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Research Article

Direct Application of Synthetic Pyrethroid Insecticides on Clove Stem Borer (*Hexamitodera semivelutina* Hell.)

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Abstract

Background and objective: Clove is Indonesia's main spice commodity and one of the 16 leading national plantation commodities. However, the production is not optimal due to the attack of clove stem borer (*Hexamithodera semivelutina*). This study was aimed to evaluate the effect of 4 commercial synthetic pyrethroid insecticides on stem borer that attacked clove plants. **Materials and Methods:** The experiment was conducted on clove plantation in Kombi District, Minahasa Regency, North Sulawesi. The method used in this study was an experimental method using a randomized block design (RBD) with 5 treatments and 4 replications. Determination of clove trees for the treatment was done intentionally by selecting the hoist holes caused by active stem borers. Symptoms that were shown on the stem of the plant were liquid discharge and also the remnants of the borehole found on the clove tree stem. **Results:** The results showed that pyrethroid insecticides H, V, B and M were able to heal the wound/hoist holes on the clove plant stem. The most effective pyrethroid insecticides were B and M which cured almost all of the boreholes. The effectiveness of each insecticide was as follows: B (100%), M (95%), H (55%) and V (50%). **Conclusion:** The data revealed that a combination of synthetic pyrethroid insecticide prallethrin 0.1%, cypermethrin 0.1% and transfluthrin 0.1% was the most effective in controlling the stem borer larvae.

Key words: pest control, stem borer, *Hexamitidera semivelutina*, pyrethroid, insecticide

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Cloves (*Syzygium aromaticum*, *Eugenia aromaticum*), a native plant of eastern Indonesia, is one of the most valuable plants in the world. The main compound in the essential oil of clove is eugenol[1]. This oil and its derivatives have been used in many industries, such as food and beverages, pharmaceuticals, cosmetics, pesticide and many other chemical industries[2,3].

The development of the clove plant industry in Minahasa (North Sulawesi, Indonesia) has dramatically been affected by pests and pathogens[4,5], while to date, most of the world's clove needs are supplied by Indonesia[6]. Approximately 75% of the world's clove oil derivatives was also contributed by Indonesia. Major pest and pathogen of clove plants among others are stem borer (*H. semivelutina* Hell.) and fungi (*Ceratocystic polychroma*) which cause leaf decay[7,8]. The combination attack of those pest and pathogen can use the clove plants to die. There are even certain locations where clove plants died due to a combination of stem borer and stem vessel diseases that cause clove leaf to decay. The stem borer alone has caused chronic damage to clove plants in several regions in Indonesia, including North Sulawesi[8].

In 2011, almost all the clove plantation area was attacked by stem borer *H. semivelutina* which caused heavy damage to plants resulting in interference with plant growth. Symptoms of attacks on the clove tree trunk was the appearance of 3-5 mm holes that removed the remains of the hoist and insect droppings that flow down. Around 10-20 holes were found in one clove tree and if the holes were opened, the funnels that connects the holes were observable. The burrows were irregular and if the burrows surrounded the stem, the plant parts above the burrow showed symptoms of molt and result in plant death[8].

The control of clove stem borer has been carried out intensively but the results are far from expected. Some actions that have been taken by farmers to counteract further attacks from the stem borer among others are: (a) "Patu-patu", a mechanical method to look for directly the stem borer larvae on the burrow in the clove stem. However, this method has a potential to injure the plant stems and provide an opportunity for pathogenic fungi *C. polychrome* to infect the plants, (b) Chemical method by spreading furadan insecticide grains around clove trees[9,10]. Considering the importance of clove plants, this research aimed at evaluating the alternative methods for applying insecticides to clove plants to control the stem borers by minimizing the impact on the environment.

