showed the effectiveness of the natural pesticides of cigarette waste made from tobacco with higher concentrations followed by an increase in the number of dead pests. Tobacco has the highest nicotine content, as much as 5% of the weight of tobacco is nicotine which is a strong nerve poison and is used in insecticides, so that when used in higher doses, it will be effective in controlling pests. There was no significant difference in the population of leaf-sucking pests between concentration treatments of botanical pesticides from tobacco stem waste, but there appeared to be differences in pest populations with the abamectin and control treatments.

Overall it can be seen that the population of leaf-sucking pests from observation 1 (21 dap) to observation 5 (49 dap) continued to increase in all treatments and tended to decrease in observations 6 (56 dap) to 8 (70 dap). In the treatment with chemical pesticides, there was a significant increase in the population of leaf-sucking pests on 70 dap potato plants. This could be due to the invasion of pests from the surrounding plantations, due to their polyphagous nature and the presence of alternative hosts causing high pest populations to be found. Chemical pesticides with the active ingredient Abamectin have the property of killing insect pests which work as contact and stomach poisons. They should be able to reduce the population of leaf-sucking pests on potato plants, but the population recorded in this study was very high. This contradicts Manuh's statement [11] that the insecticide with the abamectin compound with the chemical name Avermectin B1 (C48H72O14) is an active ingredient that works lethally on insects by interfering with nerve transitions. Abamectin has few systemic properties, but has a strong translaminar effect. This pesticide is relatively friendly to the environment because it is rapidly degraded photochemically in the environment. In addition, abamectin is also strongly bound in the soil. In practice, the negative effect of Abamectin on useful insects is minimal, although some useful insects are sensitive to Abamectin.

3.2. Attack Intensity of Potato Leaf-sucking Pests

The damage caused by leaf-sucking pests can be seen from the symptoms of the attacks they cause. Symptoms of

Thrips spp. pest attack, namely on the leaves there are white spots, then turn silver gray and dry (Fig. 4-right). Symptoms of attack from *Aphis* spp., leaves shrink and curl, then gradually turn yellow and wither (Fig. 4-middle). *Aphis* spp. pests can suck nutrients from host plants, puncture marks cause chlorotic spots to appear, while *Bemisia tabaci* pests have symptoms such as leaves showing necrotic spots, yellow leaves, curling, curling to form a bowl and plants become stunted (Fig. 4 – left).

Fig. 4. Symptoms of insect pests Bimisia tabaci (left), Aphids spp. (middle), and Thrips spp. (right)

The average percentage of damage experienced by potato plants due to leaf-sucking pest attacks ranged from 20.3% to 62.4%. In the control treatment, the intensity of leaf-sucking pest attacks was always the highest. In the abamectin treatment, the average attack intensity was lowest during the observation. According to Kardinan [12], chemical pesticides that are applied to control pests react faster in the insect's body because the working system of these active ingredients is contact, stomach and nerve poisons, so that even though the population of leaf-sucking pests is recorded to be the highest, the percentage of damage to potato plants The damage it causes remains low, this happens because the level of damage caused by a pest can be determined by the type of pest, how it attacks and the part of the plant that is attacked [13].

Thus the number of pest populations in the Abamectin treatment which caused attack symptoms on potato plants remained low. In the treatment of botanical pesticides with Virginia tobacco stem waste at different concentrations, the results were not much different, the higher the concentration given, the more able to control the population level and intensity of attack by leaf-sucking pests. This is in line with Purba [14], who stated that the increase in concentration is directly proportional to the increase in the poison, so the killing power is higher. The content of Nicotine, Saponins and Alkaloids in tobacco stems has a high killing power against insects through contact poisons, stomach poisons, food repellents and is systematic.

