Effectiveness of Kantutay (*Lantana camara* Linn.) Extract against Rice Stem Borer

Josephine A. Gonzales
College of Industrial Technology
Central Bicol State University of Agriculture – Sipocot
Sipocot, Camarines Sur 4408 Philippines
jhogonzales72@yahoo.com

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Abstract

This experimental study determined the effectiveness of the Kantutay (Lantana camara Linn.) as an organic pesticide against rice stem borer (Sciropophaga incertulas). A single factor randomized complete block design was utilized for efficacy tests of the L. camara extract under laboratory and field conditions. Results showed that the extracted L. camara had an insecticidal activity against the rice stem borer. The pure concentration obtained the highest mortality rate – 86.11 and 85.19% under field and laboratory conditions, respectively. Under field conditions, the plant's extract was significantly less effective compared to the commercial pesticide. However, it was not significantly different in terms of effectiveness under laboratory conditions.

***Keywords**:* organic pesticides, *Lantana camara*, rice insect pest, stem borer

1. Introduction

One of the most important global concerns is protecting crops from insects. Hence, synthetic chemicals are continuously used. However, their toxicity endangers the health of farm operators, animals, and food consumers. Hikal (2017) underscored that the negative effects of synthetic chemicals on human health led to a resurgence of interest in botanical insecticides due to the minimal costs and ecological side effects.

The use of synthetic pesticides is commonly observed in controlling pests particularly in agriculture, commercial and industrial industries. Li and Jennings (2017) emphasized that in fighting agricultural diseases to help improve and increase productivity, pesticides are highly useful in eradicating the pests. However, utilizing synthetic pesticides can pose hazards to human health because they can move through the air, water, and soil. Today, authorities are working on a worldwide jurisdiction in regulating pesticide standard values for residential surface soil, residential air, drinking water, surface water, groundwater and food.

Ahmad *et al*. (2010) further discussed that conventional or synthetic pesticides are widely utilized by people as control agents against pest. However, because of their hazardous and toxic contents, some people opt to use organic pesticides. These organic pesticides are identified as safer compared with the commercial ones owing to their natural components, which make them eco-friendly.

Some common sources of organic pesticide are plants containing pesticidal properties that have pest-control potential like the *Lantana camara*. According to Stuart (2015), the Tagalog term for this plant is “Kantutay” and “Asin-asin” in some parts of Bicolandia and “Bahug-bahug” by the Visayans. *L. camara* is recognized as noxious and invasive (Wei and Xing, 2010). It is a perennial shrub that generally grows best in open, unshaded conditions such as wastelands, edges of rain forests, agricultural areas, grasslands, scrub or shrublands, wetlands, and forests recovering from fire or logging. It does not grow at ambient temperatures below 50 °C. *L. camara* is highly abundant and accessible in many places. Almost all removal strategies of this weed have been unsuccessful so far (Patel, 2011); hence, weed management is required.

In the recent study of Ayalew (2020), the extracted oil and powder from the leaves of *L. camara* was found to be effective in controlling maize grain weevils (*Sitophilus zeamais*) with extracted by methanol fraction showed highest percentage of mortality rate (74%). Having large amounts of sesquiterpene hydrocarbons, mainly β-caryophyllene, essential oil from *L. camara* is a promising fumigant material against *Sitophilus granaries* under laboratory conditions (Zoubiri and Baaliouamer, 2012). Similarly, Rajashekar *et al.* (2014) revealed that the methanol extract of *L. camara* is a potential source of biopesticide against stored grain pests (*Sitophilus oryzae*, *Callosobruchus chinensis* and *Tribolium castaneum*). In the work of Zandi-Zandi-Sohani *et al.* (2012), it was discovered that essential oil from *L. camara* leaves had high content of sesquiterpenes mainly: α-humelene, *cis*-caryophyllene, germacrene-D, and bicyclogermacrene, which were primary responsible for the repellent and insecticide activity against the attack of *Callosobruchus maculatus* on beans. Lastly, the leaf extract of this plant, as a biopesticide, was also reported by Negi *et al.* (2019) to have larvicidal activity against three mosquito species.

Aside from *L. camara*, there are also various plant species that produce poisonous substances protecting them against the insects that feed on them. For instance, the Douglas fir has a special sap that wards off beetles if it is attacked. Neem trees produce oil that alters the hormones of bugs so that they cannot fly, breed, or eat (National Academy of Sciences, 1992). With these, it is highly possible to produce effective, harmless, biodegradable natural insecticides that provide many advantages over the synthetic ones. At the same time, it is more cost-effective and does not pose hazards to human, animals and environment.

