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Study Effectiveness of Liquid Smoke as a Natural Insecticide for Main Pest Control of Soybean Crops

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Abstract

Until now, farmers still rely on synthetic insecticides to pests control on soybeans, but synthetic insecticides can cause resistance and resurgence of pests and other negative environmental impacts. It is therefore necessary to find natural insecticides that environmentally friendly. The purpose of this study was to get raw materials local resources and liquid smoke concentrations as a natural pesticide that is effective for main pests control on soybeans. The study was done in South Lampung from March to November 2015. The experimental were split plot with factorial design, consisting of 3 main plot treatments and 6 subplot treatments, with four replications. Treatment at the main plot were raw material liquid smoke i.e. rice husk, coconut shell and wood waste. Treating subplot was the concentration of liquid smoke that were (A) Not sprayed (control), (B) 15 ml/lt of water, (C) 45 ml/lt of water, (D) 75 ml/lt of water, (E) 105 ml/lt of water and (F) Syntetic pesticides (as a comparison). The parameters measured were level attacks of armyworm pests, pod borer and pod sucking attacking naturally. The results showed that liquid smoke from wood waste, coconut shell and rice husks materials a potential as natural insecticide. Liquid smoke effectively prevent pest of armyworms, pod borer and pod sucking on soybean plants with a concentration of 15 ml / liter of water.

Keywords: Soybean; main pests; natural insekticide; liquid smoke.

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1. Introduction

In the cultivation of soybean pests that attack in soybean occurred since the start of germination to harvest. Until now, farmers still rely on synthetic insecticides to control pests on soybeans. The use of synthetic insecticides continuously and applied inappropriately, can cause resistance and resurgence of pests and have a negative impact on the environment especially human health [5,6]. Seeing the negative effects of synthetic insecticides it is necessary to look for the utilization of natural insecticides that are environmentally friendly. Of the many pests that attack, armyworm (*Spodoptera sp*.), Pod borer (*Etiella sp*.), pod sucking (*Nezara viridulla*, *Riptortus linearis*, and *Piezodorus hybneri*) are the main pest of soybean [20]. Armyworm attacks if not controlled can cause yield losses until 80% even not harvest [9]. Likewise with pod borer attacks can cause yield losses until 80%, if no control measures could even crop failure [12]. Attack of sucking pods caused no pithy seed, empty pods, the pods fall, seed rot and black [3]. Liquid smoke is a result of condensation or pyrolysis of material which contains lignin, cellulose, hemicellulose and other carbon compounds that availability is plentiful as agricultural waste [10]. Crude liquid smoke contains a variety of compounds include phenol, carbonyl, acids, furans, alcohols, lactones, hydrocarbons, and polycyclic aromatic that are anti-microbial and toxic to insect pests so the opportunity was developed as a natural pesticide [18,19]. Liquid smoke has been used as pesticide in countries where syntetic chemicals are not populer, or where the chemicals has been too expensive for small scale farmers [7]. Liquid smoke is declared safe impact on the environment and humans, as shown by experiments on mice in which the results of LD50 liquid smoke of coconut shell is greater than 15,000 $mgkg^{-1}$ body weight of mice, so not considered dangerous are used for food products [11,14]. Coconut shell liquid smoke was an effective insecticide against the rice brown planthoper. LC50 of the neutral Coconut shell liquid smoke at 12,5% concentration rate was the appropriate to be developed into application dosage [4]. Results of research [16], coconut shell liquid smoke effective against pests Trips, Apids, caterpillars in pepper, tomato and paddy at a dose of 71 ml / ltr, but the effect is on pepper and tomato leaf having a little wilted. While on soybean crop this case is not yet known. Liquid smoke has never been reported as an insecticide for pest control in soybeans. Seeing some of the results of research on the potential of liquid smoke is then necessary to study the effectiveness of liquid smoke on soybean plants with the aim of obtaining raw materials of local resources of liquid smoke as a natural insecticide that is effective to control the main pests of soybean, which is easily made by farmers.