Table 2 shows that the chemical pesticide treatment showed the lowest intensity of damage to potato plants caused by leaf-sucking pests in each observation and was significantly different compared to the other treatments. In the treatment of botanical pesticides, Virginia tobacco stem waste 2.0 ml/L and 4.0 ml/L did not significantly affect the intensity of pest attacks. This happens because at low doses, the active ingredients contained in botanical pesticides are less active [11]. On the other hand, in the treatment of botanical pesticides from Virginia tobacco stem waste 6.0 ml/L and 8.0 ml/L had a significant effect on the intensity of the attack compared to the control. Thus, it can be said that the treatment of plant-based pesticides from Virginia tobacco stem waste at higher concentrations is able to reduce the intensity of attacks from leaf-sucking pests.

Table 2. Average percentage of attack intensity of potato leaf sucking pests

Treatment	Attack intensity (%)
Control	62.4^{a}
Abamectin 0.5 ml/L	20.3^{c}
Tobacco pesticide 2 ml/L	50.3^{ab}
VirginiaTobacco pesticide 4 ml/L	50.7^{ab}
VirginiaTobacco pesticide 6 ml/L	40.2^{b}
Virginia Tobacco pesticide 8 ml/L	39.4^{b}

In the treatment using 8 ml/L Virginia tobacco stem waste botanical pesticide showed the lowest intensity of sucking pest attacks compared to other Virginia tobacco stem waste botanical pesticides because the concentration of the 8 ml/L virginia tobacco stem waste botanical pesticide contained nicotine in that concentration and worked well. According to Aryadan Yori [15] nicotine compounds contained in plant pesticides from tobacco stem extract can kill pests in a specific way of working, namely interfering with insect communication, causing insects to refuse to eat, reducing appetite, blocking the ability to eat, and repelling insects so that insect pests are reluctant to approach or eat the treated plants.

Damage to potato plants due to leaf-sucking pests in this study was measured by the extent of attack symptoms caused by pests such as physical damage to plants. The symptoms are silver gray spots, necrotic spots, and the leaves are smaller and curled. Trends in the intensity percentage of attack by leaf-sucking pests on potato plants showed fluctuations that tended to be the same between treatments, but the difference was the high intensity of attack for each observation and treatment.

Some of the symptoms it causes are symptoms of attack from *Thrips* spp., namely on the leaves there are white spots, then turn silver gray and then dry. Symptoms of attack from *Aphis* spp., causing the leaves to shrink and curl, then gradually turn yellow and wither. Pests Aphis spp., can suck nutrients from the host plant, the puncture marks cause chlorotic spots to appear. In contrast, the symptoms of the *Bemisia tabaci* pest include visible necrotic spots on the leaves, yellow leaves, curling, curling to form a bowl and the plants become stunted.

The development of the attack intensity of leaf-sucking pests on potato plants showed a pattern of increase and decrease which tended to be the same between treatments, but the difference was the percentage of attack intensity for each observation and treatment. The increase and decrease in attack intensity is thought to be due to the density of pest populations, the availability of food and the difference in the ratio of damage to the number of leaves infected with leaves that are still healthy at the time of the previous observation. According to Sarjan [9] the amount of yield loss as a result of leaf damage is determined by the density of the attacking pest population, the ability to eat nymphs, the parts of the plant that are attacked, the growth phase and the sensitivity of the plant to the level of damage is closely related to its tolerance in genetics.

In the control treatment, the population and attack intensity of leaf-sucking pests were always the highest, this happened because the control treatment was not given pesticide treatment in pest control, so that from the beginning of the observation to the end of the observation of plants aged 21-70 DAP the average control treatment was always the highest compared to other treatments. The treatment with chemical pesticides showed the lowest average attack intensity during the observation. However, the population obtained is the highest, this occurs because the level of damage caused by a pest can be determined by the type of pest, how it attacks and the part of the plant that is attacked [13]. Thus, the number of pest populations treated with chemical pesticides that cause attack symptoms on potato plantations remains low. In the treatment of botanical pesticides from Virginia tobacco stem waste with different concentrations for each treatment the results were not much different, the higher the concentration given, the more able to control the population and intensity of attack by leaf-sucking pests. The increase in concentration is directly proportional to the increase in the poison, so the killing power is higher. The content of Nicotine, Saponins and Alkaloids in tobacco stems has a high killing power against insects through contact poisons, stomach poisons, food repellents and is systematic [14].