MATERIALS AND METHODS

Experimental design: The study was carried out on clove plantations in Kombi District, Minahasa Regency, North Sulawesi from March-June, 2019. A Randomized Block Design (RBD) was used to evaluate the study. The following 4 pyrethroid insecticides were used in this study: insecticide H (d-allethrin 0.08 g L^{-1}, dimefluthrin 8.01 g L^{-1}), V (transfluthrin 0,6%), B (prallethrin 0.1%, cypermethrin 0.1%, transfluthrin 0.1%) and M (d-trans-allethrin 0.11%, imiprothrin 0.03%, permethrin 0.06%). The purposive sampling method was used to select clove plants which were still actively attacked by stem borer. The presence of this pest was indicated by the symptoms of the liquid discharge and the remaining of grinding on the hole. The study consisted of 5 treatments with 4 replications each. Trees were treated randomly and the experimental block design is presented in Fig. 1. Each of asteric symbol represents one clove tree. The letters represent the 4 insecticides and the number represents the repetitions of each treatment.

Experimental analysis: The experiment was conducted by spraying each of the active hoist holes directly with insecticide for 5 sec. After the application, each hoist hole was closed with sterile soil for insecticide to effectively kill the larvae inside the holes. Observations were made 2 days after the application. Subsequently, the observations were conducted 5 times with interval of 2 days. Observation parameters consisted of active hoist holes and cured holes due to the use of pyrethroid insecticides.

The formula used to measure the success of pyrethroid insecticide application was as follows:

$$P\ (\%) = \frac{x}{y} \times 100$$

P = Average percentage of healed hoist holes
x = Number of healed hoist holes
y = Number of observed hoist holes/treated hoist holes

*****H1	*****M1	*****V1	*****B1
*****B2	*****V2	*****M2	*****H2
*****V3	*****B3	*****H3	*****M3
*****M	*****H4	*****B4	*****V2
*****C3	*****C1	*****C4	*****C2

Fig. 1: Experimental block design, *:Clove trees, with 5 treatments consisted of 4 insecticides (H, V, B, M) and control/no insecticides applied C

Statistical analysis: The data were statistically analyzed separately for each experiment and were subjected to the analysis of variance (ANOVA) using SPSS Ver. 24 software (Statistical Package for Social Sciences, USA). The smallest real difference (SRD) test was used to determine the significant level between treatments if any. The differences at $p \leq 0.05$ were considered significant.

RESULTS

The use of 4 type of insecticides against clove stem borer *H. semivelutine* showed different results for each treatment as shown in Table 1 and Fig. 2. The data in Table 1 shows that treatment with insecticide B gave the highest effect on healing the hoist holes in clove plants (100% healed hole). All treatments also showed that the maximum number of healed holes occurred in the 3rd and 4th week of observations. Maximum healing of the hoist holes (100%) when treated with insecticide B occurred on 4th week. Insecticides M and H healed the hoist holes on 3rd weeks of application, 95% and 55%, respectively.

Healing of the maximum hoist holes by insecticide B occurred on 4th day (100% healed), Insecticide M and H healed on 3rd week, 95 and 55%, respectively. Insecticide V healed on the 4th week (50%). The criterion of the healed hoist hole caused by the use of insecticides was that the hoist holes no longer secreted liquid, powder or the remnants of hoists by *H. Semivelutina* larvae. The results showed that insecticides B (prallethrin 0.1%, cypermethrin 0.1%, transfluthrin 0.1%) and M (d-trans-allethrin 0.11%, imiprothrin 0.03%, permethrin 0.06%) gave the best results in controlling the insect larvae.

