

Response of Insect Pests to Botanical Insecticide Application on Leaf and Pod Soybean (*Glycine max* L.) of Organic Farming System

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ABSTRACT

Leaf and pod insect pests are important on soybean (*Glycine max* L.) in Indonesia, causing loss of seed production. The study was carried out to evaluate the potential of water crude extract mixture of *Azadirachta indica* seed, *Cymbopogon nardus* plant and *Alpinia galanga* rhizome to control leaf and pod insect pests on soybean. The study was conducted in the organic farming system cultivation of soybean and it was arranged with Randomized Block Design. The concentrations of crude extract were 5, 10, 20 and 40% (v/v) applied on soybean. The result showed that crude extract significantly affected on the damages of leaf and pod caused by the insect pest and seed production. The 20 and 40% of extracts concentrations resulted in 16.07 and 14.97% leaf damage caused by insect, pod damage of 5.38 and 5.33% and 7.56 and 6.77% caused by sucking insect and pod borer insect, respectively. Those concentrations yielded 436.0 and 540.6 g of seed production/3m² plot size, respectively. This study showed that the mixture of crude extracts has the potential to be used in controlling insect pests on soybean.

Keywords: *Alpinia galanga*, *Azadirachta indicata*, *crude extracts mixture*, *cymbopogon nardus*, *seed production*

1. INTRODUCTION

Soybean *Glycine max* (L.) Merr. is the most important legume crop and major source of protein. The most known soybean products in Indonesia are tempe and tofu (tahu). The consumption of soybean in 2016-2017 is 2.9 million tons. Despite Indonesia has program to be self-sufficient on soybean, Indonesia still imports soybean for its domestic consumption due to low production of soybean. Indonesia government has imported the average of 2.3 and 2.7 million tons soybean in 2016 and 2017, respectively [1, 2].

Pest is one of the limiting factors in the effort to optimize soybean production in Indonesia. Leaf and pod damages of soybean caused by insect pests showed significant yield losses (up to 80%) [3, 4]. In order to control the pests, most farmer in Indonesia applied synthetic insecticides. The wide spread use of synthetic insecticide may cause a serious hazard to both man and wildlife. It may cause insect resistance, resurgence, decreasing of natural enemy population and other environmental problem [5]. By using synthetic insecticide, it is costly and reduces farmer profit. It is important to find the new bioactive substances as alternative insecticide which is compatible with Integrated Pest Management Program.

There are some evidences that the plant semiochemicals content bioactive substances affecting insects. According to

Prakash and Rao [6], plant products as botanical insecticides offer many advantages over synthetic chemicals. Botanical pesticides in general possess low mammalian toxicity and less health hazard and environmental pollution. Application of botanical insecticides is less risk when use in natural forms. The occurrence of pest resurgence of non-target organisms has not been reported, except for synthetic pyrethrins. Botanical pesticides are less expensive and ready to be made due to the materials are available in developing countries. Many plant materials show promising effects to insects. Higher plants are a rich source of novel insecticides [7]. Botanical insecticides show a broad range of pest insect control, are harmless to non-target organism, fairly specific in their mode of action. Moreover, they are easily to produce by farmer [8].

Insecticidal activity of Annonaceous seed extract or powder had been reported by some researchers. Mariapan and Saxena [9] reported that mixtures of seed oil of custard-apple *Annona squamosa* and Neem *Azadirachta indica* were significantly effective in reducing the survival of leafhopper *Nephotettix virescens*. Rhizome powder of *Alpinia galanga* mixture with stored grain 1% (w/w) was found to protect the grains against infestations of *Sitophilus oryzae* and *Corcyra cephalonica* and showed 100% mortality to both insects up to 45 days [6]. *Cymbopogon nardus* contains essential oil as

geraniol 35.7%, trans-citral 22.7%, cis-citral 14.2%, geraniol aasetat 9.7%, citronnelal 5.8%, citronnelol 4.6% [10]. The use of botanical insecticide in soybean organic farming is expected to maintain soybean yield potential.

The purpose of this work was to evaluate the potency of crude extract mixture of *A. indica*, *C. nardus* and *A. galanga* in controlling leaf and pod soybean insect pests in organic farming.

1.1. Materials and Methods

The research was conducted at field research station of Agriculture Faculty, Islamic University of North Sumatra, Gedung Djohor Medan, Indonesia, from June to August 2018. The plot preparation was done by loosen the soil. Organic fertilizers containing cow manure were applied 3 kg/plot at 2 weeks before planting. Completely Randomized Block Design was used in this research with five concentrations of crude extracts and replicated five times. The soybean variety planted was Anjasromo. The plot size was 1.5 x 2 m² and the space between plants was 30 cm x 40 cm. The seed was 3 seeds per hole. After planting the seed, the soil was covered with rice straw to avoid the bean fly attacks. After 2 weeks only one soybean plant was left.