Symptoms of attack intensity from leaf-sucking pests can be seen from the beginning of the observation, because these pests damage the young parts of the potato plants such as leaves, stems and flowers. These leaf-sucking pests suck the nutrient liquid contained in potato plants, resulting in disrupted growth and development of potato plants. The intensity of attack is very important to know, so that it can determine the economic threshold of potato plants.

3.3. Relationship between Population and Intensity of Leaf Sucking Pest Attack

The value of the treatment regression equation analysis P0 (control), P1 (chemistry), P2, P3, P4, P5 respectively $Y = 12.017x-4.52$, $Y = 0.0347x+0.0077$, $Y = 0.0955x - 0.0296$, $Y = 0.1063 x-0.0805$, $Y= 0.0752x-0.0183$, $Y= 0.0906x-0.1025$, meaning that for every increase of one leaf-sucking pest, there is an increase in pest attack intensity of 12%, 0.03%, 0.09%, 0.10%, 0.07%, 0.09% with correlation coefficient values of 0.88, 0.71, 0.87, 0.89, 0.73, 0.76 it can be said that the results of the regression analysis of all treatments showed a very strong relationship between leaf-sucking pest populations and the intensity of pest attacks they caused. The results of this regression can be interpreted that the number of pest populations found on potato plants during the observation, is capable of causing high attack intensity. More precise concentrations of botanical pesticides and chemical pesticides are needed to control pests. Novisan [16] stated that higher concentrations were needed to be more effective in controlling sucking pests.

Based on the regression relationship, it shows a very strong relationship between leaf-sucking pest populations and attack intensity. Thus, a more precise concentration of botanical pesticides and chemical pesticides is needed to control pests. This is in accordance with Novisan's statement [16], that higher concentrations are needed to be more effective in controlling sucking pests.

3.4. Occurrence of virus diseases

The average results of observations of the incidence of viral diseases from each treatment of leaf-sucking pests can be seen in the tables below (Table 3 and Table 4).

The incidence of PVY and PLRV virus diseases can be seen that the two types of symptoms have not appeared since the initial observation. PVY symptoms began to appear at the 3rd observation at 35 DAP and PLRV virus symptoms at the 4th observation at 42 DAP The lowest percentage of PVY virus symptoms occurred at the beginning of the observation until the 2nd observation and the lowest PLRV virus symptoms occurred at the beginning of the observation until the second observation -3, this is because no symptoms are found so the value is 0%. The highest percentage of PVY virus symptoms occurred at the 6th observation at 56 DAP and PLRV virus symptoms at the 7th observation at 63 DAP. This can happen because the observation method used is conventional by looking directly at the symptoms shown by plants. Observations using this method are basically inaccurate and only look at symptoms or morphological changes shown by potato plants, because it could be that the symptoms displayed by the PVY and PLRV viruses were already visible but cannot be detected.

Table 3. Average percentage of PVY symptoms on Potato Plants

Treatment	Plant age (days after planting)							
	21	**28**	**35**	**42**	**49**	**56**	**63**	**70**
Control	0.0	0.0	2.5	2.5	50.0	55.0	25.0	12.5
Abamectin 0.5 ml/L	0.0	0.0	0.0	7.5	15.0	10.0	2.5	2.5
Tobacco pesticide 2 ml/L	0.0	0.0	2.5	0.0	25.0	47.5	22.5	12.5
VirginiaTobacco pesticide 4 ml/L	0.0	0.0	2.5	12.5	35.0	50.0	10.0	10.0
VirginiaTobacco pesticide 6 ml/L	0.0	0.0	0.0	5.0	17.5	35.0	10.0	10.0
Virginia Tobacco pesticide 8 ml/L	0.0	0.0	0.0	10.0	15.0	15.0	20.0	15.0