Distributed throughout the Philippines, rice stem borer (*Sciropophaga incertulas*) is considered a serious pest in paddy. This insect belongs to phylum Arthropoda, class Insecta, order Lepidoptera, family Pyralidae, genus Scirpophaga (Tryporyza) and species Incertulas. Samiksha (2020) highlighted that this insect bore into the plant that causes the young plant's central shoot to dry up resulting in "dead hearts." When the plants get mature, there is a formation of whitish and chaffy around the earheads. This formation is caused by the insect like *S. incertulas* that decreases rice production. Almost all insects, attacking the mature plants, depend upon the climatic conditions. The larva may be fully grown in about 20-40 days and may measure about 20 mm in terms of length and either white or yellowish-white in color. The life cycle of the stem borer reached up to two to three cycles for every single cropping.

Unlike the previously reported works which mainly focused on the leave extract of *L. camara*, this study aimed to produce organic pesticide from *L. camara*'s leaves, roots and berries extract against rice stem borer (*S. incertulas*). This study also identified the most potent concentration in field and laboratory conditions.

2. Methodology

2.1 Study Area

The laboratory test was conducted at Central Bicol State University of Agriculture – Sipocot Campus, Camarines Sur, Philippines located along Maharlika highway, 2 km away from the town proper. It is geographically located at a coordinate of 13° 47'8" N and 122° 58'45" E with an approximate total land area of 14.064 ha. The institution is a mountainous area with different kinds of vascular and nonvascular plants growing around the vicinity, namely ferns, cone, fruit-bearing and flowering plants, wild floras, and shrubs. The in vivo test was conducted at San Pedro, Cabusao, Camarines Sur – the nearest place where rice is cultivated and attacked by pests.

2.2 Experimental Design and Treatments

This was an analytical-experimental research. A single factor randomized complete block design (RCBD) with four treatments of concentration rate of the plant's extract. Three replicates were used in identifying the potency level of the extracted *L. camara* through testing and application of the different concentrations on rice stem borers.

2.3 Instrument

An established rubric (Miller, 2010) with the following rating scale was used in assessing the effectiveness of *L. camara* plant against rice insect pest: highly effective (81-100% mortality rate); moderately effective (61-80% mortality rate); effective (41-60% mortality rate); less effective (21-40% mortality rate); and not effective (0-20% mortality rate). Moreover, the available laboratory test result, showing the chemical properties of the *L. camara* plant extract, from the Department of Science and Technology (DOST) – Industrial Technology Development Institute (ITDI) Standards and Testing Division (2016) was used.

2.4 Plant Preparation and Extraction

The *L. camara* plants were collected from Ngaran Impig, Sipocot, Camarines Sur. Extraction was done to obtain the plant's necessary component (Moss, 2020) for the production of organic pesticide. A total of 2100 g of leaves, roots, and berries in a 1:1:1 ratio were boiled within 20 min in 2100 ml distilled water. The boiled material was then squeezed out through a clean cloth to separate the extract from the solid materials. Subsequently, the extract was placed in a beaker and prepared for the dilution process to make different concentrations.

2.5 Preparation of Chemical Insecticide Solutions

The extract from *L. camara* plant was diluted by adding water to make the following four dilutions/solutions (treatments): 100% - pure extract without adding water; 75% - 75 ml of pure extract diluted with 25 ml distilled water;

50% - 50 ml of pure extract diluted with 50 ml distilled water; and 25% - 25 ml of pure extract diluted with 75 ml distilled water.

2.6 Application of Different Concentrations

The experiment was conducted to determine the effectiveness of *L. camara* extract performed in an in vivo and in vitro conditions. The in vivo setup was accomplished in a rice field condition wherein each concentration per trial tested 12 stem borers (*S. incertulas*) which were observed within 15 min in their natural habitat – the leaf and stem of the rice. On the other hand, the in vitro laboratory trial setup was done inside a laboratory using a water bottle sprayer; applying very minimal pressure on it to ensure that the population of nine rice stem borers was treated in each concentration per trial. Thereafter, a prepared checklist with rubrics (scale of 1-5) was used to rate the effectiveness of *L. camara* plant in terms of the observed mortality rate.