2. Material and Methods

Materials and tools

The study was conducted in South Lampung, Indonesia from March to November, 2015. Raw materials used in this study are rice husks, coconut shell, and wood waste. Equipment used include pyrolysis reactor made of stainless steel pipe, equipped with tar catcher and aset of condensation tools. The reactor serves to burn raw materials to be used. In the pyrolysis process produces a substance in three forms namely solid, liquid and gas. The results from the condensation is grade 3 liquid smoke.

Implementation Research

This study begins with the pyrolysis process with varying material such as rice husks, coconut shell, and wood waste. At first weight of shell material that has been cleaned and has been reduced in size inserted into the pyrolysis reactor, heated to a temperature of 160ºC for 11 hours. From the light fraction will be channeled into the pipe so that the condensation of liquid smoke. The quality parameters of liquid smoke is covering the determination of pH, total phenols, and acid levels. The quantity parameters of liquid smoke is through the determination of yield. The yield of liquid smoke is calculated by comparing the results obtained with liquid smoke weight of raw materials used (v/w).

$$\text{The yield of liquid smoke} = \frac{\text{Volume of liquid smoke}}{\text{raw material weight}} \text{ x } 100\%$$

Study of the application of liquid smoke

The study was conducted in experiment station in South Lampung, Indonesia. Liquid smoke was applied is pure liquid smoke is mixed with water. The experimental was split plot with factorial design, consisting of 3 main plot treatments and 6 subplot treatments, with four replications. Treatments at the main plot were raw material liquid smoke i.e. rice husk, coconut shell and wood waste. Treating subplot was the concentrations of liquid smoke that were (A) Not sprayed (control), (B) 15 ml/lt of water, (C) 45 ml/lt of water, (D) 75 ml/lt of water, (E) 105 ml/lt of water and (F) Syntetic pesticides (as a comparison). The area of each subplot 4 m x 5 m. Spacing 40 cm x 20 cm. Seeds were planted two seeds per hole. Spraying liquid smoke made according to the dosage of each treatment on the age of the plant 7, 14, 28, 42, 56, and 70 days after planting.The parameters measured were level attacks of armyworm pests, pod borer and pod sucking attacking naturally. The intensity of pest attack leaves (armyworms) calculated using the formula:

$$I = \frac{\sum_{i=0}^{z} (n \text{ x } v)}{Z \text{ x } N} \text{ x } 100\%$$

I = The intensity of the attack (%)

N = Score

V = Total infected plant at every score

Z = The highest score (5)

N = Total plants per plot (30)

While the intensity of pod pest attacks were calculated using the formula:

$$I = \frac{A}{B} \text{ x } 100\%$$

I = The intensity of the attack (%)

A = Number of pods attacked

B = Total number of pods observed

Pest scoring system (8)

Table 5

Score	Crop Damage Level (%)
0	No attack symptoms
1	>0 - 20
2	>20 - 40
3	>40 - 60
4	>60 - 80
5	>80 - 100

The data were analized by anova and then Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

Characteristics of the resulting liquid smoke

Pyrolysis process with temperature achieved during the production of liquid smoke an average of up to 160 ° C, reached within 11 hours. The color of liquid smoke of the third raw material clear brown to red-brown. The yield of liquid smoke produced of coconut shell, wood waste and rice husk, respectively, were on average 13.12%, 12.63% 10.80% (Table 1).

