

ACTIVITY OF LIQUID SMOKE OF TOBACCO STEM WASTE AS AN INSECTICIDE ON *Spodoptera litura* Fabricius LARVAE

AKTIVITAS ASAP CAIR LIMBAH BATANG TEMBAKAU SEBAGAI INSEKTISIDA TERHADAP LARVA *Spodoptera litura* Fabricius

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ABSTRACT

The use of chemical insecticide in crop protection around the world has resulted in disturbances of the environment. Therefore, it is necessary to develop for environmentally friendly insect pest management techniques such as the activity of liquid smoke made from tobacco stem waste as an insecticide to *Spodoptera litura*. Activity of liquid smoke of tobacco stem waste was carried out at the laboratory condition. The results showed that the application of liquid smoke by using the spraying method (direct method) showed better results compared to the results of feeding method (indirect method). Lethal concentration (LC) at 5 days after treatment, LC₅₀ and LC₇₅ values the direct method of 2.9% and 8.87%, while the indirect method of 6.99% and 21.03%. The sub lethal concentration did not cause mortality of *S. litura* larvae, but inhibited the growth such as indicated by lower weight of larval and pupal in treated larvae than in control. Liquid smoke of tobacco stem waste has activity as an insecticide to *S. litura*.

Keywords: activity, liquid smoke, *Spodoptera litura*, tobacco stem waste

INTISARI

Penggunaan pestisida kimia dalam pengendalian hama di dunia telah menimbulkan gangguan terhadap lingkungan. Maka teknik pengendalian hama yang ramah lingkungan perlu dikembangkan, misalnya aktivitas asap cair limbah batang tembakau sebagai insektisida pada *Spodoptera litura*. Aktivitas asap cair limbah batang tembakau dilakukan pada kondisi laboratorium. Hasil penelitian menunjukkan bahwa aplikasi asap cair secara langsung (metode semprot) lebih efektif daripada tidak langsung (metode celup pakan). Lethal concentration (LC) pada 5 hari setelah perlakuan, LC₅₀ dan LC₇₅ pada aplikasi langsung sebesar 2,9% dan 8,87%, sedangkan pada aplikasi tidak langsung 6,99% dan 21,03%. Konsentrasi subletal tidak menyebabkan kematian *S. litura* tetapi mampu menghambat pertumbuhan yang diindikasikan dengan rendahnya bobot larva dan pupa *S. litura*. Asap cair limbah batang tembakau bersifat insektisida terhadap larva *S. litura*.

Kata kunci: aktivitas, asap cair, batang tembakau, *Spodoptera litura*

INTRODUCTION

Spodoptera litura is a significant pest on several agricultural commodities in Indonesia. Severe leaf damage due to this pest could decrease the crop production significantly. The control of this pest is mainly achieved by the use of chemical insecticide such as methyl parathion, chlorpyrifos, phosalone, endosulfan, deltamethrin and alphamethrin (Ramegowda, 2003). On the other hand, the use of the insecticide has lead to serious environmental pollution (water, air, and soil), pest resistance, pest resurgence, and toxicity to human (Dhaliwal *et al.*, 2004; Horowitz & Ishaaya, 2012). Therefore, the need of the future is to develop an eco-friendly approach to combat insect pests that

should be able to regulate pest populations and safe to the environment. Recently, the use of botanical pesticide offered new possibilities of promising control techniques against insect pests.

The use of botanical pesticide as insecticide is an old practice and used all over the world. Botanical pesticide has been used widely both in small scale subsistence farming and commercial agriculture (Isman, 2008). A good botanical insecticide should fulfill some requirements before being developed, such as easier to produce in large quantities, not toxic to non-target organism, and has lethal effect to insect pest. Botanical pesticide has many advantages over chemical pesticide, such as minimal health hazards and environmental pollution, safe to non-

target organism, no adverse effect on plant growth, and safe for humans (Pavela, 2014; Dimetry, 2014).

The development of botanical pesticide based on tobacco material has been progressing. However, the use of tobacco stem extract is still limited, and so far there are no document on their potentials for a wider adoption for insect control. Therefore, further development of botanical pesticide based on tobacco stem waste product is needed.

Currently, one of the methods to utilize the potential of tobacco stem waste is by pyrolysis to produce liquid smoke which can be used as an insecticide against *S. litura*. Liquid smoke is a product obtained from a process of chemical decomposition of organic materials by heating in a room with lack or no oxygen content to break the bonds of complex molecules into smaller molecular bonds (Czernik & Bridgewater, 2004). The liquid smoke is containing several compounds that have function as an insecticide so it can be a natural substance to overcome pest problems (Tiilikkala *et al.*, 2010; Tiilikkala *et al.* 2011).

