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Larvicidal Activity against the Cabbage Webworm, *Hellula undalis* (Fabricius) (Lepidoptera: Pyralidae) of the Extract from Pongam Leaves (*Pongamia pinnata* L.)

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ABSTRACT

Background: The cabbage webworm, *Hellula undalis* (Fabricius) (Lepidoptera: Pyralidae) is destroy insect pest in vegetable crops. Vegetable growers spray many kinds of chemical pesticides to control this insect pest. The objective of this study was to investigate the efficacy of the extract from pongam leaves, *Progamia pinnata* L. against the cabbage webworm.

Methods: The experiment was carried out at the Laboratoty of Entomology, Faculty of Agronomy, University of Agriculture and Forestry, Hue University, Vietnam during 2020 and 2021. Different concentrations of pongam leaf extract was tested its efficacy against first and second instar larvae of the cabbage webworm on potted plants of leaf mustard, *Brassica integrifolia* West.

Result: The efficacy of pongam leaf extract was more efficacious against the first instar than the second instar of *H. undalis*. At five days after treatment, the efficacy of the pongam leaf extract against first and second instars of *H. undalis* was 93.2 and 68.4% at concentrations of 1.0%, respectively. Therefore, the pongam leaf extract can be recommended as potential botanical insect ides to control the cabbage webworm.

Key words: Botanical insecticide, Cabbage, *Hellula undalis*, Leaf extract, Pongam.

INTRODUCTION

The cabbage webworm, *Hellula undalis* (Fabricius) (Lepidoptera: Pyralidae) was destroy insect pest in vegetable in the world (Waterhouse and Norris, 1989). Previous studies reported its serious damage in Malaysia (Sivapragasan and Chua, 1997), India (Dhawan and Matharu, 2011), Vietnam (Tran *et al*., 2019). Larvae of the cabbage webworm damage plant leaves and stems. They make a silk web around their damage area. Its damage can cause either plant death or production which are not marketable (Sivapragasan, 2005). Vegetable growers applied many kinds of chemical pesticides to control the cabbage webworm (Tran *et al*., 2018). However, over applying of chemical pesticides caused negative impact to human, environment and benefit species (Tran *et al*., 2004; Tran and Ueno, 2012). Insects can develop their resistance to insecticides if farmers continuously use of the chemicals, thus efficacy of the insecticides is decreased its efficacy. Therefore, people have to increase the dosage and frequency of use leads to increased costs, increased pesticide residues in agricultural product, soil and water (Nguyen *et al*., 2018).

Botanical pesticides have been used as potential alternatives synthetic pesticides because the natural products would cause lesser impact on environmental and human health than many conventional chemical pesticides (Isman *et al*., 2011). Erler *et al*. (2010) reported that many species of plants have been used as botanical pesticides to control target pests. Previous studies indicated high effectiveness of plant extract in insect pests control (Mamun *et al*., 2009; Gupta and Srivastav, 2008; Dharanipriya and Kannan, 2020; Shunmugadevi and Anbu Radhika, 2020; Nasrin *et al*., 2021).

Pongam trees, *Progamia pinnata* L., belonging to the family Fabacae was widely distributed in many Asian countries including India, the Philippines, Malaysia, Indonesia and Vietnam (Atote and Yeole, 2010). It can planted on many type of soil and has low demand on humidity. Pongam trees have planted for agriculture and environment management. The various parts of pongam tree have been used for controlling of insect pests and diseases (Shoba and Thomas, 2001; Meera *et al*., 2003). The insecticidal feature of *P. pinnanta* have been widely tested (Kerasi *et al*., 2010). The leaf extract of pongam contain insecticidal feature against caterpillar insect pests such as the beet armyworm and the tobacco armyworm (Tran *et al*., 2017). The objectives of this study were to investigate laboratory efficacy of the extract from pongam leaves against larvae of the cabbage webworm.

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MATERIALS AND METHODS

The experiment was carried out at the Laboratoty of Entomology, Faculty of Agronomy, University of Agriculture and Forestry, Hue University, Viet Nam during 2020 and 2021 with different concentrations of pongam leaf extract against first and second instar larvae of the cabbage webworm on potted plants of leaf mustard, *Brassica integrifolia* West.

Seedlings of leaf mustard were separately planted in a plastic pot (9 cm × 10 cm) contenting approximately 0.5 kg of a mixture soil. Properties of the potting soil was with pH = 5.2, 1.5% organic carbon and available content of 4.59 mg K_2O, 0.65 mg N and 10.5 mg P_2O_5 per 100 g of soil. Two weeks after planting, the potted plants were maintained in a chamber with 60-70% humidity, 30±1.0°C and 12L: 12D photoperiod.