Azadirachta indica (fruits), *Cymbopogon nardus* (aerial part of plant), and *Alpinia galanga* (rhizome) were obtained around Medan City. Preparation of crude extract was adopted from Astuti et al. [11]. *A. indica* (240 g), *C. nardus* (180 g) and *A. galanga* (180 g) plant materials were washed with tap water and cut into a small size and smothered with electric blender. All grinded plant put together in a jar then added with 600 ml of distilled water and soaked for 24 hr then filtered. The crude extract was diluted with distilled water to obtain concentrations of 5, 10, 20 and 40% (ml crude extract/ml solution). Application of crude extract solution by soaking seeds 30 minutes before planting, then by spraying the extract mixtures at 15 days after planting (DAP) until 71 DAP with 14 days interval between applications. The equipment used was Knapsack Sprayer with flat fan nozzle of 5/64inch orifice diameter and spray volume of 500l/ha. The number of samples was 5 plants/plot. The observed variables were leaf damage intensity and pod damage percentage caused by the pest and seed production.

Statistical analysis was carried out by using ANOVA ($P < 0.05$). Duncan's Multiple Range Test (DMRT) at 5% confidence interval was used to determine the difference of variable from each crude extract concentration. All statistical analysis was done by using SPSS Statistic 24 Program.

1.2. Our Contribution

This research presents to provide the Soybean insect pest management by using botanical insecticide which is environmentally friendly. These botanical insecticides easily produce by farmer and the plants are locally available.

1.3. Paper Structure

The paper is organized as follow: Section 2 introduces the importance of soybean in Indonesia, and insect pest as one of the limiting factors in the efforts to get the optimum production. This section explains it is important to find the plant substances as alternative synthetic insecticide which is compatible with Integrated Pest Management (IPM). Section 3 presents the research methodology and statistical analysis used to find the effect of botanical insecticides against insect pests. Section 4 explains the result of study and comparing with another similar studies about the bioactive components in controlling insect pests. Finally, in the section 5 concludes the result.

2. RESULTS AND DISCUSSION

There was a significantly difference on leaf damage intensity caused by insect pests at 42, 56, and 70 day after treatment (DAT) ($F = 3.45, 7.49, \text{ and } 19.17, df = 4 \ \& \ 16, P < 0.05$) among plant extract concentrations. The mean of leaf damage intensity was shown on Table 1.

Application of botanical insecticide caused a significance effects on leaf damaged at 42 DAT. Botanical insecticide application at 10% caused lower leaf damage (17.26%) than control (23.77%). At 70 DAT, both of botanical insecticide concentrations reduced leaf damage about 40.94 to 44.98% over control. The extract mixture of *A. indica*, *C. nardus*, and *A. galanga* showed the effectiveness against insect which caused leaf damage. The insects found attacked the plant were *Lamprosema indicata* and *Valanga nigricornis*. Azadirachtin is the first active ingredient isolated from the neem and it has been proven to be the main constituent for controlling insect pest. The bioactive chemicals contained in these plants have been reported by several researchers. From numerous field trials, larvae of most lepidopterous pests are highly sensitive to neem seed [5]. Weekly application of 4% methanolic neem kernel extracts almost completely protected the cabbage crop against the pest [12]. Chandramohan and Sivasubramanian [13] reported that aqueous neem leaf extracts were effective to protect the groundnut from leaf miner.

Aqueous extract serves as a good antifeedant against pest of vegetables crops. *A. galanga* rhizome contains abundant bioactive compounds, such as 1,8-cineole which possess strong contact toxicity against *Lasioderma serricornis* [14]. Abdullah et al. [15] added that the 1,8-cineole possess antifeedant and repellent effects against termites *Coptotermes gestrodes* and *C. curvignatus*. Meanwhile, *Cymbopogon nardus* (citronella grass) contains cymbopogone and cymbopogonol, α and β -citral, myrcene, linalool, linalyl acetate, citronellal and nerol. Labinas and Crocomo [16] reported that Java grass *Cymbopogon winterianus* contains citronellal (42.15%), citronellol (22.03%) and geraniol (16.44%) and showed repellency and insecticide properties to *Spodoptera frugiperda* larvae. Setiawati et al. [17] reported that *C. nardus* oil effective to control *Helicoverpa armigera*. The leaf damage on control treatment was about 27.21%, it's due to new leaf growth.