The cessation of the liquid and the remaining hoist in the hole treated with pyrethroid began to occur at the first

Table 1: Percentage of *H. semivelutin* hole hoist recovered because of insecticide applications from the 1st week until 5th week of observations

	Observation in week Hole hoist recovery (%)				
Treatments	1st	2nd	3rd	4th	5th
B	2.50^{a}	3.25^{a}	4.50^{a}	5.00^{a}	5.00^{a}
M	3.00^{a}	3.75^{a}	4.75^{a}	4.75^{a}	4.75^{a}
H	1.50^{b}	2.25^{b}	2.75^{b}	2.75^{b}	2.75^{b}
V	1.25^{b}	1.50^{b}	2.25^{b}	2.50^{b}	2.50^{b}
C	0.00^{d}	0.00^{d}	0.00^{d}	0.00^{d}	0.00^{d}
SRD 5%	0.474	0.502	0.391	0.322	0.322

Numbers followed by different letters in the same column show significant differences at the 5% level

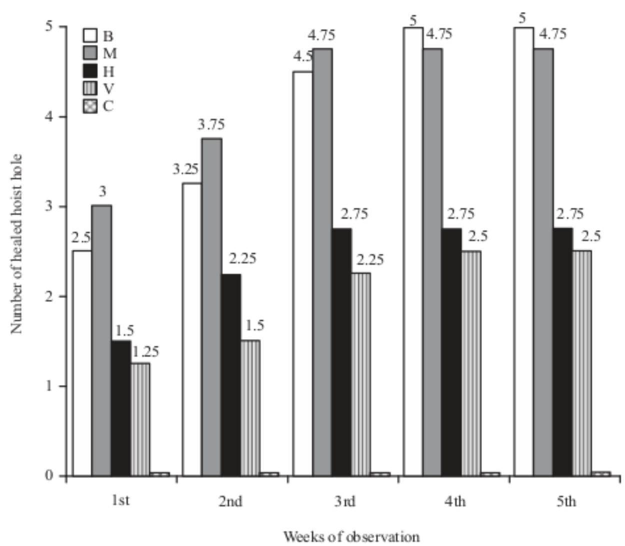

Fig. 2: Number of healed hoist holes after application of insecticides in 1-5 weeks of observation

Fig. 3: Dead *H. Semivelutine* larva in the hoist hole treated with B insecticide on the 3rd day after application

observation (2 days after application). This indicates that the larval activity had stopped because they became inactive and died because of to the influence of the insecticides. The death of the larvae in the hoist holes was proven by the opening of the grinding hole treated with insecticide on the 3rd day after application (Fig. 3). The recovery of the holes from the attack of the larvae after the application of insecticides appeared in week 1 until week 5 of observation.

DISCUSSION

The direct application of pyrethroid insecticides H, V, B and M caused the healing of the hoist holes, where the insecticides B and M were the most efficient. As synthetic derivatives of natural pyrethrins, pyrethroids are 2250 times more toxic to insects because their sodium channels are sensitive to it Chrustek *et al.*[11]. Pyrethroids have very specific effects on insects' nerve cells, therefore only a very small amount of it is needed to produce the necessary effect. Pyrethroid has the effect of knocking down or turning off insects quickly but it is also rapidly degraded in nature. Basically pyrethroid is chemically stable in the form of natural pyrethrum and has an enzyme called Irac MoA group 3 which interferes with sodium transport in insect nerve cells[12]. Transfluthrin is one of the pyrethroid insecticides which acts fast with low persistency. Prallethrin is used to control mosquitoes, flies, cockroaches, ants and termites in households[13]. The toxicity profile of this insecticide is increased due to its structural modifications and its use is limited by its rapid biodegradability[12]. Cypermethrin, a class 2 pyrethroid pesticide, behaves or functions more as a neurotoxin[14] and provides a rapid effect on insects. D-Allethrin is a pyrethroid mixture, a powerful contact insecticide that produces a fast and strong knock-down in controlling household pests because of its neurotoxicity by bioactivation, lipid peroxidation and DNA damage[15]. Deltamethrin, a pyrethroid ester, belongs to type 2 pyrethroids. It attacks sodium channels which results in membrane depolarization of neurons, repetitive discharges and synaptic disturbances[12] causing paralysis in the organism.