Out of the long history of pyrolysis use, there can be found only a limited number of researches which focus on liquid smoke from tobacco stem as insecticide, and this is the subject of recent researches. Information on the toxicity of the liquid smoke from tobacco stem waste, as well as the activity of liquid smoke to the growth and feeding activity of *S. litura*, has not been available. Therefore, it is necessary to do research on this topic to provide information about the use of liquid smoke from tobacco stem waste as an insecticide that can be used by farmers to control larvae of *S. litura* in an eco-friendly way. The objective of this study is to determine the activity of liquid smoke of tobacco stem waste as an insecticide on *S. litura* larvae.

MATERIALS AND METHODS

The research was carried out at the Laboratory of Pest and Disease of Indonesian Sweetener and Fiber Crops Research Institute from August 2015 to January 2016.

Extraction of Tobacco Stem Waste

The tobacco stem was collected from tobacco fields in Karangploso Experimental Station and surrounding area of Malang, East Java. This experiment used Virginia Coker 176 variety. Two kilograms of tobacco stem were cut into small pieces approximately 2–4 cm in length. This material was put into a closed pyrolysis equipment. The smoke was distilled to obtain the liquid smoke and it was used for bioassay.

Mass Rearing of S. litura Larvae

Larvae of *S. litura* were collected from Karangploso Experimental Station, Malang, East Java. The larvae were allowed to feed on leaves of Chinese cabbage (*Brassica rapa* var. *chinensis*) in a plastic jar (1.5 kg) that was covered with a gauze for ventilation under laboratory condition. They were kept until developed into pupae. The pupae were collected and placed inside of another plastic jar up to adult emergence. Male and female moths were allowed to mating and produce egg masses. The egg masses were kept for hatching. The newly hatching larvae were collected and reared on cabbage leaves to produce 2nd instar. The second instar of F2 generation were used for bioassays.

Bioassay of Liquid Smoke of Tobacco Stem Waste

A preliminary test was carried out with concentration rates of 3.125; 6.25; 12.5; 25; 50; 100 %; and control. Each of concentration rates and control had four replications. Each replication used ten of 2nd instar larvae.

A sprayer with low pressure compressor producing droplets of 2–3 mm in diameter was used to spray the test larvae with liquid smoke. The larvae were placed on a Chinese cabbage leaf of 4×4cm in size in a jar of 13 cm in diameter and 14 cm height of which a piece of filter paper was lined on under leaf. The larvae were then sprayed with liquid smoke according to the concentration rates. The plastic jar was then covered with gauze. The percentage of dead larvae was observed daily during five consecutive days after treatment.

The preliminary test was continued with the definitive test. The concentration rates of the liquid smoke adopted the rates used by Harwanto *et al.* (2012), i.e. LC₁₀, LC₂₅, LC₅₀, LC₆₀, LC₇₅, LC₉₅, and the control. Larvae and equipments used were similar to those used in the preliminary test. The seven levels of treatment (concentration rates) with four replication were arranged in Completely Randomized Design (CRD). Each of concentration rates used 15 larvae, hence, with each treatment had 60 larvae. Application of the liquid smoke was conducted by two methods, i.e spraying method (direct method) and feeding method (indirect method). The spraying method was done such as the same with the previous preliminary test. Meanwhile, protocol of the feeding method was as follows. A 4×4cm Chinese cabbage leaf was dipped into liquid smoke, and dried. The test larvae were allowed to feed on treated and untreated leaves in a jar which was covered with gauze.

Number of dead larvae were recorded daily during five consecutive days. Value of Lethal Concentration

(LC) was determined by probit analysis using software of POLO Plus (Prijono, 1999; Kranthi, 2005).

The Effect of Liquid Smoke of Tobacco Stem Waste on Larval and Pupal Weight of *S. litura*

In order to ascertain the effect of liquid smoke on larvae development, a test was carried out with sub lethal concentrations of LC₂₅ (0.48%), LC₅₀ (2.07%), LC₇₅ (8.89%) and the control was based on calculation from the definitive test (Syahputra, 2013; Syahputra & Prijono, 2011). Each of concentration rates including control used 25 second instar larvae. Treatment method and culture of larvae were same with those that conducted for the preliminary test. The cabbage leaf was replaced with the new one daily. The larvae were cultured until developed into pupae. Fresh body weight of the larvae were measured at 4, 7, and 10 days after treatment. Fresh body weight of the pupae were also measured. Analysis of variance and Duncan Multiple Range Test $\alpha=0.05$ were applied to determine significant effect of the treatment

RESULTS AND DISCUSSION

The activity of the liquid smoke of tobacco stems waste against the *S. litura* larvae was determined with the parameter of larval mortality and larval growth inhibition.