2.7 Statistical Analysis

For accuracy of the result, statistical treatment was used in analyzing and interpreting the gathered data. Frequency percentage was utilized to identify the mortality rate of rice stem borer at 100, 75, 50 and 25% concentration of the plant. Analysis of variance (ANOVA) was used in distinguishing the significant difference in the mortality rate of rice stem borer among the different concentration levels of *L. camara*. Two-tailed *t*-Test was used in determining the significant difference in the mortality rate of rice insect pests between the extracted *L. camara* and the chemical insecticide (malathion).

3. Results and Discussion

3.1 Insecticidal Component of L. camara

The chemical constituents of the plant were described by having traces (+), moderate (++), abundant (+++) and absence (-) of chemical constituents. Table 1 presents the results of previous chemical analysis of the *L. camara* (DOST – ITDI Standards and Testing Division, 2016)

Table 1. Chemical constituents of the *L. camara*

Chemical Constituents	Leaves	Roots	Berries
Sterols	+	+	+
Triterpenes	++	-	++
Flavonoids	-	-	-
Alkaloids	++	+	+
Saponins	+++	++	+++
Glycosides	++	+	+
Tannins	++	+	+

Note: (+) Traces, (++) moderate, (+++) abundant, (-) absence of constituents

Upon submission of the sample to the DOST, it was found out that there was already a prior chemical test analysis on the same plant sample conducted in October 2016. The results revealed that there were traces (+) of sterols in the leaves, roots, and berries of the *L. camara* while triterpenes in moderate amount (++) was detected in the leaves and berries but absent (-) in the roots. However, flavonoids were absent (-) in all three parts of the plant whereas alkaloids, glycosides, and tannins were detected in a moderate amount (++) in the leaves and only traces (+) in the roots and berries. Out of all the chemical constituents, only saponins were detected in abundant quantity (+++) from the leaves and berries while only in moderate quantity (++) in the roots.

Based on the result of the phytochemical analysis, it can be seen that there were six types of chemical constituents that can be found in the leaves, berries, and roots of the *L. camara*. These chemicals are the components that helped in enhancing the effectiveness of the plant's extract as an organic pesticide. Saponins, triterpenes, alkaloids, glycosides, and tannins have greater amount found in the plant sample. Hence, these chemical constituents contributed more accountability to the medicinal and pesticidal properties of the plant.

Aside from the previously mentioned works in the preceding section, Kalita *et al*. (2013) cited that in the last few decades, scientists and researchers around the globe have elaborately studied the chemical composition of the whole part and the biological pharmacological activities of *L. camara*. Their studies established the therapeutic potential of the plant in modern medicines and as a possible candidate for drug discovery. For the pesticidal components, the triterpenes and saponins provide protection against pathogens and pests (Thimmappa *et al*., 2014). The presence of glycosides, tannins, and sterols (Hikal, 2017) explained that the plant contains botanical insecticides affecting only the target insects excluding the beneficial natural enemies. Alkaloids act as protective substances against the animal or insect attacks (Hill, 2003).

3.2 Field Trial

Table 2 discloses that the control variable – commercial pesticide – was highly effective against rice insect pests since mortality rate of the test insects in each trial reached the scale of highly effective (91.67 to 100%). Also, the second treatment (100% concentration of *L. camara*) was highly effective among other concentrations. The average mortality rate of test insects in the said concentration was 86.11%, which reached the highly effective scale.

Table 2. Mortality rate of rice stem borer in the in vivo experiment

Treatment	Trial	Larvae	Mortality	Mortality Rate (%)	Level of Effectiveness	Mortality Rate Average (%)
1 (Commercial Pesticide)	1	12	11	91.67	Highly Effective	97.22
	2	12	12	100	Highly Effective	
	3	12	12	100	Highly Effective	
2 (100% Concentration)	1	12	10	83.33	Highly Effective	86.11
	2	12	11	91.67	Highly Effective	
	3	12	10	83.33	Highly Effective	
3 (75% Concentration)	1	12	7	58.33	Effective	58.33
	2	12	8	66.67	Moderately Effective	
	3	12	6	50	Effective	
4 (50% Concentration)	1	12	4	33.33	Less Effective	3.33
	2	12	5	41.67	Effective	
5 (25% Concentration)	1	12	1	8.33	Not Effective	5.55
	2	12	0	0	Not Effective	
	3	12	1	8.33	Not Effective	

Given that the computed F-value (59.3) was found higher than the tabular F-value (4.07), the null hypothesis was rejected. Thus, the findings present that there was a significant difference in the mortality rate of stem borers among a different concentration of extracted *L. camara*.