The results of the study above show that combination of three synthetic pyrethroid i.e., prallethrin 0.1%, cypermethrin 0.1%, transfluthrin 0.1% and d-trans-allethrin 0.11%, imiprothrin 0.03%, permethrin 0.06% gave the best results compared to single transfluthrin 0.6% and combination of 2 pyrethroid d-allethrin 0.08 g L^{-1}, dimefluthrin 8.01 g L^{-1}. Therefore insecticides B and M were very effective in controlling clove stem borer pests. The high percentage of healed holes in B insecticide treatment can be caused by the presence of more complex active ingredients compared to other pyrethroid insecticides. According to Macan *et al.*[16], cypermethrin is a type of active ingredient in the pyrethroid group. Cypermethrin is a group of insecticides that have specific properties for insect control, among others: high effectiveness, lack of toxins to mammals, loss of effectiveness relatively quickly and have fast knock-down effect. In Pakistan, cypermethrin has been used to control the spotted stalk borer (*Chilo partellus*) in maize fields[17]. A research showed that chlorpyrifos 500 g L^{-1} and cypermethrin 50 g L^{-1} at all levels of concentration were effective in suppressing the population of D. citri flea pests. on citrus plants[18].

According to Mulasari[19], transfluthrin 0.03% gave the fastest paralysis effect on *Cx quinquefasciatus* mosquitoes and *A. Aegypti*, while the d-allethrin 0.30% had the fastest paralysis effect on *An aconitus* mosquitoes and *A. aegypti*. Furthermore, according to mosquito poison containing transfluthrin and d-allethrin caused an increase in hemoglobin levels when used within 2 and 4 h. Divakar *et al.*[20] showed that the was a significant decrease and leukocyte and significant increase in lymphocytes in Swiss albino mice after being treated with d-allethrin.

The finding of this study suggested that insecticide application must be carried out on target, so it does not cause disturbance to the environment, especially to non-target insects but can efficiently kill target insects. Although pyrethroids are relatively safe to use when applied directly to targets, it is advisable to look for alternative natural materials that are more environmentally friendly for stem borer control in clove plants.

CONCLUSION

This study concluded that insecticide B and M were very effective in controlling *H. semivelutina* larvae in clove plants. Average recovered holes caused by *H. semivelutina* due to the use of pyrethroid insecticides were 5.0 (100%) for B, 4.75 (95%) for M, 2.75 (55%) for H and 5 (50%) for V.

SIGNIFICANCE STATEMENT

This study discovers that in order to control the larvae of stem borer (*Hexamitodera semivelutina* Hell.) in clove plants, synthetic pyrethroid insecticides were suggested to apply when other control programs were less effective. Insecticide B (prallethrin 0.1%, cypermethrin 0.1%, transfluthrin 0.1%) was the most effective in controlling the stem borer larvae.