Table 4. Average percentage of PLRV symptoms on Potato Plants

Treatment	Plant age (days after planting)							
	21	**28**	**35**	**42**	**49**	**56**	**63**	**70**
Control	0.0	0.0	0.0	0.0	17.5	25.0	52.5	27.5
Abamectin 0.5 ml/L	0.0	0.0	0.0	5.0	2.5	5.0	15.0	2.5
Tobacco pesticide 2 ml/L	0.0	0.0	0.0	0.0	22.5	27.5	47.5	22.5
VirginiaTobacco pesticide 4 ml/L	0.0	0.0	0.0	0.0	17.5	12.5	22.5	17.5
VirginiaTobacco pesticide 6 ml/L	0.0	0.0	0.0	0.0	7.5	15.0	35.0	17.5
Virginia Tobacco pesticide 8 ml/L	0.0	0.0	0.0	0.0	10.5	15.0	17.5	10.0

An increase and decrease in symptoms may occur, because the potato plants which were suspected of having virus symptoms in the previous observation, did not show symptoms of the virus in subsequent observations or the plants returned to health (normal). This means that the symptoms seen earlier may not be symptoms due to a virus but other factors such as symptoms of nutrient deficiency. In accordance with the statement that conventional methods for diagnosing viruses based on observation of symptoms are not always fit for purpose, because: 1) The presence of a virus that can induce symptoms similar to those caused by other viruses, 2) two or more viral infections often occur in one plant , 3) virus multiplication in susceptible plants does not always cause visible symptoms, 4) not adaptive (not suitable) for presymptomatic diagnosis (before symptoms appear). Due to the limited diagnosis of the virus, it is necessary to have a method that has better prospects, namely a specific, fast and sensitive virus detection device [17]. The characteristic symptoms of the PVY virus found in potato plantations are a mosaic on the yellow leaves, and the symptoms of the PLRV virus are the leaves rolling up to form a tubular shape, the color of the leaves is more rigid, the color of the leaves is yellowish. The following are symptoms suspected of being infected with the PVY and PLRV viruses in Figure 5.

Fig.5. Symptoms of suspected PVY (left) and PLRV (right) viruses in Sembalun Bumbung (personal collection)

The intensity of leaf-sucking pest attack symptoms found in potato plantations was higher, compared to symptoms suspected of being infected with a virus which was found to be very small. Although leaf-sucking pests act as vector pests, they do not cause many viral symptoms. This can be influenced by plant resistance and potential pests as vectors. According to Agrios [18], in general there are two types of resistance mechanisms possessed by plants, namely structural resistance and biochemical resistance. Structural resistance are structural properties that function as physical barriers and prevent pathogens from gaining opportunities to enter and spread within the plant, while biochemical resistance are biochemical reactions that occur in plant cells and tissues that produce toxic substances for pathogens or create conditions that are harmful to the plant. inhibit the growth of pathogens in these plants.

Vector pests must first suck the fluids from diseased plants so that the virus can be transmitted back to healthy plants. Transmission of the virus in the field is most detrimental and is through insects (Insects). Insects salivate when sucking plant fluids. While the saliva is released into the phloem cells, the viruses contained in the saliva will move passively into the phloem cells. Saliva is known to contain enzymes that can damage cell walls making it easier for insects to suck plant fluids and transmit viruses [19]. According to Smith (1931) in Ismiati [20], which stated that potato virus Y (PVY) was transmitted by the insect *Myzus persicae* (Sulz), whereas according to the research of Khaled et al. [21] stated that *Myzus persicae* has the potential to transmit the PLRV virus by 90% after being confirmed using DAS-ELISA.

The PVY virus is non-persistent in the insect body. The spread of this virus is highly dependent on the presence of winged aphids. Aphids can be infective and infect healthy plants in just a few seconds. After sucking on healthy plants, the vector cannot transmit the virus, the aphids have to suck up diseased plants again [22]. In the insect body, the PLRV virus has a latent period of 24-48 hours. After that the insect becomes infective and this infective trait persists for a long time. Duriat [23] stated that Myzus would remain infective for 5 days. It is said that the PLRV virus is persistent in the bodies of insects. According to Van Soest and Cats [24], infective insects can transmit the virus if allowed to suck on healthy plants for 15 minutes.