The cabbage webworm (*H. undalis*) used for the present study were collected from leaf mustard fields at Thua Thien Hue province, Central Vietnam (16°43′16.14″ N; 107°71′ 56.29″ E). The insects were reared on potted plants set inside a cage with the size of 60 × 160 × 180 cm. The colony of *H. undalis* were established on the potted plants in an incubator (25 ± 1°C and 12L: 12D photoperiod). Using the larvae of *H. undalis* collected from the colony maintained on these plants for two to three generations in the experiments.

The leaves of *P. pinnata* were collected from the open fields at Thua Thien Hue Province, Vietnam. The collected leaves were washed under tap water in order to remove debris. Afterwards the clean leaves were placed in shade for air-drying and then dried in the oven at 60°C to gain a constant weight. The dried leaves were grinded and sieved through a 25 mesh sieve to collect fine powder. The powder was preserved in airtight condition in polythene bags till use in extract preparation. The powder was evenly packed in Soxhlet's apparatus and the extraction was done with methanol. The leaf extract was concentrated in vacuum evaporator and dried and then labeled and stored at 4°C in amber colored airtight bottles.

A stock solution of 200 ml with a concentration of 5% leaf extract was prepared by diluting with Acetone 300, 99.5 +% (GC). The stock solution was dissolved in acetone to make tested concentrations until being equivalent to 0.6, 0.7, 0.8, 0.9 and 1.0%. The fluids were mixed with teepol of about 0.003 ml or three drops from a needle tip were added to give the extracts a slightly sticky characteristic. The leaves of potted plants was sprayed with the leaf extract until runoff (approximately 5 *ml* per a potted plant) using a power-pack aerosol hand sprayer (Hand Spray Nozzle, Takeda Engei Co., Japan).

Five first instar or second instar larvae collected from the laboratory colony of *H. undalis* and exposed to a potted plant after one hour spraying. The plant were replaced to a plastic cage (10 × 15 × 20 cm) covered with a fine nylon mesh. The potted plants as control was sprayed with distilled acetone in the same way as extract above. Twenty five larvae were tested each treatment. All plants were maintained in an incubator (60–70% humidity, 28±1.0°C and 12L: 12D). After 1, 3 and 5 days treatment, larval mortality was counted.

Mortality of insects in the laboratory was calculated using the corrected formula of Abbott (1925). Percentage data was transformed into arcsine square root before analysis. Data was analyzed with Tukey-Kramer test after one way ANOVA by using STATISTICA 10.0 software.

RESULTS AND DISCUSSION

From the leaves of pongam tree, *P. pinnata* collected in Thua Thien Hue Province, Vietnam, five organic compounds belonging to the furanoflavone group were isolated and identified, including pongaglabrone, pongapinnatin, pongapin, pongamone D, gamatin (Nguyen *et al.*, 2014). These compounds have larvicidal activity against insect pests (Ghosh, 2000). Our results showed that the extract from the leaves of pongam tree has significant larvicidal activity against young and older instars of the cabbage webworm, *H. undalis*. The efficacy was varied at different concentrations of the leaf extract and between first and second instars of the cabbage webworm. High concentrations of the pongam leaf extract caused higher mortality of *H. undalis* larvae.

At one day after treatment, the efficacy of the pongam leaf extract at the concentrations of 0.6 and 0.7% against the first instar larvae of *H. undalis* was not significantly difference (P>0.05), ranging from 36.7 to 38.3%. When increasing the concentration to 0.8%, the efficacy was higher and no significantly difference between the concentrations of 0.6 and 0.7% (P<0.05). There was no significantly difference in the efficacy of the leaf extract at the concentrations of 0.8, 0.9 and 1.0%, ranging from 46.7 to 51.7% (Table 1). The efficacy of the leaf extract increased with time after treatment. At three days after treatment, the efficacy was increased at all concentrations. There were no significantly difference in the efficacy at the concentration of 0.8, 0.9, 1.0% and higher than at the concentration of 0.6 and 0.7% (P>0.05). At five days after treatment, the highest efficacy was 93.2% at the concentration of 1.0%. There was no significant difference in the efficacy at the concentrations of 0.9 and 0.8% (P>0.05).