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REFERENCES

1. Tursiloadi, S., N. Artanti and A. Sulaswatty, 2015. Chemical catalytic and biocatalytic process of clove oil derivatives review. Indones. J. Applied Chem., 17: 69-85.
2. Towaha, J., 2012. The benefits of cloves eugenol in various industries in Indonesia. Perspektif, 11: 79-90.
3. Nikolic, N., M. Höferl and G. Buchbauer, 2018. Pesticides in essential oils and selected fragrance extracts. Some examples. A review. Flav. Frag. J., 33: 373-384.
4. Rumagit, G.A.J., 2007. An economic study of the linkages between the development of national cloves and kretek cigarettes industries. Ph.D. Thesis, Institut Pertanian Bogor, Indonesia.
5. Hariyadi, B.W., 2017. Analysis of results on crop loss cloves wooden vessels due to attack bacteria cloves (BPKC) case study in sub-district Wonosalam district Jombang. Gontor Agrotech. Sci. J., 3: 23-54.
6. Razafimamonjison, G., M. Jahiel, T. Duclos, P. Ramanoelina, F. Fawbush and P. Danthu, 2014. Bud, leaf and stem essential oil composition of *Syzygium aromaticum* from Madagascar, Indonesia and Zanzibar. Int. J. Basic Applied Sci., 3: 224-233.
7. Van Wyk, M., J. Roux, I. Barnes, B.D. Wingfiled and E.C.Y. Liew *et al*., 2004. *Ceratocystis polychroma* sp. nov., a new species from *Syzygium aromaticum* in Sulawesi. Stud. Mycol., 50: 273-282.
8. Runaweri, C., J. Pelealu and J. Manueke, 2017. Attacks and damage to clove plant caused by *Hexamitodera semivelutina* Hell. in Rerer village of Minahasa district. Eugenia, 23: 76-81.
9. Warouw, J., P.P. Pakasi, A. Komalig, H. Kawamatan, S. Sumanauw and B. Masinambouw, 1975. Report of the clove disease and pest management survey in North Sulawesi. The Cooperation Project of the North Sulawesi Plantation Office and the Faculty of Agriculture, Sam Ratulangi University, Manado.
10. Siswanto and I.M. Trisawa, 1997. Clove plant borer pests and control efforts. Monograph No. 2, Cloves:103-111. Agricultural Research and Development Agency, Research Institute for Spices and Medicines, Pages: 210.
11. Chrustek, A., I. Hołyńska-Iwan, I. Dziembowska, J. Bogusiewicz, M. Wróblewski, A. Cwynar and D. Olszewska-Słonina, 2018. Current research on the safety of pyrethroids used as insecticides. Medicina, Vol. 54, No. 4. 10.3390/medicina 54040061.
12. Ray, D.E., D. Ray and P.J. Forshaw, 2000. Pyrethroid insecticides: Poisoning syndromes, synergies and therapy. J. Toxicol. Clin. Toxicol., 38: 95-101.
13. Loroño-Pino, M.A., Y.N. Chan-Dzul, R. Zapata-Gil, C. Carrillo-Solís and A. Uitz-Mena *et al*., 2014. Household use of insecticide consumer products in a dengue endemic area in México. Trop. Med. Int. Health, 19: 1267-1275.
14. Singh, A.K., M.N. Tiwari, O. Prakash and M.P. Singh, 2012. A current review of cypermethrin-induced neurotoxicity and nigrostriatal dopaminergic neurodegeneration. Curr. Neuropharmacol., 10: 64-71.
15. Vences-Mejía, A., J. Gómez-Garduño, H. Caballero-Ortega, V. Dorado-González, R. Nosti-Palacios, N. Labra-Ruíz and J.J. Espinosa-Aguirre, 2012. Effect of mosquito mats (Pyrethroid-based) vapor inhalation on rat brain cytochrome P450s. Toxicol. Mech. Methods, 22: 41-46.
16. Macan, J., V.M. Varnai and R. Turk, 2006. Health effects of pyrethrins and pyrethroids. Arh. Hig. Rada Toksikol., 57: 237-243, (In Croatian).
17. Akhtar, Z.R., A. Noreen, A.A. Anjum, Z. Saeed and S. Ahmed *et al*., 2018. Resistance evaluation in *Chilo partellus* against synthetic pyrethroid in maize cropping system. J. Entomol. Zool. Stud., 6: 258-261.
18. Wicaksono, R.C. and S. Wuryantini, 2016. Effect of insecticide with active ingredient chlorpyrifos and sipermetrin on citrus psyllid (*Diaphorina citri*) and aphids (*Toxoptera* sp.) in citrus crop. Proceedings of National Seminar II 2016, Cooperation of Biology Education Study Program FKIP with Center for Environmental and Population Study (PSLK), March 26, 2016, Muhammadiyah University of Malang, East Java, Indonesia, pp: 77-84.
19. Mulasari, S.A., 2009. Mosquito repellent contains transfluthrin lower erythrocytes. Ahmad Dahlan University, Public Health Faculty, Yogyakarta.
20. Divakar, D., D. Sasmal, A. Kumar, A. Kumar and N. Sharma, 2015. Prophylactic role of piperine and curcumin in allethrin altered hematological and biochemical parameters in Swiss Albino mice. Pharmacologia, 6: 396-412.

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