In Table 5 it appears that in treatment P0 (control) the symptoms of PVY and PLRV viruses were found to be the most and lowest in treatment P1 (chemical). In the treatment of plant-based pesticides from Virginia tobacco stem waste 2 ml/L and 4 ml/L had no significant effect, while the treatment of plant-based pesticides from Virginia tobacco stem waste 6 ml/L and 8 ml/L had a significantly different effect on PVY virus symptoms compared to P0 (control). On the other hand, on the PLRV virus symptoms, treatments P2, P3 and P4 had an effect that was not significantly different and treatment P5 had a significantly different effect compared to P0 (control). Thus, the treatment of plant pesticides with higher concentrations of Virginia tobacco stem waste and chemical pesticides can be said to be able to suppress the emergence of PVY and PLRV virus symptoms from leaf-sucking pest attacks which are suspected as vector pests.

Table 5. Average percentage of viruses (PVY and PLRV) occurrence in potato plants

Treatment	PVY	PLRV
Control	18.4 [a]	15.3 [a]
Abamectin 0,5 ml/L	4.3 [c]	3.8 [b]
Virginia tobacco pesticide2 ml/L	13.7 [ab]	15 [a]
Virginia tobacco pesticide 4 ml/L	15 [ab]	9.4 [ab]
Virginia tobacco pesticide 6 ml/L	9.6 [bc]	9.4 [ab]
Virginia tobacco 8 ml/L	9.6 [bc]	6.6 [b]
HSD 5 %	1.95	2.94

Remarks: Numbers followed by the same letters are not significantly different

The P5 treatment (8 ml/L) was the concentration that showed the lowest viral symptoms compared to the concentrations of other botanical pesticides. In accordance with Susilowati's statement [25], the higher concentration of tobacco leaf extract affects its effectiveness as an insecticide. Botanical pesticides containing tobacco stem extract contain an active ingredient in the form of nicotine which can act as a contact and nerve poison which can react quickly so it doesn't take long to work effectively for pests, especially leaf-sucking pests which are suspected of being vector pests in potato plantings.

3.5. Relationship between Population and the incidence of PVY and PLRV viral diseases

The results of the regression analysis between population variables with symptoms of PVY virus and PLRV showed that the relationship between pest populations and the incidence of PVY virus disease was higher than the incidence of PLRV virus disease. The results of the regression analysis showed that the population of leaf-sucking pests could affect the value of the PVY virus disease incidence in a row of P0 58% (medium), P1 1% (very low), P2 56% (moderate), P3 77% (strong), P4 60% (strong), P5 39% (low) with the regression equation Y= 0.0392x-2.3905, Y= 0.0009x+4.1979, Y= 0.0295x+1.72, Y= 0.0428x-2.5205, Y= 0.0287x-1.0156, Y= 0.0176x+4.0705 and the incidence of PLRV disease is P0 4% (very low), P1 2% (very low), P2 34% (low), P3 16% (low), P4 8% (very low), P5 19% (very low). With the regression equation Y=0.0096x+10.194, Y= 0.0011x+3.1423, Y= 0.0363x-2.5675, Y= 0.0105x+4.4441, Y= 0.0109x+5.2967, Y= 0.0117x+ 2.813. This shows that every increase in the pest population there is an increase in the incidence of PVY disease by (0.039), (0.009), (0.03), (0.04), (0.02), (0.017) times and in PLRV disease (0.009), (0.0011) , (0.02), (0.01), (0.01), (0.011) times. All treatments of botanical pesticides from Virginia tobacco stem waste as well as chemical treatments suppressed the emergence of PLRV virus symptoms caused by leaf-sucking pests suspected of being virus vectors in potato plants.

IV. CONCLUSION

It was concluded that the botanical pesticides from Virginia tobacco stem waste had an effect on reducing leaf-sucking pest populations and suppressing the intensity of leaf-sucking pest attacks and were able to suppress the emergence of viral disease symptoms, compared to controls which had high scores. Virginia tobacco stem waste pesticide with a concentration of 8 ml/L is the best concentration in controlling populations and attack intensity with the lowest average yield, but its ability is still below chemical pesticides, so higher concentrations are needed to be able to match these chemical pesticides

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