3.3 Laboratory Trial

Similar to the result of the field trial experiment, the commercial pesticide was classified as highly effective against rice pest since the mortality rate of test insects in each trial lies in the highly effective scale. It is comparable with the result of the second treatment (100% concentration) in which trials one and two were classified as highly effective since both trials obtained 88.89% mortality rate (Table 3).

Table 3. Mortality rate of stem borer in laboratory condition

Treatment	Trial	Larvae	Mortality	Mortality Rate (%)	Level of Effectiveness	Mortality Rate Average (%)
1 (Commercial Pesticide)	1	9	9	100	Highly Effective	96.30
	2	9	8	88.89	Highly Effective	
	3	9	9	100	Highly Effective	
2 (100% concentration)	1	9	8	88.89	Highly Effective	85.19
	2	9	8	88.89	Highly Effective	
	3	9	7	77.78	Moderately Effective	
3 (75% concentration)	1	9	6	66.67	Moderately Effective	55.57
	2	9	4	44.44	Effective	
	3	9	5	55.56	Effective	
4 (50% concentration)	1	9	3	33.33	Less Effective	29.63
	2	9	3	33.33	Less Effective	
	3	9	2	22.22	Less Effective	
5 (25% concentration)	1	9	0	0	Not Effective	11.11
	2	9	1	11.11	Not Effective	
	3	9	0	0	Not Effective	

However, trial three was moderately effective with mortality rate of 77.78%. Despite this, the average mortality rate still confirmed that the second treatment was highly effective with 85.86% average mortality rate. On the other hand, the third treatment (75% concentration) was generally categorized as effective with an average mortality rate of 55.56% – trials one, two and three had 66.67, 44.44 and 55.56% mortality rates, respectively.

In addition, the fourth treatment (50% concentration) was considered as less effective because of low mortality rate obtained in each trial, which resulted in an average mortality rate of 29.63%. The fifth treatment (25% concentration) was classified as not effective which is similar to the field experiment where very low mortality was obtained in each trial with an average mortality rate of 11.11% for the laboratory trial (Table 3).

The computed F-value resulted in 59.3 with a tabular F-value of 4.07. The computed F-value was found to be higher than the tabular F-value, which means that there was significant difference among the concentrations used in the laboratory trial experiment.

3.4 Effectiveness of L. camara Extract and Chemical Pesticide

3.4.1 Field Trial

The effectiveness difference between commercial pesticide and 100% concentration of *L. camara* extract was compared with the field trial setup. The computed T-value resulted in 2.8259 that was found to be greater than the tabular T-value of 2.776 implying that there was a significant difference between the commercial pesticide and 100% concentration. This means that the *L. camara* extract was significantly less effective than the commercial pesticide.

3.4.2 Laboratory Trial

The result of the *t*-Test used for the laboratory trial setup of the commercial pesticide and 100% concentration of extracted *L. camara* showed that the 2.123 computed T-value was found to be higher than the 2.776 tabular T-value. Thus, the commercial pesticide and 100% concentration of extracted *L. camara* were not significantly different from each other. Hence, it implies that the performance of a pure extract of the *L. camara* plant as an organic pesticide against rice stem borer was comparable to the performance of commercial pesticides.

4. Conclusion and Recommendation

Saponins, triterpenes, alkaloids, glycosides, and tannins were the chemical components with greater amount found in the *L. camara* extract sample. Thus, these chemical constituents contributed to the insecticidal property of *L. camara* plant. This insecticidal property naturally serves as protection and toxic in the plant. Based on the result of the field and laboratory trials, the performance of the pure *L. camara* extract as an organic insecticide against the rice stem borer was comparable with the performance of the commercial pesticide (malathion). Thus, a 100% concentration can be an alternative pesticide against the said rice pest.

Further study on the chemical properties and uses of the chemical constituents of *L. camara* for insecticidal purposes is highly advised for possible production of an innovative product. Since it was revealed that lower concentrations of *L. camara* extract were not effective as evidenced by the low mortality rate of rice stem borer, the community is advised to use higher concentration or the pure extract to achieve desirable result. Also, future studies should asses *L. camara* extract against other insects for further comparison of findings and evaluation on its potency. Lastly, the intervening factors such as weather and length of application must also be considered to ensure the maximum effect of the solution.

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