Bioassay of Liquid Smoke of Tobacco Stem Waste

The preliminary test in bioassay study resulted concentration rates from LC₁₀, LC₂₅, LC₅₀, LC₆₀, LC₇₅, LC₉₅ ca. 1.18; 2.911; 7.89; 11.49; 21.42; and 89.98%. The average percentage mortality from definitive test showed that liquid smoke of the tobacco stem waste was able to cause the death of *S. litura* larvae (Figure 1 and 2). The application of liquid smoke for 120 hours after treatment with spraying method and the feeding method was able to cause the mortality of *S. litura* as much as 95%. On the second day of treatment, the mortality rate of *S. litura* was increasing. And on the fourth day, the mortality rate is above 80%. These data showed that liquid smoke reacted slowly in destroying pest but was able to cause the death of the pest with the percentage of above 80%. Figure 1 and 2 also show that there was a variation in the mortality rate of *S. litura* at each applied level of liquid smoke concentration. Increasing concentration was followed by increasing mortality of *S. litura*. This was made possible due to the fact that with increment concentration, the amount of poison exposed would be greater so that more larvae would be death.

LC₅₀ value is used as one of the insecticidal activity criteria to the liquid smoke. The lower the LC₅₀ value the more poisonous of insecticide. The results showed

that spraying treatment method was more effective than feeding treatment method such as indicated by lower value of lethal concentration (LC) (Table 1). Within 5 days after treatment, LC₅₀ was ca. 2.91% for spraying method which was lower than ca. 6.99% for the feeding method. It implies that the liquid smoke when to be sprayed may kill directly to the target pest or indirectly by feeding leaves containing residues of the liquid smoke.

The activity of the liquid smoke of tobacco stem waste was agree with the results of previous researches. For example, the uses of liquid smoke of laban wood with a concentration of 5% caused the death of termite *Coptotermes curvignatus* up to 100% (Oramahi *et al.*, 2014). The liquid of coconut shells were able to cause death of *Nilaparvata lugens* up to 100% (Wagiman *et al.*, 2014). The liquid smoke of birch wood caused the death of *Myzus persicae* up to 95% (Tiilikkala *et al.*, 2010). The liquid smoke of tomatoes and tobacco leaves was able to kill *Leptinotarsa decemlineata* up to 80% and 94% respectively (Booker *et al.*, 2010; Caceres *et al.*, 2015).

According to Kim *et al.* (2008), most of the properties of liquid smoke as a contact poison are caused by the acetic acid contained in the liquid smoke which could damage the cuticle permeability of an insect causing it to die. Other researches also show that the liquid smoke works better in contact than if it is fed or applied indirectly. Application of the liquid smoke of coconut shell on brown planthopper also has a lower concentration of LC in the direct method (spray method) when compared with the indirect or feeding method (Wagiman *et al.*, 2014).

The Effect of Liquid Smoke of Tobacco Stem Waste on Larval and Pupal Weight of *S. litura*

In order to ascertain the sub-lethal effect of liquid smoke of tobacco stem waste on *S. litura*, an observation was conducted on the development of *S. litura* which had been applied with liquid smoke by using the parameter of larvae weight four, seven, and ten days after treatment, and measuring the pupal weight. The sub lethal concentration did not cause mortality of *S. litura* larvae, but inhibited the growth such as indicated by lower weight of treated larvae than the control ones (Table 2). The survival larvae had the ability to neutralize or detoxify the poison that enter the body so that the poison did not cause death. However, the consequence was that the detoxification process needs energy from the body, which should have been used for growth and development of the insect. This naturally resulted in an inhibition of the insect growth, vis-à-vis a healthy insect (Farrar, 1989). This was the reason why the application of the liquid