There was a significant difference on pod damage caused by sucking insect and pod borer, and seed production ($F = 11.52, 12.30, \text{ and } 11.09$ $df = 4 \ \& \ 16, P < 0.05$) among plant extract concentrations. The means of pod damage and seed production was showed at Table 2.

The average number of pod was about 80-100 pods per plant. Botanical insecticide application affected pod damage

caused by sucking and pod borer insects. Botanical insecticides at 20% reduced pod damage by 63.47% and 56.57% caused by sucking and pod borer insects, respectively over control. Mollah et al. [18] sprayed 2.5ml/l water of azadirachtin fresh (collected from the Crashing mill) and azadirachtin stored (16 months stored azadirachtin was collected from laboratory) at 10 days interval from first flowering to the last harvest of Lablab bean reduced number of Green Stink Bug 36.73 and 49.64%, respectively over control. It was showed that *C. nardus* and *A. galanga* have potential to be effective to the soybean insect pest. Papulwar et al. [19] reported that citronella grass oil at 1% caused 100% mortality of pod borer *Heliothis armigera* larvae. It was due to the antifeedant and repellent activities of citronella grass. *A. galanga* essential oil at 20% caused 100% mortality of *Crociodolomia pavonana* larvae [20].

The result of seed production showed that botanical insecticides at 20 and 40% yielded 436.0 and 540.6 g (1.45 and 1.8 ton/ha), respectively (Table 2). The average of North Sumatera soybean seed production in 2017 was 1.28 ton/ha [21]. The reduction of leaf and pod damages caused by insect pest resulted in high seed production. The mixture of *A. indicata*, *C. nardus* and *A. galanga* showed to have potential to control soybean insect pest effectively.

Table 1 Leaf damaged caused by insect after treating with botanical insecticides

Crude extracts Conc. (%)	Leaf damage intensity (% \pm SEM)*				
	14 DAT	28 DAT	42 DAT	56 DAT	70 DAT
0	2.59 \pm 0.22	14.26 \pm 1.81	23.77 \pm 3.54 a	23.13 \pm 1.96 a	27.21 \pm 1.51 a
5	2.23 \pm 0.53	16.71 \pm 1.74	19.67 \pm 2.41 ab	19.19 \pm 0.42 a	22.11 \pm 0.94 b
10	2.30 \pm 0.55	16.55 \pm 2.03	17.26 \pm 2.00 b	20.87 \pm 1.91 a	22.74 \pm 1.50 b
20	2.58 \pm 0.26	12.36 \pm 2.20	15.70 \pm 2.08 b	15.46 \pm 0.38 b	16.07 \pm 0.79 c
40	2.21 \pm 0.31	12.21 \pm 2.10	15.41 \pm 2.70 b	14.14 \pm 1.25 b	14.97 \pm 0.90 c

*Means in a column followed by different letters are significantly different ($P=0.05$) by Duncan's Multiple Range (DMRT) Test. SEM = Standart Error of Mean; DAT= Day AfterTreatment

Table 2 Pod damage caused by insect after treated with botanical insecticides

Crude extracts Conc. (%)	Pod damage caused by sucking insect pest (% \pm SEM)*	Pod damage caused by borer insect pest (% \pm SEM)*	Seed production/plot (g \pm SEM)*
0	14.59 \pm 2.23 a	17.41 \pm 1.72 a	262.2 \pm 41.62 c
5	8.43 \pm 0.64 b	13.26 \pm 1.22 a	314.8 \pm 35.30 c
10	9.24 \pm 1.92 b	13.81 \pm 1.99 a	330.6 \pm 43.50 c
20	5.38 \pm 0.99 c	7.56 \pm 1.14 b	436.0 \pm 16.86 b
40	5.33 \pm 0.81 c	6.77 \pm 0.85 b	540.6 \pm 45.17 a

*Means in a column followed by different letters are significantly different ($P=0.05$) by Duncan's Multiple Range (DMRT) Test. SEM = Standart Error of Mean.

No synthetic pesticide and synthetic fertilizer was used in this study. Therefore, farmer would receive more benefits.

3. CONCLUSION

Water crude extract mixtures of *Azadirachta indica* seed, *Cymbopogon nardus* plant and *Alpinia galanga* rhizome at 20 and 40% of concentration showed a potency to be used in controlling leaf and pod insect pests on soybean.

ACKNOWLEDGMENT

We thank to Dean of Faculty of Agriculture, Islamic University of North Sumatra for supporting field trial, given advised and motivation.

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