Table 1: Average yield of liquid smoke results from several types of raw materials

Parameters	Raw Liquid Smoke		
	coconut shell	wood waste	rice husk
Raw material weight (kg)	29,5	19	25
Water content example (%)	7,52	3,62	3,3
Results of liquid smoke (liter)	3,87	2,4	2,7
The yield of liquid smoke (%)	13,12	12,63	10,80
pH	4	3,8	3
The average temperature (° C)	160	160	160
Time (hours)	11	11	11

The yield of liquid smoke produced only ranges from 10.80 to 13.12%. Low liquid smoke produced allegedly caused by the temperature during the pyrolysis process is relatively low at only 160°C, so that the yield of liquid smoke generated is not optimal. Product yield (%) and acidity (pH) of liquid smoke obtained at 450, 550 and 600°C in the extruder type pyrolysis process were 55.1, 69.7, and 57% and 2.8, 3.2 and 3 respectively (1).

Chemical composition of liquid smoke

Chemical compounds of liquid smoke depending on the raw materials used. Chemical compounds in the liquid smoke of coconut shell consists 24 components, in the liquid smoke of wood waste consists 25 components, and in the liquid smoke of rice husk consists 23 components. In Table 2 only showing some components of the chemical sequence of the largest (in terms of concentration) of each of the raw material after the separation of tar.

Table 2: Some of the largest sequence of chemical compounds (in terms of concentration) in the liquid smoke coconut shell, wood waste and rice husks.

No.	Chemical Compounds	Raw material/consentration (%)		
		coconut shell	wood waste	rice husk
1	Acetic acid (CAS) Ethylic acid	53,00	52,87	72,22
2	Phenol, 2-methoxy-(CAS) Izal	14,34	2,04	-
3	Phenol (CAS) Izal	-	-	0,74
4	Phenol, 2-methoxy-(CAS) Guaiacol	4,61	10,88	7,49
5	Phenol, 2,3-dimethyl- (CAS) 2,3-Dimethylphenol	0,26	-	-
6	Phenol, 2,6-dimethoxy-(CAS) 2,6-Dimethoxyphenol	0,73	6,08	1,34
7	Phenol, 2-methyl-(CAS)o-cresol	0,47	1,18	0,21
8	Phenol, 3-ethyl-(CAS) m-Ethylphenol	-	-	2,61
9	2-Propanone, 1-hydroxy-(CAS) Acetol	7,33	-	-
10	2(3H)-Furanon, dihydro-(CAS)Butyrolactone	0,16	2,11	0,87
11	2-Methoxy-4-methylphenol	1,17	5,06	2,84
12	2,5-Dimethoxytoluene	0,42	1,11	0,90
13	9-Octadecenoic acid (Z)-(CAS) Oleic acid	0,99	1,67	0,61
14	Benzenesulfonic acid, 4-hydroxy- (CAS) Benzenesulfonic acid, p-hydroxy	12,70	-	-
15	Carbamic acid, phenyl ester (CAS) Phenyl carbamate	-	4,95	0,78
16	2,5-Dimethoxybenzyl alcohol	-	2,29	0,26
17	Acetic acid, Anhydride with Formic Acid	-	-	4,34
18	2,5-Dimethoxybenzyl alcohol	-	2,29	0,26

19	4-Hexen-2-one, 3-Methyl	-	-	1,04
20	3-nonynoic acid (CAS)	-	-	1,02

Analyzed in Forest Product Testing Laboratory, Bogor, Indonesia.

Chemical compounds contained in the liquid smoke is very dependent on the conditions of pyrolysis and the raw materials used, it is highly influenced by comparison contents of cellulose, hemicellulose and lignin, as well as differences in water content of the samples during pyrolysis can also affect the amount of volatile compounds were obtained [13,17]. In addition the process of pyrolysis of raw material that did not perfect can cause chemical components of liquid smoke that resulting did not complete [2].

In Table 2 is shown that dominant chemical compounds on liquid smoke were phenol and its derivates, and acetate acid. Concentration of acetic acid highest in liquid smoke from rice husk was 72.22%, and then from coconut shell was 53.00% and from wood waste was 52.87%. While the concentration of phenol and its derivates highest in liquid smoke from the coconut shell was 20.41%, and then from wood waste was 20.18%, and the lowest from rice husks was 12.39% (Table 2). According Yatagai in2002, acetic acid in liquid smoke is used to accelerate the growth of plants and plant disease prevention, while phenol and its derivates serve to prevent pests and diseases of plants [15].