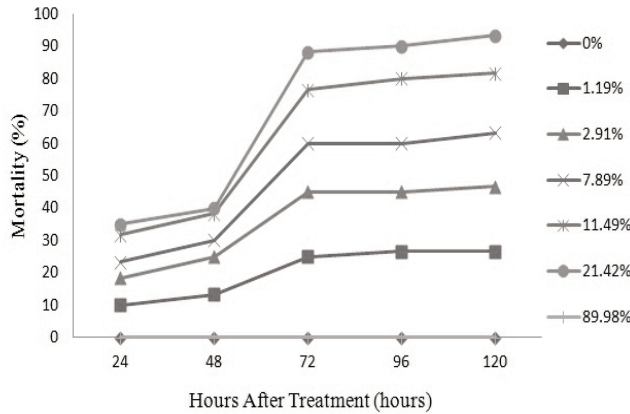


Figure 1. Effect of liquid smoke of tobacco stem waste applied with spray method on definitive test against *Spodoptera litura* mortality at 120 hours after treatment

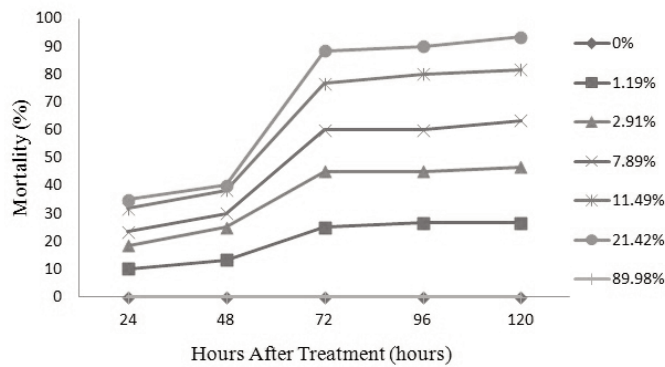


Figure 2. Effect of liquid smoke of tobacco stem waste applied with feeding method on definitive test against *Spodoptera litura* mortality at 120 hours after treatment

Table 1. Lethal concentration (LC) of liquid smoke of tobacco stem waste against *Spodoptera litura* on 120 hours after treatment

| | Lethal concentration | | |
|-----------------|-------------------------------|-------------------------------|-------------------------------|
| | LC ₂₅ (CI 95%) (%) | LC ₅₀ (CI 95%) (%) | LC ₇₅ (CI 95%) (%) |
| Spraying method | 0.483 (0.19–0.87) | 2.911 (1.24–2.99) | 8.87 (6.44–12.91) |
| Feeding method | 2.320 (1.43–3.28) | 6.985 (5.21–9.23) | 21.03 (4.62–10.26) |

Table 2. Effect of liquid smoke of tobacco stem waste on larval and pupal weight of *Spodoptera litura*

| Concentration rate of liquid smoke (%) (equal to LC) | n ^a | Larval weight four days after treatment (gram) ^b | Larval weight seven days after treatment (gram) ^b | Larval weight ten days after treatment (gram) ^b | Pupal weight (gram) ^b |
|------------------------------------------------------|----------------|-------------------------------------------------------------|--------------------------------------------------------------|------------------------------------------------------------|----------------------------------|
| Control | 25 | 0.08 ± 0.03 b | 0.40 ± 0.02 c | 0.57 ± 0.09 b | 0.29 ± 0.01 c |
| 0.48 (LC ₂₅) | 25 | 0.06 ± 0.01 ab | 0.23 ± 0.10 b | 0.35 ± 0.05 a | 0.21 ± 0.01 b |
| 2.07 (LC ₅₀) | 25 | 0.04 ± 0.02 a | 0.15 ± 0.02 ab | 0.33 ± 0.05 a | 0.19 ± 0.01 a |
| 8.89 (LC ₇₅) | 25 | 0.04 ± 0.01 a | 0.13 ± 0.02 a | 0.28 ± 0.01 a | 0.18 ± 0.02 a |

a = Number of larvae used per concentration.

b = The average in colloum followed by the same letter is not significantly different by DMRT ($\alpha = 5\%$).

smoke of tobacco stem waste caused the lower weight of larvae and pupa compared with the control. Result of the study indicated that the liquid smoke of tobacco stem waste had an insecticidal against larvae of *S. litura*.

CONCLUSION

The application of liquid smoke of tobacco stem waste with spray method and the feeding method was able to cause the mortality of *S. litura* up to 95%. The spraying treatment method was more effective than feeding treatment method such as indicated by lower value of lethal concentration. Within 5 days after treatment, LC₅₀ was ca. 2.9% for spraying method which was lower than ca. 8.87% for the feeding method. The sub lethal concentration did not cause mortality of *S. litura* larvae, but inhibited the growth such as indicated by lower weight of larval and pupal in treated larvae than in control. Liquid smoke of tobacco stem waste has an insecticidal activity against *S. litura* larvae

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