Similar to the first instar larvae, all different concentrations of the pongam leaf extract were effective against the second instar larvae of the cabbage webworm. The efficacy of the pongam leaf extract was less efficacy against the second instar larvae than the first instar larvae of *H. undalis* and was according to the evaluation time (Table 2). At one day after treatment, the efficacy reached 20.0-35.6%. There was significantly difference in the efficacy at concentrations of 0.8, 0.9 and 1.0% compared with those of the concentrations of 0.6 and 0.7% (P<0.05). The insecticidal efficacy gradually increased after tested time. At five days after treatment, the highest efficacy was 68.4% at the concentration of 1.0%, followed by 60.0, 61.0, 53.8 and 48.0% at the concentrations of 0.9, 0.8, 0.7 and 0.6%, respectively (P<0.05) (Table 2).

Many previous studies also reported that the pongam leaf extract were also high effctive against various lepidopteran insects such as the beet armyworm, *Spodoptera exigua* (Hübner) and the tobacco armyworm, *Spodoptera litura*

Table 1: Efficacy (%) of different doses of pongram leaf extract on *H. undalis* first instar larvae.

Concentration (%)	1 DAT*	3 DAT	5 DAT
0.6	36.7±2.11b	66.1± 2.00b	79.3±0.47c
0.7	38.3±1.67b	72.8±2.34b	84.3±2.59bc
0.8	46.7±2.11a	79.6±2.61a	88.2±3.06ab
0.9	46.7±3.33a	84.8±2.16a	91.3±1.78ab
1.0	51.7±1.67a	84.8±2.16a	93.2±2.17a
$LSD_{0.05}$	0.369	0.580	1.920

Means with the same letters within the same column are not significantly different by one way ANOVA, $P<0.05$.
*DAT (days after treatment).

Table 2: Efficacy (%) of different doses of pongram leaf extract on *H. undalis* second instar larvae.

Concentration (%)	1 DAT*	3 DAT	5 DAT
0.6	20.0±2.36b	30.6±2.81c	48.0±2.54d
0.7	21.1±2.61b	34.0±3.19c	53.8±2.94cd
0.8	28.9±2.00a	44.2±2.06ab	61.0±2.79b
0.9	30.0±2.36a	43.0±2.39b	60.0±1.76bc
1.0	35.6±1.76a	52.4±3.56a	68.4±2.15a
$LSD_{0.05}$	0.581	0.728	0.532

Means with the same letters within the same column are not significantly different by one way ANOVA, $P<0.05$.
*DAT (days after treatment).

Fabricius (Lepidoptera: Noctuidae) (Tran *et al.*, 2017) and other insects such as the cotton aphis, *Aphid gossypii* (Glover) (Hemiptera: Aphididae), the cotton leaf hopper, *Amrassca devasttans* (Distant) (Hemiptera: Cicadellidae) (Kulat *et al.*, 1997) and the turnip aphid, *Lipaphis pseudobrassicae* (Davis) (Heminoptera: Aphididae) (Tran *et al.*, 2016). This study shown the pongam leaf extract was high larvicidal activity against the cabbage webworm, *H. undalis*. Larvicidal activities of the pongam leaf extracts can be also attributed to some organic compounds including karanjin and pongapin, the major flavonoid of the leaf extract (Asolkar *et al.*, 1992; Katekhaye *et al.*, 2012). Verma *et al.* (2011) reported that karanjin and pongapin had high insecticidal properties. Poonia and Kaushik (2013) also indicated a significant synergistic effect of the pongam leaf extract.

The pongam leaf extract also has sub-lethal effect such as antifreedant and repellent effects on many insect pests. Previous studies have demonstrated the antifeedant effect of pongam extracts on *S. litura* (Lepidoptera: Noctuidae), *Trogoderma granarium* Events (Coleoptera: Dermestidae) and *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) (Kumar *et al.*, 2006) and the repellent effect on mosquito (Lale and Kulkarni, 2010). This study was not tested on antifeedant or repellent effects, the previous studies provided evidence that low concentrations of the pongam leaf extract caused significantly reduction of population growth of the beet armyworm, the tobacco armyworm and and the turnip aphid (Tran *et al.*, 2016; Tran *et al.*, 2017).

CONCLUSION

The extract from pongam leaves, *P. pinnata* had high larvicidal activity against first instar and second instar larvae of the cabbage webworm, *H. undalis*. Applying plant extracts for pest management was less impact on environment, health and development of insect resistance to insecticides (Isman, 1995; Breuer *et al.*, 2003). Charleston *et al.* (2006) indicated that plant extracts could attract more natural enemies. Therefore, the pongam leaf extract can be recommended as potential botanical insect ideas for being used together with biological control agents to control the cabbage webworm.

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