Experiments of liquid smoke to main pest of soybean

Analysis of variance showed no interaction effect between raw material x concentration of liquid smoke against armyworm, pod borer and pod sucking (Table 3). This indicates that treatment factors independently acting of one another and do not affect each other against attack of armyworm, pod borer and pod sucking. While the concentration treatment significantly indicates there are differences of emphasis armyworm, pod borer and pod sucking attacks from several different concentrations of liquid smoke.

Table 3: Analysis of Variance of spraying of liquid smoke to attack of.armyworm, pod borer and pod sucking

Source of variation	df	MS		
		Armyworm	Pod borer	Pod sucking
Replication	3	88,115	19,806	34,427
Liquid smoke (L)	2	11,208 ^{ns}	0,031 ^{ns}	18,384 ^{ns}
Concentration (C)	5	82,303 **	27,618**	26,387 ^{ns}
L x C	10	5,272 ^{ns}	4,561 ^{ns}	8,619 ^{ns}
Error	51	13,936	5,732	15,981

** = significant at α 1%; ns = not significant

Further analysis of the effect of the concentration of liquid smoke showed the highest attack on unsprayed treatment (Table 4). This indicates that the pest prefers soybean plants are not sprayed. In accordance with the statement (21), that the phenolic compounds which is the active ingredient in a solution of liquid smoke has a deterrent properties against insect pests of Lepidoptera.

Table 4: Effect of raw material and the concentration of liquid smoke against armyworms, pod borer and pod sucking

Perlakuan	Armyworm attack (%)	Pod borer attack (%)	Pod sucking attack (%)
Raw material of liquid smoke:			
Wood waste	14,10 a	3,18 a	3,19 a
Coconut shell	12,77 a	3,15 a	2,99 a
Rice husk	13,71 a	3,22 a	1,58 a
Concentration of liquid smoke:			
(A) Not sprayed (control)	18,28 a	6,02 a	4,62 a
(B) 15 ml/lt of water	13,69 b	2,61 b	0,74 b
(C) 45 ml/lt of water	13,31 b	3,22 b	2,95 ab
(D) 75 ml/lt of water	13,24 b	2,58 b	1,63 ab
(E) 105 ml/lt of water	12,26 b	3,13 b	1,71 ab
(F) Syntetic pesticides (as a comparison).	10,37 b	1,51 b	3,86 ab

Numbers followed by the same letter in the same column was not significantly different according to

Duncan Multiple Range Test (DMRT) 5%.

In the synthetic insecticide treatments were not significantly different pests by treatment with liquid smoke. These results prove that the liquid smoke has the same potential with synthetic insecticides, so that the liquid smoke can be used as a natural insecticide for pest on soybean plants. The results showed the concentration of liquid smoke 15 ml/ltr of water was effective against attacks armyworm, pod borer and pod sucking with emphasis damage 25.11%, 56.64% and 83.98% respectively compared with the control. Research results [21] showed that the solution of liquid smoke made from coconut shell is a secondary antifeedant weak to moderate against caterpillars Crocidolomia pavonana at a concentration of 3% and 22%.

4. Conlusion and Suggestion

Conlusion

Liquid smoke from wood waste, coconut shell and rice husks materials a potential as natural insecticide. Liquid smoke effectively prevent pest of armyworms, pod borer and pod sucking on soybean plants with a concentration of 15 ml/liter of water.

Suggestion

Liquid smoke is recommended for soybean crops started one week old plants and applied every two weeks until the hard pods. We recommend that farmers create their own liquid smoke because the tool is simple enough, but it is necessary to improve the integrated furnace so that the yield of liquid smoke produced can be more.

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